



Proceedings of the 12th World Rabbit Congress

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List of all the authors

(alphabetical order, independently of the session)



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- INRAE, Department of Animal Physiology and Farming Systems
- INRAE, Department of Animal genetics
- Nantes Métropole
- ASFC Association Scientifique Française de Cuniculture, French branch of WRSA



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Aknowledgments

The organisation committee wants to make special thanks to the GenPhySE (INRAE) staff (Valérie GAVALAND, Manuela FERRE) for their valuable help in the preparation of this Congress, to Laurence BARDON for her helpful works in graphic design.

The organisation committee wants also to thank the staff of the Palais des Congrès of Nantes for his help in the material organisation of the Congress it-self

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- Biology & Physiology : **M Milan MAROUNEK** (Czech Republic)
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Ethology & Welfare : **Mrs Angela TROCINO** (Italy)
Farming & Economy : **M Luis Carlos MACHADO** (Brazil)
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PREFACE

Je suis très heureux et fier d'annoncer, enfin, la tenue de notre congrès mondial sur les sciences cunicoles. La branche Française de la WRSA succède avec plaisir à la branche Chinoise pour l'organisation de ce congrès, afin que les chercheurs du monde entier puissent se rassembler avec les professionnels de la filière cunicole au sens large, et ainsi contribuer à construire notre intelligence collective sur le lapin, de la biologie à son élevage, et contribuer à l'alimentation de l'Homme, et sans oublier l'impact de la cuniculture sur notre environnement.

Cette douzième édition de notre congrès, initié en France en 1976 à Dijon, nous a réservé quelques grosses surprises, du fait de la pandémie COVID. Prévus en juin 2020, la pandémie nous a contraint à un premier report d'un an, puis un second report pour nous retrouver, enfin, aujourd'hui.

Le travail du bureau de la WRSA a débuté ainsi en 2018, jusqu'à maintenant. Donc trois années de préparation, très intense dans ces derniers mois. De nouveaux outils de communications sont arrivés maintenant pour permettre la participation à distance de nombreux collègues de divers pays. C'est un nouveau challenge pour nous tous. Il nous faudra, à l'avenir, tenir compte de ce nouveau paradigme de la communication, pour réussir nos futurs rassemblements. Le mode "hybride" est certes plus compliqué à organiser et à gérer pour chacun, mais le mode "distanciel" est aussi une opportunité pour nos collègues de pays lointains, ou de pays en développement de participer encore plus, tout en réduisant notre impact environnemental.

Grâce à l'aide financière de plusieurs branches (Chine, Italie, France) la WRSA a pu offrir plusieurs bourses d'étude pour ce congrès à de jeunes chercheurs de pays en développement. Je souhaite que ce travail et ces efforts soient amplifiés à l'avenir. Le succès de ce congrès provient du travail de très nombreux bénévoles, mais aussi de l'aide financière de nombreux partenaires: je tiens à tous vous remercier chaleureusement.

Avec plus de 230 communications acceptées par les relecteurs, 8 conférences invitées, et 5 tables rondes, nous pouvons déjà dire que cette douzième édition est un franc succès. Tous ces documents seront bientôt aussi disponibles, en libre accès et avec l'accord des auteurs, sur le site internet de la WRSA. Les séances seront également enregistrées et disponibles sur YouTube. Enfin, la WRSA est engagée, depuis plusieurs années, dans une diffusion libre de nos recherches et de nos connaissances, à l'exemple de notre journal scientifique "World Rabbit Science", qui est "en accès libre et gratuit" depuis 2013.

Je suis confiant en l'avenir d'une recherche ouverte, ayant l'intelligence du respect de notre environnement, et travaillant pour améliorer notre écosystème global "Terre et êtres vivants".

Thierry GIDENNE
Président of the World Rabbit Science Association



FOREWORD - PREFACE

I am very happy and proud to announce, at last, the opening of our world congress on rabbit science. The French branch of the WRSA is pleased to succeed the Chinese branch in organizing this congress, so that researchers from all over the world can gather with professionals of the rabbit chain in the broadest sense, and thus contribute to build our collective intelligence on rabbits, from biology to breeding, and to contribute to human food, and without forgetting the impact of rabbit farming on our environment.

This twelfth edition of our congress, initiated in France in 1976 in Dijon, had some big surprises, due to the COVID pandemic. Scheduled for June 2020, the pandemic forced us to postpone for a year, then a second postponement to finally meet us today.

The work of the WRSA office started this way in 2018, until now. So three years of preparation, very intense in these last months. New communication tools have arrived now to allow remote participation of many colleagues from various countries. This is a new challenge for all of us. In the future, we will have to take into account this new paradigm of communication, to succeed in our future gatherings. The "hybrid" mode is certainly more complicated to organize and manage for everyone, but the "remote" mode is also an opportunity for our colleagues from distant or developing countries to participate even more, while reducing our environmental impact.

Thanks to the financial support of several branches (China, Italy, France) the WRSA was able to offer several scholarships for this congress to young researchers from developing countries. I hope that this work and these efforts will be amplified in the future.

The success of this congress is due to the work of many volunteers, but also to the financial support of many partners: I would like to thank you all warmly.

With more than 230 papers accepted by the reviewers, 8 invited lectures, and 5 round tables, we can already say that this twelfth edition is a great success. All these documents will soon be available, in free access and with the agreement of the authors, on the WRSA website. The sessions will also be recorded and available on YouTube. Finally, the WRSA is committed, for several years a free dissemination of our research and knowledge, following the example of our scientific journal "World Rabbit Science", which is "open access and free" since 2013.

I am confident in the future of an open research, having the intelligence to respect our environment, and working to improve our global ecosystem "Earth and living beings".

Thierry GIDENNE
President of the World Rabbit Science Association



WELCOME to the Congress

On behalf of the French Organizing Committee, it is our great pleasure to welcome you to the 12th World Rabbit Congress.

Six years ago, at the General Assembly of the ASFC, the French branch of the WRSA, the idea that we could organise the 12th WRC convinced the audience. Very quickly a committee was formed bringing together R&D managers from the private sector and active or retired academic scientists. It was with pride, a tricolour ribbon in the buttonhole, that the local organising committee presented France's application and was selected during the splendid 11th WRC in China.

As Newcomers in the field, we were aware that the adventure would be rich and long, but no one imagined the obstacles we would have to overcome. It is true that our motivation has had its ups and downs, but the organising committee has held firm. The health crisis that we are still going through, with its repeated pandemic peaks, has not affected our strength and determination. Determined to maximise face-to-face exchanges and to allow as many participants as possible from all over the world to present their work on rabbit biology and breeding, we had to innovate. The solution proposed by the committee was an edition of the WRC in hybrid version *i.e.* for one part of the attendees a classical face to face participation, and simultaneously for the others an online participation while remaining in their country. We have then invested ourselves in digital communication technologies both to allow everyone to exchange around oral communications and to read the posters.

Twenty-three meetings of the committee and 3 postponings of the congress's date later, the curtain's up! At the time of writing, we hope that everything will go according to plan, but we already know that this major event in rabbit research was awaited by both the scientific community and companies interested in rabbits for meat production, for their use as biomedical models or as pets. The number of papers presented and the number of attendees who will be present in face-to-face or remote sessions show that public and private research remains very active despite research budgetary restrictions. The advances and research on rabbits are also a source of inspiration for other species. Let's not forget that we have been pioneers in the field of reduction in antibiotics utilisation. New challenges such as animal welfare await us in the coming years to rethink our breeding models.

In conclusion, we are pleased with the outcome of all the energy and time we have devoted to the preparation of the 12thWRC. We would like to thank all of our 20 sponsors as well as the Metropole de Nantes and INRAE for their financial support in making the 12th WRC in Nantes a success.

Chantal DAVOUST & Sylvie COMBES
Co-presidents of the local committee of organisation

The organising committee gratefully thanks all the sponsors who support the congress organisation

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Congress Scientific Program at glance

Tuesday Nov 2nd	Wednesday Nov. 3rd	Thursday Nov. 4th	Friday Nov. 5th
	8:00-9:00 Registration / Welcome coffee	8:00-8:30 Registration	8:00-8:30 Registration
	9:00-9:30 Opening ceremony	8:30-9:00 Invited paper 4. Ethology	8:30-9:00 Invited paper 7. Genetic
	9:30-10:00 Invited paper 1. Pathology	9:00-9:30 Invited paper 5. Reproduction	9:00-9:30 Invited paper 8. Economy
	10:00-10:30 Invited paper 2. Nutrition	09:30-10:30 O7 - BG1 room A450 O8 - E1 room R200 O9 - R1 room GH80	09:30-10:30 O16 - F1 room A450 O17 - R2 room R200 O18 - BP4 room GH80
	Coffee break	Coffee break	Coffee break
	11:00-11:30 Invited paper 3. Physiology	11:00-11:30 Invited paper 6. Quality	11:00-12:30 O19 - N4 room A450 O20 - BG2 room R200 O21 - O1 room GH80
	11:30-12:30 O1 - N1 room A450 O2 - P1 room R200 O3 - BP1 room GH80	11:30-12:30 O10 - P3 room A450 O11 - E2 room R200 O12 - Q1 room GH80	
	Lunch	Lunch	Lunch
14:00-18:00	14:00-15:30 Guided POSTER Tour P1= Nutrition, P2= Pathology, P3= Biology	14:00-15:00 Guided POSTER Tour P4= Ethology, P5= Reproduction, P6+ P9 = Quality + Open session	14:00-14:30 Guided POSTER Tour P7= Genetic, P8= Farming & Economic
	15:30-16:30 O4 - N2 room A450 O5 - P2 room R200 O6 - BP2 room GH80	15:00-16:00 O13 - N3 room A450 O14 - BP3 room R200 O15 - Q2 room GH80	14:30-15:30 O22 - P4 room A450 O23 - BG3 room R200
Registration	Coffee break	Coffee break	Coffee break
	17:00-18:30 Round table 1 room R200 Round table 2 room A450 Round table 3 room GH80	16:30-18:00 Round table 4 room A450 Round table 5 room R200 WRSA room GH80	16:00-17:00 Awards and closing ceremony
	Welcome reception	18:00-23:00 Transport to Gala Dinner Chateau de la Poterie Gala dinner	

BP: Biology & Physiology = 4 oral sessions : BP1 - BP2 - BP3- BP4
BG: Breeding & Genetic = 3 oral sessions: BG1 - BG2 - BG3
E: Ethology & Welfare = 2 oral sessions: E1 - E2
F: Farming system & economy = 2 oral sessions: F1 -F2
N: Nutrition & Feeding = 4 oral sessions: N1 - N2 - N3 - N4
O: Open session = 1 oral session: O1
P: Pathology & Hygiene= 4 oral sessions: P1 - P2 - P3 - P4
Q: Quality & Products = 2 oral sessions : Q1 - Q2
R: Reproduction = 2 oral sessions : R1 - R2

Three rooms run in parallele for oral and 3 virtual "rooms" for on-line attendees

A450: Auditorium 450 seats
R200: 200 seats
GH: 80 seats

The 5 round tables

Nov. 3rd : 7h00 – 18h30

R200 - *Round table 1* : The rabbit farming in the post-antibiotic era: a challenge that can be won?

A450 - *Round table 2* : Rabbit housing - new farming systems with the regulations and social demand?

GH 80 - *Round table 3* : Rabbits for wealth creation in the developing world.

Nov. 4th : 16h30 -18h00

A450 : *Round table 4* : Condemnation of rabbit carcasses: causes and opportunities for farm level measures to reduce them.

R200 ; *Round table 5* : Coccidiosis management at farm level : in parallel to classical coccidiostats, which alternatives ?

List of communications presented during the different sessions

Click on the name of the first author to load the external **full text** .pdf
Click on the communication N° (ex BG-21)
to access directly to the corresponding **abstract** inside this E-Book

Session BIOLOGY & PHYSIOLOGY

Invited paper

[González-Mariscal G.](#) -Neuroendocrinology applied to rabbit breeding (Invited paper) [BP-00](#)

Short communications

[Afanassieff M.](#), Gavin-Plagne L., Perold F., Bouchereau W., Buff S., Joly T., Rival-Gervier S., Beaujean N. - Rabbit pluripotent stem cells: a promising and useful biotechnology tool. [BP-02](#)

[Aroun Rabiha](#), Tlili Thiziri, Benamara Liza, Khaldoun-Oularbi Hassina, Daoudi-Zerrouki Nacira - Histofunctional characteristics of the mammary gland in a synthetic rabbit strain. [BP-03](#)

[Cauquil L.](#), Beaumont M., Schmaltz-Panneau B., Liaubet L., Lippi Y., Gress L., Bluy L., Duranthon V., Combes S. - Coprophagy in rabbit upregulates immune system gene expression in ileum. [BP-05](#)

[Chen Saijuan](#), Liu Yajuan, Yuan Wanzhe, Li Jiangtao, Pang Lixin, Gu Zilin, Chen Baojiang.- Distribution of nutrient transporter related genes in different segments in small intestine of rabbits. [BP-06](#)

[Chen Yang](#), Zhao B.H., Li J.L., Hu S.S., Yang N.S., Bao Z.Y., Wu X. - LNCRNA2919 mediated hair follicle development and growth in Angora rabbits. [BP-07](#)

[Cholis Nur](#), Nursita Ita Wahyu - Use of rabbit feces and rural by-products with addition of *Azotobacter* microbial culture and its effect on media quality and *Lumbricus rubellus* productivity. [BP-08](#)

[Cotozzolo E.](#), Collodel G., Signorini C., Mattioli S., Cartoni Mancinelli A., Dal Bosco A., Castellini C. - Effect of dietary n-6/n-3 ratio on fatty acid distribution in different rabbit tissues. [BP-09](#)

[Ding H.S.](#), Cheng G.L., Leng J.J., Yang Y.X., Zhao X.W., Wang X.F., Qi Y.X., Huang D.W., Zao H.L. - Analysis of histological and micro-RNA profiles changes in rabbit skin development. [BP-10](#)

[El-Gindy Y.](#), Zahran S., Abd El-Rahman M., Ameen A. - Physiological responses of manno-oligosaccharide on lipid profile of heat stressed rabbits. [BP-11](#)

[Gardan-Salmon D.](#), Maupin M., Bebin K., Robert R. - Impact of different levels of feed restriction during fattening period on growth performances and mammary gland development in mid-term pregnant does. [BP-12](#)

[Knudsen C.](#), Gidenne T., Cauquil L., Pascal G., Briens C., Duperray J., Rebours G., Salain J.M., Travel A., Weissman D., Combes S. - Both quantitative and energetic intake levels affect caecal microbiota composition and activity in the growing rabbit. [BP-16](#)

- [Kuang Liangde](#), Min Lei, Li Congyan , Guo Zhiqiang, Ren Yongjun, Zhang Xiangyu, Zheng Jie, Zhang Cuixia, Yang Chao, Mei Xiuli, Tang Li, Ji Yang, Deng Xiaodong, Yang Rui, Xie Xiaohong - Whole transcriptome sequencing reveals non-coding RNAs related to embryo morphogenesis and development in rabbit. [BP-17](#)
- [Li Yanhong](#), Gan Mingchuan, Li Qinlin, Wu Xuemei, Wang Jie, Jia Xianbo, Chen Shi-Yi, Lai Song-Jia - Morphological characteristics of adipose cells in liver tissues of tianfu black rabbits. [BP-18](#)
- [Liu Gongyan](#), Sun Haitao, Gao Shuxia, Bai Liya, Jiang Wenxue, Li Fuchang - Effects of dietary vitamin B6 on skeletal muscle protein metabolism of growing rabbits. [BP-19](#)
- [Liu H.](#), Li F., Liu L. - The effect of glucocorticoids on the gene expression of nutrient transporter in different rabbit intestinal segments. [BP-20](#)
- [Mattioli S.](#), Cartoni Mancinelli A., Cotozzolo E., Mancini S. Castellini C., Dal Bosco A. - Comparison of an estimated index of fatty acid metabolism and liver $\Delta 6$ -desaturase activity in rabbit. [BP-29](#)
- [Moumen S.](#), Daoudi-Zerouki N., Bouchareb C., Adjroud H. - Serum biochemical profile of rabbit does of Algerian local population (Aurees region) at different physiological stage. [BP-22](#)
- [Mussard Eloïse](#), Combes Sylvie, Helies Virginie, Aymard Patrick, Beaumont Martin - Development of a rabbit caecum organoid model: an innovative *in vitro* tool to study absorptive and barrier functions of epithelial cells. [BP-23](#)
- [Paës C.](#), Gidenne T., Barilly C., Bébin K., Duperray J., Gohier C., Guené-Grand E., Rebours G., Aymard P., Beaumont M., Combes S. - Stimulation of early solid feed ingestion in the nest accelerates the maturation of the rabbits caecal microbiota. [BP-25](#)
- [Settar A.](#), Khaldoun Oularbi H., Tarzaali D., Mekhaldi F. - Ameliorative effect of vitamins A, E, D & C on ampligo a synthetic insecticide inducing toxicity on rabbit adrenal gland. [BP-27](#)
- [Silva S.R.](#), Guedes C.M., Almeida, M., Mourão L.M., Pinheiro V. - Prediction of rabbit body fat deposits from perirenal fat measurements obtained with real-time ultrasonography. [BP-28](#)
- [Song B.](#), Zhao J.P., Ren Z.J. - The differences of caecal communities in rabbits and hares. [BP-30](#)
- [Tlili Thiziri](#), Aroun Rabiha , Benamara Liza, Khaldoun-Oularbi Hassina, Daoudi Zerrouki Nacira - Study of the histofunctional characteristics of the ovarian structures of rabbits of the synthetic strain in the state of pregnancy. [BP-31](#)
- [Velasco-Galilea M.](#), Piles M., Viñas M., Rafel O., Ramayo-Caldas Y., González-Rodríguez O., Guivernau M., Sánchez J.P. - Prediction of growth and feed efficiency performances in growing rabbits from their gut microbiota. [BP-32](#)
- [Zhang Bin](#), Shen Lei, Liu Lei, Li Fuchang - Effects of different iodine contents in diets on growth and development of growing rex rabbits. [BP-04](#)
- [Zhang Xiangyu](#), Li Congyan, Kuang Liangde, Zhen Jie, Zhang Cuixia, Yang Chao, Ren Yongjun, Guo Zhiqiang, Yang Rui, Tang Li, Ji Yang, Lei Min, Mei Xiuli, Huang Dengpin, Xie Xiaohong - Solexa sequencing and bioinformatics analysis on micro-RNA from the rabbit muscle . [BP-34](#)
- [Zubiri-Gaitán A.](#), Martínez-Álvaro M., Ccalta R., Satué K., Blasco A., Hernández, P. - Correlated response to selection for intramuscular fat on the liver fat and its fatty acid profile. [BP-35](#)

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Session BREEDING & GENETICS

Invited paper

[García M.L.](#), Gunia M., Argente M.J. - Genetic factors of functional traits (Invited paper) . [BG-00](#)

Short communications

- [Agea I.](#), Muelas R., García ML., Hernández P., Santacreu M.A., Armero E., Blasco A., Argente M.J. - Correlated response in plasma fatty acids profile in rabbits selected for environmental sensitivity. [BG-02](#)
- [Casto-Rebollo C.](#), Argente M.J., Garcia M.L., Blasco A., Ibáñez-Escriche N. - Immunological genes selected for environmental variance could control the animal resilience. [BG-04](#)
- [Demars J.](#), Labrune Y., Iannuccelli N., Aymard P., Benitez F., Leroux S., Gilbert H., Riquet J. - Deciphering the molecular architecture of the coat colour variability in a European rabbit population. [BG-05](#)
- [Eiben Cs.](#), Mészáros M., Gulyás B., Végi B., Drobnyák Á., Barna J., Molnár T., Szalay I.T., Liptói K. - Conservation and performance of the native Hungarian Giant rabbit breed. [BG-06](#).
- [Garreau H.](#), Labrune Y., Chapuis H., Ruesche J., Riquet J., Demars J., Benitez F., Richard F., Drouilhet L., Zemb O., Gilbert H. - Genome wide association study of growth and feed efficiency traits in rabbits. [BP-07](#).
- [Girardie O.](#), Robert R., Maupin M., Hurtaud J., Joly T , Ruesche J., David I., Garreau H., Canario L. - Genetic trends in doe and kit behaviour and performances assessed with comparison of old and modern-type lines in a crossfostering design. [BG-08](#)
- [Gunia M.](#), Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Riou M., Robert R., Shrestha M., Garreau H. - Pasteurella multocida experimental infection 2): Genetic parameters. [BG-09](#)
- [Herbert C.](#) , Yviquel J. , Flatres-Grall L., Pong-Wong R. , Lenoir G. - Optimal contribution selection in C line Hycole: prospect for genetic gain. [BG-10](#).
- [Iannuccelli N.](#), Cabau C., Sarry J., Bouchez O., Billon Y., Riquet J., Allain D., Demars J. - Heterologous hybridization using the human exome - A molecular tool to target and identify major genes. [BG-11](#)
- [Kasza R.](#), Matics Zs., Gerencsér Zs., Szendrő Zs., Nagy I., Csóka Á., Donkó. T. - Connection between the computed tomography (CT) estimated total body fat content of rabbits at 10 weeks of age and before the first insemination. [BG-12](#)
- [Laghuaouta H.](#), Sosa-Madrid B.S., Zubiri-Gaitán A., Blasco A., Hernández P. - Genome-wide association study for fatty acid composition in rabbits. [BG-14](#)
- [Machado L. C.](#), Faria C. G. S., Zeferino C. P., Castilha L. D., Silveira J. M. M., Silva V. G. P., Pereira D. L. - Productive performance and mortality in growing rabbits from different genotypes. [BG-15](#)
- [Nagy I.](#), Farkas J., Atkári T., Kövér Gy. - Estimating lethal equivalent of the Pannon White rabbit population applying generalised linear mixed models. [BG 17](#).
- [Oseni, S.O.](#), Bashiru, H.A., Atumah C. - On-farm phenotypic characterization of heterogeneous rabbits for fertility and reproductive performance in south-western Nigeria. [BG-18](#).
- [Piles M.](#), Sánchez J. P., Pascual M., Rodríguez-Ramilo S. T. - Inbreeding depression on growth and prolificacy traits. [BG-20](#)

- [Piles M.](#), Tusell I., Velasco-Galilea M., Ballester M., Sánchez J.P. - A comparative study of support vector machine and GBLUP to predict average daily gain from single nucleotide polymorphisms. [BG-19](#).
- [Piles M.](#), Tusell L., Velasco-Galilea M., Helies V., Drouilhet L., Zemb O., Sánchez J.P., Garreau H. - Machine learning algorithms for the prediction of feed efficiency based on caecal microbiota. [BG-21](#)
- [Savietto D.](#), Debrusse A.M., Bonnemère J.M., Labatut D., Aymard P., Fortun-Lamothe L., Gunia M. - Characterization of the French rabbit breed Fauve-de-Bourgogne in an intensive system. [BG 22](#)
- [Utzeri V.J.](#), Ribani A., Fontanesi L. - Variability in the tyrosinase (TYR) gene (the albino locus) in domestic and wild rabbits. [BG-23](#)
- [Zhang Kai](#), Fu Xiangchao, Liu Ning, Wen Bin, Xu Changwen, Du Dan, Yu Zhiju, Jian Wensu, Wang Ping, Guo Xiaolin, Wang Lihuan, Liu Hanzhong - Rex rabbit illumina sequencing and bioinformatics analysis on miRNA in testes. [BG-24](#)
- [Zubiri-Gaitán A.](#), Martínez-Álvaro, M., Hernández P., Blasco A. - Correlated response to selection for intramuscular fat on the gut metagenomic profile. [BG-25](#)

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Session ETHOLOGY & WELFARE

Invited paper

[Rödel H.G.](#) - Aspects of social behavior and reproduction in the wild rabbit – implications for rabbit breeding ? (Invited paper). [E-00](#)

Short communications

- [de Greef K.H.](#), Rommers J.M. - The Dutch route to improve commercial rabbit welfare – rather collectively than by law enforcement. [E-01](#)
- [Dutra D.](#), Villegas-Cayllahua E., Ferrari F., Costa M., Rein A., Silva A., Moraes P., Borba H. - Cage floor enrichment contributes to physical and thermal comfort of fattening rabbits. [E-02](#)
- [Fetiveau M.](#), Savietto D., Warin L., Pujol S., Gidenne T., Huang Y., Fortun-Lamothe L. - Outdoor access for growing rabbits: effect of stocking rate on behaviour and performance. [E-03](#)
- [Fortun-Lamothe L.](#), Breda J., Savietto D., Aymard P., Combes S., Gidenne T., Warin L., Huang Y. - Space use and exploratory behaviour in growing rabbit housed in large partitioned pens. [E-04](#)
- [Gerencsér Zs.](#), Farkas T.P., Nagy I., Odermatt M., Radnai I., Kasza R., Matics Zs., Szendrő Zs. - Location preference of rabbit does in a pen system combining group and individual housing. [E-05](#)
- [Guené-Grand E.](#), Davoust C., Launay C. - A new alternative outdoor housing method (Wellap®) for fattening rabbits: first results. [E-06](#).
- [Guené-Grand E.](#), Davoust C., Launay C. - A new alternative outdoor housing method (Wellap®) for fattening rabbits: behavior and space use. [E-07](#).
- [Huang Y.](#), Breda J., Savietto D., Debrusse A., Combes S., Gidenne T., Warin L., Fortun-Lamothe L. - Part-time grouping of rabbit does in enriched housing: effects on spatial position, performance and lesions. [E-09](#)

- [Huang Y.](#), Breda J., Savietto D., Labatut D., Pujol S., Combes S., Gidenne T., Warin L., Fortun-Lamothe L. - Effect of housing and enrichment on behaviour and performance of growing and reproducing rabbits. [E-08](#)
- [Laclef E.](#), Savietto D., Warin L., Huang Y., Bonnemère J.M., Combes S., Gidenne T., Fortun-Lamothe L. - Part-time group housing of familiar rabbit does in large partitioned space: effects on performance and behaviour. [E-10](#)
- [Pasqualin D.](#), Zomeño C., Santagiuliana M., Dalla Costa A., Trocino A., Lavazza A., Dorigo F., Bonfanti L., Birolo M., Xiccato G., Menegon F., Di Martino G. - A protocol for measuring health and welfare of reproducing does and litters in rabbit farms. [E-11](#)
- [Ramón-Moragues A.](#), Martínez-Paredes E., Villagrà A. - Differences in milk production and lactation-related behaviours in breeding does housed in individual enriched cages and part-time systems. [E-12](#)
- [Rommers J.](#), de Greef K. - Are plastic mats effective for diminishing footpad lesions of rabbit does? – survey after 10 years in The Netherlands. [E-13](#).
- [Trocino A.](#), Zomeño C., Birolo M., Pirrone F., Xiccato G. - Effect of grouping time and group stability on behavior and aggression among rabbit does in a part-time housing system. [E-14](#).
- [Van Damme L.](#), Delezie E., Tuytens F. A. M., Maertens L. - Advances in part-time group housing systems for does: an overview of reproductive performances. [E-15](#)
- [Villegas-Cayllahua E.](#), Dutra D., Cavalcanti E., Fidelis H., Montanhim G., Silva A., Moraes P., Borba H. - Assessment of stress during handling of commercial rabbits. [E-16](#)
- [Warin L.](#), Mika A., Souchet C., Bouvarel I. - Feasibility and repeatability of the EBENE® welfare assessment measures for rabbits. [E-17](#)

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Session FARMING & ECONOMY

Invited paper

- [Wu L.P.](#), Lukefahr S.D. - Rabbit meat trade of major countries: regional patterns and influencing factors (Invited paper). [F-00](#)

Short communications

- [Arнау-Bonachera A.](#), Blas E., Cervera C., Ródenas L., Martínez-Paredes E., Pascual J.J. - Towards a sustainable rabbit production system combining genetic type and weaning strategy. [F-01](#)
- [Birolo M.](#), Trocino A., Zuffellato A., Xiccato G. - Performance, mortality and slaughter traits of group-housed rabbits submitted to different time-based feed restriction programs. [F-02](#)
- [Gerencsér Zs.](#), Kasza R., Radnai I., Matics Zs., Dalle Zotte A., Cullere M., Szendrő Zs. - Effects of hair shearing on production performance and carcass traits of growing rabbits in high ambient temperature. [F-03](#)
- [Gidenne T.](#) - Feed intake regulation strategies for the growing rabbit: a 2005-2015 retrospective on economic and environmental impact in France. [F-04](#)
- [Goby J.P.](#), Chevallier L., Gidenne T. - Organic rabbit pasturing: effect of grazing density on grass intake and growth of the rabbit. [F-05](#)
- [Huang Y.](#), Gigou M., Goby J.P., Roinsard A., Savietto D., Gidenne T. - Digital breeding and assisted management in organic rabbit farming: the first results. [F-06](#)

- [Li D. Y.](#), Wu L.P. - Analysis of the competitiveness of Chinese rabbit industry. [F-08](#)
- [Nate J.A.](#), Natividad E.D.C., Lavarias J.A., Gavino R.B., Castillo C.C. - Optimization of biofeed plan and space requirement for rabbit (*Oryctolagus cuniculus* L.). [F-10](#)
- [Pascual M.](#), Martin E., Fabre C., Garreau H., Gilbert H., Piles M., Sanchez M., Sánchez J.P. - Is feed restriction an alternative to the use of antibiotics in non controlled environment farms?. [F-13](#)
- [Paul A.](#), Johnson J., Lallo C. - The effects of stocking rate on growth performance and welfare of the fattening rabbits when produced under humid tropical condition in Trinidad. [F-14](#)
- [Rebours G.](#), Raffin J., Vastel P., Reys S. - Descriptive study of speed of fattening rabbit's daily feed intake in constant and progressive hourly feeding with two nutritional levels of feed. [F-15](#).
- [Rebours G.](#), Raffin J., Vastel P., Reys S. - Effect of a progressive hourly feeding and nutritional level of feed on performance and feed cost of fattening rabbits. [F-16](#)
- [Saiz del Barrio A.](#), Perea-Goya L., Martín-Chaves E., Alfonso-Carrillo C., Marco M. , Fernández B., Terreros E., García-Ruiz A.I. - Evolution of growth performance and weight uniformity of growing rabbits under feed restriction. [F-17](#)
- [Schwarz J.](#), Schädler J., Albin S., Peter-Egli J., Schüpbach G., Wiederkehr D. - Promoting rabbit health and welfare by collection and establishment of reliable health and performance data in the two major Swiss meat rabbit integrations. [F-18](#)
- [Silva K.G.](#), Sotomaior C.S. - Housing conditions of growing rabbits in Brazil. [F-20](#)
- [Silva S.R.](#), Guedes C.M., Almeida, M., Pinheiro V. - Use of infrared thermography images to predict live weight of growing rabbits. [F-21](#)
- [Zhang M. Y.](#), Wu L. P. - Consumer demand for rabbit meat in urban China:2011-2018. [F-22](#).
- [Zhang Shunli](#), Zhu J.F. - Cost and benefit analysis of meat rabbit breeding based on 2018 national survey data of 13 provinces [of China]. [F-19](#).

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Session NUTRITION & FEEDING

Invited paper

- [Martínez-Paredes E.](#), Nicodemus N., Pascual J.J., García J. - Challenges in rabbit does feeding, including the young doe (Invited paper). [N-00](#)

Short communications

- [Alves R.](#), Ribeiro D.M., Martins C., Pinho M., Freire J.P.B., Falcão-e-Cunha L. - Alternative feeds for the growing rabbit: carrot roots. Effect on performance and digestion. [N-03](#)
- [Atkári T.](#), Jós D., Gerencsér Zs., Nagy I. - Using a mixture of red clover and bird's-foot trefoil in diets for growing rabbits. [N-04](#)
- [Boudour Khedidja](#), Daoudi-Zerrouki Nacira, Lankri Elhassen, Aichouni Ahmed - Effect of incorporation of *Malva sylvestris* powder in rabbit diets on zootechnical and blood parameters. [N-06](#)
- [Chen J.](#), Wang J., Li F. - Effects of dietary iron levels on growth performance and iron metabolism-related genes expression in growing Rex rabbits. [N-07](#)

- [Colin M.](#), Prigent A.Y., Van Lissum M. - Effects of a fermented product of *Saccharomyces cerevisiae* on growth, health and mortality of rabbits at two different slaughtering ages. [N-08](#)
- [Craveiro J.M.S.](#), Madeira A.S., Nicolau J.T.S., Souza J.H.A., Ribeiro L.B., Castilha L.D. - Performance and blood parameters of rabbits fed diets containing decreasing levels of alfalfa hay. [N-23](#)
- [De Oliveira F.](#), Rani Z. T, Stuart J., Gous R. M. - Effect of non-conventional and pelleted feed on Californian rabbit growth performance in South Africa. [N-10](#)
- [Dorbane Z.](#), Kadi S.A., Boudouma D., Bannelier C., Berchiche M., Gidenne T. - Nutritive value of holm oak (*Quercus ilex*) acorn for growing rabbits. N-11
- [Farias-Kovac C.](#), Simbaña F., Reyes M., Ávila A.B., Carabaño R., Nicodemus N., García J. - Effect of cellobiose supplementation in drinking water and feed restriction on apparent faecal digestibility and growth performance in rabbits. [N-12](#).
- [Farias-Kovac C.](#), Simbaña F., Reyes M., Avila A.B., Nicodemus N., Carabaño R., García J. - Effect of cellobiose supplementation in drinking water and feed restriction on energy and nitrogen retention efficiency in growing rabbits. [N-13](#)
- [Farias-Kovac C.](#), Simbaña F., Reyes M., Carabaño R., Nicodemus N., García J. - Effect of xylooligosaccharides supplementation in drinking water and feed restriction on faecal digestibility, growth traits and energy and nitrogen retention efficiency in growing rabbits. [N-14](#)
- [Gayrard C.](#), Bretaudeau A., Gombault P., Hoste H., Gidenne T. - Effects of dehydrated sainfoin in rabbit diet on the performance of does and growing rabbits. [N-15](#)
- [Gohier C.](#), Menini F.X., Bourdillon A. - Effect of a feed supplemented with Cunidigest® on fattening rabbit performances. [N-16](#)
- [Gonçalves C.](#), Della Badia A., Martínez-Paredes E., Ródenas L., Blas E., Pascual J.J. - Fitting digestible protein to digestible energy ratio in growing rabbits selected by growth rate. [N-17](#)
- [Guené-Grand E.](#), Davoust C., Poisson A., Launay C. - Impact of the access time to the feeder before weaning on the growth performance of rabbits raised in litters of 11 kits by multiparous rabbit does. [N-18](#)
- [Guermah H.](#), Maertens L - Nutritive value of dehydrated chicory pulp for fattening rabbits. [N-19](#)
- [Harouz-Cherifi Z.](#), Kadi S.A., Mouhous A., Bannelier C., Berchiche M., Gidenne T. - Effect of increasing level of brewer's grain in diet of rabbits on growth and carcass traits. [N-20](#).
- [Hernández M.](#), Nouel-Borges G., Sánchez-Blanco R. - Inclusion of *Prosopis juliflora* pods preserved in sugar cane molasses and *leucaena* leaves in rabbits diets. [N-21](#)
- [Kouadio Kouakou Serge](#), Yapi Yapo Magloire, Kimse Moussa, Alla Konan Jean Bédél, Sangare Sidiki, Gidenne Thierry, Wandan Eboua Narcisse - Effects of sun-dried stylo hay (*Stylosanthes guianensis* cv ciat 184) on rabbits growth and slaughter performances. [N-22](#).
- [Lebas F.](#) - Bentonite in rabbit feeding – a short review. [N-24](#)
- [Liu Tingting](#), Cao Ningkun, Xia Xueru, Cui Jia, Chang Xingfa, Wei Yuchao, Sun Lei, Li Nan, Chen Baojiang - Effects of different starch sources on endogenous nitrogen and energy losses in meat and wool rabbits. [N-26](#)
- [Malabous A.](#), Robert D., Barotin.L., Prigent A.Y. Van Lissum M., Colin M. - Influence of metabolites derived from the fermentation of 2 strains of *lactobacilli* distributed only in maternity on the reproductive and the total performances of rabbits (maternity, growing fattening, slaughtering). [N-27](#)

- [Matics Zs.](#), Szendrő Zs., Kasza R., Radnai I., Ács V., Dalle Zotte A., Cullere M., Singh Y., Gerencsér Zs. - Effect of silkworm (*Bombyx mori*) oil dietary inclusion on live performance and carcass traits of growing rabbits. [N-29](#)
- [Menini F.X.](#), Gohier C., Bourdillon A., Leroy G.- Effect of the monopropylene glycol addition in drinking water at different periods during maternity period on the performance of rabbit does and kits. [N-30](#)
- [Nursita I.W.](#), Cholis N. - The effect of complete feed substitution with kelor (*Moringa oleifera*) dried leaves on the physiological and production performance of male weaned crossed New Zealand White rabbits. [N-31](#)
- [Oliveira T.C.](#), Nicolau J.T.S., Souza J.H.A., Leite S.M., Ribeiro L.B., Castilha L.D.1. - Effect of physical form of diet and feeder type on performance of growing rabbits. [N-33](#)
- [Paës C.](#), Gidenne T., Bannelier C., Bébin K., Duperray J., Gohier C., Guené-Grand E., Rebours G., Aymard P., Combes S. - Suckling rabbit digestibility: effect of the age at introduction of a starter feed. [N-34](#)
- [Parra-Almao J.](#), Nouel-Borges G., Sánchez-Blanco R. - Effects of sugar cane molasses, rice bran and *Leucaena leucocephala* leaves on digestibility and performance of growing rabbits. [N-35](#)
- [Prado Y.M.](#), Martínez-Paredes E., López-Luján M.C, Ródenas L., Blas E. - Digestibility in lactating rabbit does and growing rabbit: a comparative study. [N-36](#)
- [Raffin J.](#), Rebours G., Vastel P., Reys S. - Effect of the dietary ratio between digestible and indigestible fibres on the digestive health and performances of fattening rabbits. [N-37](#)
- [Ribeiro D.M.](#), Martins C., Pinho M., Freire J.P., Falcão-e-Cunha L. - Effect of using carob pulp in growing rabbit diets on performance, digestibility, intestinal morphology and caecal parameters. [N-09](#)
- [Sangare S.](#), Kimse M., Bléyé M. N., Yapi J. N. - Effect of spirulina (*Spirulina platensis*) on growth performance and rabbit health (*Oryctolagus cuniculus*). [N-39](#)
- [Santinoni J.T.](#), Miranda V.M.M.C., Angelo S.S., Souza J.H.A., Ribeiro L.B., Castilha L.D. - Performance and organ weights of growing rabbits fed diets with extruded broken bean at various levels. [N-40](#)
- [Singh Y.](#), Cullere M., Gerencsér Zs., Matics Zs., Cappellozza S., Dalle Zotte A. - Effect of dietary replacement of sunflower oil with silkworm (*Bombyx mori* L.) oil on the total tract apparent digestibility and nutritive value in growing rabbits. [N-41](#)
- [Xiccato G.](#), Birolo M., Pascual Guzman Á., Bordignon F., Trocino A. - Effect of dietary supplementation with chestnut and grape pomace extracts on growth performance, nutrient digestibility and meat quality of rabbits. [N-42](#)

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Short communications

- [Adeoye, A.A.](#), Udoh J.E. - Morphometric traits in American Standard Chinchilla rabbits. [O-01](#)
- [Amroun Thilali](#), Daoudi-Zerrouki Nacira, Martin Patrice, Miranda Guy, Charlier Madia. - Impact of milk composition on neonatal mortality in two strains of rabbits, the white population and the synthetic strain in Algeria. [O-02](#)
- [Boucher S.](#), Nicolier A, Tatone F., Sauvaget S. - Regarding a case of blue coloration on meat rabbit carcasses. [O-03](#)

- [Boucher S.](#), Carneiro M., Vieillard J. - The Alfort jumper rabbit: review of the scientific works conducted from 1935 to 2019. [O-04](#)
- [González-Redondo P.](#), Finzi A. - Efficiency of the rabbit underground cell keeping system in maintaining good thermal regime under cold weather conditions. [O-05](#)
- [Lukefahr S.D.](#), Oseni S.O. - Vertical rabbit farming integrative systems for cities: models and opportunities – A bibliographic review. [O-06](#)
- [Oseni S. O.](#), Lukefahr S. D. - Rabbit data for development (RD4D): concept, processes, outcomes. [O-07](#)
- [Oyedele O.J.](#), Odeyinka S.M., Oyebanji B.O. - The haematological and biochemical parameters of rabbits fed with *Moringa oleifera* Lam. based diets. [O-08](#)
- [Quagliariello G.](#), Lafalla L. - Importance of the contribution of rabbit meat in the diet of families in vulnerable conditions, in departments of northeastern Mendoza, Argentina. [O-09](#)
- [Rotimi E. A.](#) - Evaluation of body weight and morphometric traits of New Zealand rabbits breed raised under semi-arid condition in Nigeria. [O-10](#)
- [Sánchez J.P.](#), Perucho O., Pascual M., Rafel O., Piles M. - Electronic feeder to record individual feed intake on rabbits raised in collective cages. [O-11](#)
- [Sangare S.](#), Kimse M., Bléyé M. N., Yapi J. N. - Typology of rabbit farmers in the district of Abidjan and the regions of south Comoé and Mé. [O-12](#).
- [Szendrő K.](#), Szabó-Szentgróti E., Szigeti O. - Consumers' motivation for (not) choosing rabbit meat - A global view -. [O-13](#)
- [Youssef Y. M. K.](#), Emam A.M, Abou Khadiga G. - Rabbit breeding situation in Egypt- a case study. [O-14](#)

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Session PATHOLOGY & HYGIENE

Invited paper

- [Capucci Lorenzo](#), Cavadini Patrizia, Lavazza Antonio - Viral haemorrhagic disease: RHDV type 2, ten years later (Invited paper). [P-00](#)

Short communications

- [Arts H.T.](#), Arts B. - *Lawsonia* bacteria, an unknown pathogen, newly discovered as pathogen in rabbit farms. [P-02](#).
- [Arts H.T.](#), Arts B., Rommers J. - Rabbit haemorrhagic disease virus type 2 (RHDV-2) in The Netherlands and Germany: clinical and epidemiological findings. [P-03](#)
- [Atkinson A.](#), Espinosa-Ayala E., Hernández P.A., Le Roux J.F, Mendoza G.D., Pulido-Huertas S., Velázquez-Cruz A.L., Prigent A.Y., Colin M. - Effect of a polyherbal mixture of *Saccharum officinarum* and of *Acacia concinna* on the oocystal excretion, zootechnical performance and meat quality of growing rabbits. [P-04](#)
- [Baratelli M.](#), Molist-Badiola J., Puigredon-Fontanet A., Pascual M., Boix O., Mora-Igual F.X., Woodward M., Lavazza A., Capucci L. - Characterization of the maternal derived antibody immunity against RHDV-2 after administration in breeding does of an inactivated vaccine. [P-05](#)
- [Belloumi D.](#), Argente M.J., García M.L., Blasco A., Santacreu M.A. - Study of biomarkers of disease sensitivity in a robust and a standard maternal line. [P-07](#)

- [Ben Chehida Faten](#), Ben Salem Ameni, Daboussi Imen, Sghaier Soufien, Kalthoum Sana, Attia-El Hili Hédia - Characterization of rabbit farms in Tunisia and retrospective epidemiological studies on RHDV-2. [P-08](#)
- [Bokreta S.](#), Khaldoun H., Makhlof C., Daoudi-Zerrouki N. - The possible alleviating effect of *Thymus vulgaris* essential oil against Voliam Targo® induced cardiotoxicity in rabbits of a local population (*Oryctolagus cuniculus*). [P-09](#)
- [Cavadini P.](#), Campisi G., Vismara A., Lavazza A., Capucci L. - Study of genetic evolution of RHDV-2 in Italy from 2011 to 2019. [P-11](#)
- [Circella E.](#), Camarda A., Schiavone A., Romito D., Schiavitto M., Casalino G., Belloli C. - Minimal inhibitory and mutant prevention concentrations of enrofloxacin for *Pasteurella multocida* from rabbits affected by pasteurellosis. [P-13](#)
- [Cornaggia M.](#), Palazzolo L., Di Castri A., Vascellari M., Tonon E., Viel L., Bano L. - Histological and immunohistochemical features of dysautonomia in commercial rabbits affected by intestinal disorders. [P-14](#)
- [Dakouri S.A.](#), Kimsé M., Koné M.W., Touré A., Komoin O.C. - Seasonal evolution of coccidial infection in domestic rabbits in Abidjan district, Cote d'Ivoire. [P15](#)
- [Dakouri S.A.](#), Kimsé M., Koné M.W., Komoin O.C., Touré Alassane - Effects of *Ficus exasperata*, *Azadirachta indica* and *Mangifera indica* leaves on oocystal coccidia excretion and on rabbit growth. [P-16](#)
- [Dakouri S.A.](#), Kimsé M., Koné M.W., Touré Alassane, Yapi Y.M., Komoin O.C. - Rabbits gastro-intestinal and external parasites in Ivorian improved system. [P-17](#)
- [Di Castri A.](#), Cornaggia M., Palazzolo L., Rizzardi A., Bottin S., Viel L., Foiani G., Vascellari M., Bano L. - Occurrence of tympanic bullae empyema in commercial rabbits. [P-18](#)
- [Garreau H.](#), Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Robert R., Gunia M. - *Pasteurella multocida* experimental infection 3): relationship between resistance to diseases and production traits in rabbits raised in commercial farms. [P-19](#)
- [Guichard P.](#), Bordas A., Moreac T., Chevance A., Blot J., Travel A., Hemonic A., Le Normand B., Liber M., Leorat J., Verdon J., Hurtaud-Pessel D., Orand J.P., Amar H., Maris P., Baduel L., Mompelat S. - Impact of disinfectant water treatment for pigs, poultry and rabbits on the stability of antibiotics. [P-20](#)
- [Gunia M.](#), Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Riou M., Robert R., Garreau H. - *Pasteurella multocida* experimental infection 1): resistance and hematological response. [P-21](#)
- [Hu Bo](#), Fan Zhiyu, Wei Houjun, Chen Mengmeng, Qiu Rulong, Song Yanhua, Zhu Weifeng, Xu Weizhong, Xue Jiabin, Wang Fang - Emergence of rabbit hemorrhagic disease virus RHDV-2 in China. [P-22](#)
- [Huneau-Salaün A.](#), Guillou-Cloarec C., Thomas R., Le Maître E., Lopez S., Nouvel L., Le Gall-Reculé G., Le Bouquin S. - Evaluation of cleaning and disinfection procedures in rabbit farms affected by rabbit haemorrhagic disease, in France. [P-23](#)
- [Legendre H.](#), Goby J.P., Le Stum J., Hoste H., Cabaret J., Gidenne T. - Organic rabbit farming: should we be afraid of gastro-intestinal parasites?. [P-24](#)
- [Liu Y.](#), Wei Q., Xiao C.W., Ji Q.A., Huang Y.E., Bao G L. - Immune efficacy of inactivated *Bordetella bronchiseptica* vaccine in rabbits. [P-25](#)
- [Makhlof C.](#), Khaldoun-Oularbi H., Zerrouk N.H., Bokreta S., Oularbi Y., Tlili T., Aroun R., Daoudi-Zerrouki N. - Beneficial effects of ascorbic acid against nephrotoxicity induced by ivermectin repeated highdose therapy in rabbits (*Oryctolagus cuniculus*). [P-26](#)

- [Montbrau C.](#), Gascon S., Ruiz M.C. - Efficacy of ERAVAC® against a heterologous challenge with a virulent RHDV-2 strain in the presence and/or absence of maternal derived antibodies. [P-27](#)
- [Moreno-Grúa Elena](#), Pérez-Fuentes Sara, Muñoz-Silvestre Asunción, Viana David, Selva Laura, Pascual Juan J., Arnau-Bonachera Alberto, Corpa Juan M. - Effect of selection for growth rate on macroscopic lesions after intradermal skin infections with *Staphylococcus aureus*. [P-28](#)
- [Patinha S.](#), Pinheiro V., Soares A.S., Dias S., Fraga M.F., Matos M., Venâncio C.A., Coelho A.C. - Occurrence of dermatophytes in captive wild rabbits without clinical signs. [P-29](#).
- [Pellicciotti S.](#), Accurso D., Lavazza A., Mula P., Bravaccini P., Dorigo F. - Evaluation of the persistence of antibiotics residues in drinking water distribution system after static and dynamic washing. [P-30](#).
- [Rosell J.M.](#), de la Fuente L.F. Badiola, J.I., Fernández de Luco, D., Casal, J. - Rhinitis in does: prevalence and seasonal effect. [P-32](#)
- [Sánchez-Matamoros A.](#), Woodward M., Navas E., Boix O., Valls L.- Effect of vaccination on protection against RHDV-2 and viral load. [P-34](#)
- [Vastel P.](#), Rebours G., Le Normand B., Chatellier S., Capucci L. - Concentration of antibodies and immunoglobulins in does and their offspring vaccinated against RHDV-2. [P-36](#)
- [Vereecken Monita](#), Willems Jan, de Vries Selinde, De Gussem Koen - Field study on the control of coccidiosis in rabbits housed in park systems. [P-37](#)
- [Wei Qiang](#), Xiao Chen-Wen, Huang Ye-e, Li Ke, Ji Quan-An, Liu Yan, Bao Guo-Lian - Establishment of infection model of pathogenic *Escherichia coli* in rabbits by oral administration. [P-38](#)
- [Wei Qiang](#), Qian Wei, Xiao Chenwen, Liu Yan, Ji Quan'an, Huang Ye'e, Li Ke, Bao Guolian - Establishment of pathogenesis model of *Bordetella bronchiseptica* in rabbits. [P-39](#)
- [Wołacewicz M.](#), Hryniewicz R., Niedźwiedzka-Rystwej P. - Preliminary studies on defensins expression in liver of rabbits experimentally infected with *Lagovirus europaeus* [RHDV] GI.1 and GI.1a. [P-40](#)

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[Leroy F.](#), Petracci M. - Rabbit meat: a valuable source of nutrition or too-cute-to-eat? (Invited paper). [Q-00](#)

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[Almeida M.](#), Silva S., Garcia-Santos S., Guedes C.M., Ferreira L.M., Dominguez R., Trindade H., Lorenzo J.M., Pinheiro V. - Effect of total replacement of soybean meal by lupine seeds (*L. albus* and *L. luteus*) on carcass characteristics and meat fatty acids composition of growing rabbits. [Q-04](#)

[Bouzaida M.D.E.](#), Resconi V.C., Romero J.V., Gimeno D., Olleta J.L., Miranda-de la Lama G.C., Asenjo B., María G.A. - Can the inclusion of pomegranate pomace in rabbits diets improve the fatty acid profile of their meat?. [Q-06](#).

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Invited paper

González-Mariscal, G., 2021. Neuroendocrinology applied to rabbit breeding (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-00, 7 pp.*

Successful rabbit production relies heavily on the use of adequate practices that enhance specific aspects of reproduction, such as mating, ovulation, and lactation. Regardless of the type of production unit or strain of rabbits used those processes rely on a complex chain of neuroendocrine steps that include particular hormones, peripheral stimuli, and activation of discrete brain regions. Such is the case, for instance, of reflex ovulation which occurs in response to copulation but is inhibited throughout lactation. Little is known about the mechanisms mediating lactational anestrus and the restoration of estrus following the cancellation of a single suckling episode (biostimulation). The latter procedure (adopted worldwide to accelerate reproduction) has, however, unwanted consequences for the doe and her litter. After successive episodes of biostimulation the former show a loss of fertility and body mass. In the kits alterations are observed in their neuroendocrine response to mildly aversive stimulation in adulthood as well as reductions in sexual behavior. In addition to milk intake a good nest is essential for the normal growth and development of the litter. If this is not available, or if it deteriorates, rabbit caretakers can easily (re) build one from hair sheared off other rabbits or using synthetic material. Lactating does will nurse equally well their own or 'alien' young, placed inside her nest. It is crucial to have a minimum of six suckling kits in the nest as the doe relies on such stimulation to maintain a normal nursing behavior, i.e., only once-a-day throughout lactation. Recent work is revealing the similarities and differences in the responsiveness to mating among estrous, lactating, and biostimulated does. The relevance of these findings for the likelihood of reflex ovulation and the additional contribution of factors contained in the semen warrant deeper investigations. New insights on these issues, essential to reproductive neuroendocrinology, can emerge by fostering a richer interaction between academic laboratories and rabbit production settings worldwide.

Short communications

Afanassieff M., Gavin-Plagne L., Perold F., Bouchereau W., Buff S., Joly T., Rival-Gervier S., Beaujean N., 2021. Rabbit pluripotent stem cells: a promising and useful biotechnology tool. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-02, 4 pp.*

Embryo-derived (ESCs) and induced pluripotent stem cells (iPSCs) are both useful biotechnology tools in mice and promising therapeutic agents in humans. In rodents, they made it possible to develop animal models thanks to their ability to produce somatic and germline chimaera. In Humans, they are already involved in clinical trials for several degenerative diseases. Rabbit pluripotent stem cells (rbPSCs) differ from their rodent counterparts but are close to their primate counterparts. In the first part of this article, we describe the state of art of these rabbit cells as well as their future use in biotechnologies for the creation of organoids, bioreactors or animal models of human diseases and for the conservation of biodiversity. In the second part we present the cryopreservation protocol we have developed in order to freeze rbPSCs without any animal products for health safety reasons.

Aroun Rabiha, Tlili Thiziri, Benamara Liza, Khaldoun-Oularbi Hassina, Daoudi-Zerrouki Nacira, 2021. Histofunctional characteristics of the mammary gland in a synthetic rabbit strain. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-03, 4 pp.*

The objective of our experiment is to provide on the one hand interpretation elements on the milk production rates recorded during the lactation period in nulliparous rabbits, 4 months old, belonging to the synthetic strain "SS" and on the other hand, to determine the functional modifications of the mammary gland in rabbits at the end of pregnancy. To do this, an evaluation of milk production during the three weeks of lactation and a histomorphometric study to evaluate the structural modifications of the mammary gland at the end of gestation were carried out. Rabbits were weighed and sacrificed by decapitation. The work took place at the private rabbit breeding station in Tizirt (Algeria). The mammary glands were collected and treated for histological study with a standard topographical haematoxylin-eosin stain. A morphometric study was carried out, targeting the measurement of the different structures of the sampled organ. The results obtained show that in the pregnant rabbit an important development of the mammary gland is observed, in this case the diameter ($107.47 \pm 5.48 \mu\text{m}$) and the surface of the acini ($10419.06 \pm 999 \mu\text{m}^2$) as well as a milk production of $3506 \pm 444 \text{ g}$ during the 21 days of lactation. These results show variations in the mammary structure that prepares for lactation during gestation to ensure growth and survival of the offspring.

Cauquil L., Beaumont M., Schmaltz-Panneau B., Liaubet L., Lippi Y., Gress L., Bluy L., Duranthon V., Combes S., 2021. Coprophagy in rabbit upregulates immune system gene expression in ileum. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-05, 4 pp.*

Amplification of coprophagous behavior in young rabbits strongly reduces mortality and stimulates the maturation of the microbiota. We hypothesized that this positive effect of coprophagy is immunemediated at the intestinal level. We thus compared the ileum transcriptome of rabbits for which coprophagic behavior was enhanced to those where this behavior was prevented. Young rabbits were allocated to three groups: in NF (No access to Feces) group ingestion of mother's hard feces was prevented, while in two further groups FF (access to Feces from Foreign does without antibiotic treatment) and FFab (access to Feces from Foreign does supplemented with antibiotics, in drinking water with tetracycline [50 mg/kg BW] and tiamulin [10 mg/kg BW]), kits had access in the nest to feces excreted by foreign females receiving either no antibiotic or tiamulin and tetracycline. Ileum mucosa was sampled in 35 and 49 days old rabbits (n=9-10 rabbits per group per age) and transcriptome analysis was carried on using an Agilent G3 Rabbit 60K microarray. As expected, a total of 209 genes were differentially expressed (DE) according to age (P<0.05) but none according to treatment. However a significant interaction between age and treatment was observed (P<0.05). Between 35 and 49 days of age, FF group exhibited 350 DE genes while the NF and FFab groups showed only 10 and 9 DE genes respectively (P<0.05). Upregulated genes coded for antimicrobial peptides, mucine production, cytokines and chemokines, pattern recognition receptors and proteins involved in immunoglobulin A secretion or antiviral responses. To gain mechanistic insight into the FF group DE annotated genes list, pathway enrichment analysis was carried out. Gene ontology analysis revealed that the 231 annotated upregulated DE genes (Ensembl gene annotation for rabbit) in FF according to age were significantly implicated in 28 biological process all related to immune system. All together, these results suggested that the beneficial effect of coprophagous behavior on rabbit survival might be mediated through an immune activation in the ileum. Interestingly, the effect of coprophagy on intestinal immune gene expression was not observed when kits ingested feces from antibiotics medicated does, probably because key immune-stimulating bacteria were missing.

Chen Saijuan, Liu Yajuan, Yuan Wanzhe, Li Jiangtao, Pang Lixin, Gu Zilin, Chen Baojiang, 2021. Distribution of nutrient transporter related genes in different segments in small intestine of rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-06, 4 pp.*

The objective of this study was to investigate the distribution of nutrient transporter related genes in different segments in small intestine of rabbit. Ten healthy rabbits of at 110 day, with similar weight were chosen to slaughter. intestinal segments samples were collected from duodenum, jejunum, ileum for detection intestinal tissue distribution of oligopeptide transporter PepT1, amino acid transporter CAT1, B0AT, EAAT3, rBAT, glucose transporter SGLT1, GLUT2, GLUT5 and fatty acid transporter FATP4 mRNA abundance by Real-time PCR. The results show that PepT1 mRNA in duodenum was the highest in intestinal segments, and the jejunum was slightly lower. CAT1, rBAT, and B 0AT mRNA were highest in ileum, and the jejunum was slightly lower. EAAT3 mRNA expression was higher in jejunum and ileum. SGLT1 and GLUT5 mRNA was higher in duodenum and jejunum. GLUT2 and FATP4 mRNA were highest in jejunum, and the duodenum was slightly lower. The result indicates that the main part of the intestinal transport absorption of oligopeptide, glucose and fatty acid is the front half of the small intestine, the main part of the transport absorption of amino acid is the posterior segment of the small intestine.

Chen Yang, Zhao B.H., Li J.L., Hu S.S., Yang N.S., Bao Z.Y., Wu X., 2021. LNCRNA2919 mediated hair follicle development and growth in Angora rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-07, 4 pp.*

The periodic regeneration of hair follicle plays a critical role in wool production. Therefore, it is an effective way to carry out the research on periodic regeneration of hair follicle to increase wools production. In this study, whole-transcriptome analysis was performed to investigate ncRNAs and mRNAs associated with the various stages of the HF cycle in Angora Rabbits. The full length, intracellular localization and coding ability of key factor lncRNA2919 were identified. Through the test of adenovirus system infection *in vitro* and *in vivo*, it was found that lncRNA2919 could inhibit the periodic regeneration of rabbit hair follicles. Further, the binding proteins of lncRNA2919 were screened by RNA pull-down and mass-spectrometric, such as STAT1, KRT16 and so on. The results will fill the gap in the research field of hair follicle regeneration from the level of long non-coding RNA, and provide a new idea to accurate breeding and high-quality production in wool traits of Angora rabbit.

Cholis Nur, Nursita Ita Wahyu, 2021. Use of rabbit feces and rural by-products with addition of *Azotobacter* microbial culture and its effect on media quality and *Lumbricus rubellus* productivity. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-08, 4 pp.*

The purpose of the research was to analyze the use of rabbit feces and rice straw; and the addition of *Azotobacter* microbes culture to be fermented as media and the effect to the media quality and the productivity of *Lumbricus rubellus*. The treatments were T0: no addition, T1: 150 ml, T2: 250 ml and T3: 350 ml / 100 kg addition of *Azotobacter* microbes culture. The experimental method was designed as Completely Randomized Design with 4 treatments repeated 4 times. The result showed that the treatment increased the quality of the media and the productivity of *Lumbricus rubellus*. The crude protein content was increased ($P < 0.01$) and the crude fibre was decreased ($P < 0.01$) compared to control. The average number (production) and hatchability of cocoon, the highest increase in number and growth of earthworms was in the treatment 350 ml/100 kg addition of *Azotobacter* microbes culture ($P < 0.01$).

Cotozzolo E., Collodel G., Signorini C., Mattioli S., Cartoni Mancinelli A., Dal Bosco A., Castellini C., 2021. Effect of dietary n-6/n-3 ratio on fatty acid distribution in different rabbit tissues. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-09, 4 pp.*

Western human diet is characterized by an imbalanced intake of polyunsaturated fatty acids (PUFA) in term of low intake of n-3 and n-3 LCP (Long Chain PUFA). The n-3 PUFA have a lot of physiological functions; therefore, it is important to know the extent of their synthesis starting from α -linolenic acid (ALA) in various tissues, then the amount need to reach an adequate level in the organism. In this study, we investigated the fatty acids distribution in different tissues of rabbits fed diets with different n-3 intake and n-6/n-3 ratio. Fifteen New Zealand White male rabbits were divided into three experimental groups and fed respectively, control, flaxseed (10%) and fish oil (3.5%) diets. At the end of the trial, rabbits were sacrificed and brain, liver, testes, epididymis and prostates were collected for the analysis of fatty acids profile. Results demonstrated that administration of n-3 PUFA affected the fatty acid distribution of these tissues, especially the brain. Benefits of n-3 PUFA on physiological function are well known, so further studies are necessary to understand the distribution of n-3 PUFA/n-6 and how to integrate these in diets to achieve a desirable level in tissues.

Ding H.S., Cheng G.L., Leng J.J., Yang Y.X., Zhao X.W., Wang X.F., Qi Y.X., Huang D.W., Zao H.L., 2021. Analysis of histological and micro-RNA profiles changes in rabbit skin development. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France,; Communication BP-10, 4 pp*

The periodic regrowth of rabbit fur is economically important. Here, we aimed to characterise the histological traits and micro-RNA (miRNA) expression profiles in the skin of Wan Strain Angora rabbits at different weeks after plucking. Haematoxylin-eosin staining showed that hair follicles were in the telogen phase in the first week, while they were in the anagen phase from the fourth to twenty-fourth weeks. In addition, two small RNA libraries were constructed. 185 miRNAs were differentially expressed between the telogen and anagen phases. The function of the differentially expressed miRNAs was explored by comparing them with known mammalian miRNAs and by GO and KEGG analysis of their predicted targets. The fibroblast growth factor 5 (FGF5) gene was verified to be a target of conservative_NC_013672.1_9290 and conservative_NC_013675.1_10734. We investigated differential miRNA profiles between the telogen and anagen phases of rabbits hair cycle and preliminarily revealed the miRNA-mediated regulation of rabbits hair follicle cycling.

El-Gindy Y., Zahran S., Abd El-Rahman M., Ameen A., 2021. Physiological responses of manno-oligosaccharide on lipid profile of heat stressed rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-11, 4 pp.*

Heat stress in Egypt is one of the major constraints affecting growing rabbit productivity and impairs health. Every chance should be made to ameliorate the heat affects. The objective of this work was to determine the physiological effects of supplementing Manno-oligosaccharide (MOS) on hematology, immunity, antioxidant and lipid profile of heat stressed growing V-line rabbits. A total number of 80 V-line rabbits at 4 weeks old with average initial live body weight of 765.46g were exposed to temperatures 29.3-35.3°C, humidity 55-70% and Temperature Humidity Index 27.22-33.53. Rabbits divided into four groups (n=20 rabbits/group), in a completely randomized design. The first group received basal diet free of MOS. The second, third and fourth groups were fed diets containing 0.5, 1.0 and 1.5% MOS/kg diet, respectively. The results reveal that final body weight and high-density lipoprotein (HDL) were improved by all MOS treatments; however, respiration rate

and rectum temperature through two months were significantly decreased by MOS supplementation. MOS diets significantly lowers the level of serum cholesterol and total lipids, however, it had numerically increasing effect on serum total antioxidant capacity (TAC) with a significant decreasing on serum malonaldehyde (MAD) as compared with control group. Sheep RBCs titer at 7th day was better by MOS treatments. The study could help to improved heat tolerance, lipid profile and immune status of growing heat stressed V-line rabbits by providing MOS.

Gardan-Salmon D., Maupin M., Bebin K., Robert R., 2021. Impact of different levels of feed restriction during fattening period on growth performances and mammary gland development in mid-term pregnant does. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-12, 4 pp.*

The aim of this study was to evaluate if different feeding practices during the fattening period would have an incidence on doe growth and mammary gland development during first pregnancy. The study tested two levels of feed restriction between 5 and 9 weeks of fattening in does, with one group (G1) receiving a stricter feeding restriction than the other group (G2). Both groups were then managed the same way until first AI and first gestation. Growth and feed conversion were followed every week until 19 weeks of age. At 14 days of gestation, 10 does from each group were euthanized. Mammary tissues were analyzed by histology. Gene expression of milk proteins or lipid enzymes were measured by RT-PCR in the mammary epithelial tissue. Feeding strategies affected body weight curves during growth, but did not affect final BW at AI, nor fertility rate. Histological examinations of mammary tissues revealed no significant difference in tissue morphology between the 2 groups. Milk protein and lipid enzyme FASN genes were significantly increased in the less strict feeding group G2 ($P < 0.01$) suggesting increased milk protein and lipid synthesis in the mammary epithelial tissue of does receiving higher feeding allowance in postweaning period. Altogether, those findings indicate that feeding strategy in early stage of reproductive life in rabbit doe can influence mammary development in first gestation with potential impact on future subsequent lactation.

Knudsen C., Gidenne T., Cauquil L., Pascal G., Briens C., Duperray J., Rebours G., Salaün J.M., Travel A., Weissman D., Combes S., 2021. Both quantitative and energetic intake levels affect caecal microbiota composition and activity in the growing rabbit. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-16, 4 pp.*

Short-term feed restriction strategies reduce rabbit post-weaning digestive disorders, but little is known about the implications of the caecal ecosystem in these beneficial effects. Our study looks into the consequences of feed (quantitative) and energy intake level on the caecal ecosystem. At weaning 320 rabbits were allotted into four groups: HE100, HE75, LE100 and LE75, differing in dietary digestible energy concentrations (HE = 10.13 vs LE = 9.08 MJ DE/kg, calculated values) and intake levels (100 = *ad libitum* vs 75 = restricted at 75% of *ad libitum*). Caecal content was sampled in ten rabbits per group at 42 and 50 days of age for ammonia and volatile fatty acid concentration measurements and for bacterial composition determination using 16S DNA sequencing. Restricted feed intake increased the acetate proportion (+2.8 units, $P < 0.001$) and decreased that of butyrate (-2.4 units, $P < 0.001$), while high energetic intake (HE diet) mainly decreased the caecal pH (-0.14, $P < 0.001$). Akkermansiaceae were increased with high energetic intake (0.54 vs 0.25%, $P_{\text{adjust}} < 0.05$), while Christensenellaceae were decreased (2.8 vs 5.6%, $P_{\text{adjust}} < 0.001$) and Eubacteriaceae increased with restricted feed intake (10.5 vs 6.9%, $p_{\text{adjust}} < 0.05$). Altogether, our results indicated that quantitative and energetic intake level modified the caecal microbial activity and composition. These modifications deserve further investigation to determine the potential causal link between microbial composition, activity and impacts on the host's health.

Kuang Liangde, Min Lei, Li Congyan, Guo Zhiqiang, Ren Yongjun, Zhang Xiangyu, Zheng Jie, Zhang Cuixia, Yang Chao, Mei Xiuli, Tang Li, Ji Yang, Deng Xiaodong, Yang Rui, Xie Xiaohong, 2021. Whole transcriptome sequencing reveals non-coding RNAs related to embryo morphogenesis and development in rabbit *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-17, 4 pp.*

The roles of Long non-coding RNAs (lncRNAs) and circular RNAs (circRNAs) in embryonic development remain unclear. We performed a comprehensive analysis of lncRNA and circRNA profiles in different stages of rabbit embryos by whole transcriptome sequencing. We identified 719 lncRNAs and 744 circRNAs that were differently expressed between stage S1, S2 and S3. A total of 241 differently expressed lncRNAs and 166 differently expressed circRNAs were significantly involved in function of embryonic morphogenesis and development. A RNA network was established and among the embryonic development-associated RNAs, lncRNA TCONS_00009253 and TCONS_00010436 were persistently downregulated, while circRNA circRNA_07129, Circrna_15209 and circRNA_12526 were continuously upregulated, and their co-expressed mRNAs TBX1, WNT3 and FGFR2 were continuously downregulated during the embryo development. These candidate

RNAs were mainly involved in the Wnt, PI3K-Akt and calcium signaling pathways. This work provides candidate lncRNAs and circRNAs that may be indispensable for the morphogenesis and development of rabbit embryos.

Li Yanhong, Gan Mingchuan, Li Qinlin, Wu Xuemei, Wang Jie, Jia Xianbo, Chen Shi-Yi, Lai Song-Jia, 2021. Morphological characteristics of adipose cells in liver tissues of Tianfu black rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-18, 3 pp.*

Liver is an important organ of energy metabolism and plays a vital role in regulating the tissue development and body growth. Although it has been widely acknowledged that domestic rabbit is a genetically fat-lacked species in comparison with other farm animals, the related molecular bases remains largely unknown. In order to better understand the fat metabolism profiles in liver, the liver tissue samples of Tianfu black rabbits at 0, 35, 56, 70 and 90 day old was used for morphologic observation with aim to profile the dynamic development processes. Results show that the area of adipose cells in liver tissues of rabbits gradually increased from the age of 56 days, and the diameter of fat cells rapidly increased ($P < 0.01$) after the age of 70 days. The results suggested that 56 days before sales was the optimal stage for fattening and selecting stage, which provided a good basis for further studies on lipid metabolism in liver of rabbits.

Liu Gongyan, Sun Haitao, Gao Shuxia, Bai Liya, Jiang Wenxue, Li Fuchang, 2021 . Effects of dietary vitamin B6 on skeletal muscle protein metabolism of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-19, 4 pp.*

This research aimed to evaluate the effects of dietary vitamin B6 on skeletal muscle protein metabolism of growing rabbits. Two hundred healthy rabbits with similar body weight were randomly assigned to one of five dietary groups, with 40 animals per group. The dietary groups consisted of different vitamin B6 supplementation levels: 0(control), 5, 10, 20 and 40 mg/kg. The feeding trial lasted 60 d. The results showed that dietary vitamin B6 had significant effects on fore legs and hind legs muscle ratio ($P < 0.05$), and on serum total amino acid (T-AA), blood urea (UR) and insulin-like growth factor-1 (IGF1) content ($P < 0.05$). Additionally, vitamin B6 had significant effects on muscle insulin-like growth factor 1 (IGF1), myogenic determination factor (MYOD) and myogenin (MYOG), myocyte regulation factor 5 (MYF5), myostation (MSTN) and WW contains E3 proteasome ubiquitin ligase 1 (WWP1) mRNA expression ($P < 0.05$). The results of western blot also showed that IGF1 (MW = 15 KD), WWP1 (MW = 36 KD) and MYOG (MW = 38 KD) significantly expression with the dietary vitamin B6 ($P < 0.05$). This study indicated that addition of vitamin B6 could obviously modify protein metabolism of growing rabbits, and the appropriate vitamin B6 supplementation level was 20 mg/kg for growing rabbits.

Liu H, Li F., Liu L., 2021. The effect of glucocorticoids on the gene expression of nutrient transporter in different rabbit intestinal segments. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-20, 4 pp*

In rabbits, stress disrupts nutrient digestion and absorption. However, the underlying molecular mechanism is not clearly understood. The objective of this study was to investigate if the stress alter the nutrient transporter expression in different segments in small intestine. We analysed the effects of 3 h (short-term) or 7 d (long-term) dexamethasone (DEX) (2mg/kg body weight) treatment on the gene expression of most nutrient transporters. The results showed that short-term DEX treatment significantly decreased PepT1, B0AT, rBAT and SGLT1 expression in small intestinal segments ($P < 0.05$). Long-term DEX treatment also significantly decreased PepT1, CAT1, B0AT, rBAT and SGLT1 in small intestinal segments ($P < 0.05$). In conclusion, DEX could decrease the gene expression of most nutrient transporters affect the transport of intestinal amino acids and monosaccharides.

Moumen S., Daoudi-Zerouki N., Bouchareb C., Adjroud H., 2021. Serum biochemical profile of rabbit does of Algerian local population (Aurees region) at different physiological stage. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-22, 4 pp*

One hundred and twenty local Algerian female rabbits in first parity were used in this present study at the experiment farm of the University of Batna 1. The animals were divided into four equal groups with 30 replicates (empty female, pregnant female, pregnant-lactating female and lactating female only). Natural mating was used, the kits were weaned at 28 days. Four blood samples were collected on females at different physiological stages. The physiological status affected significantly ($p < 0.05$) cumulative BCS, milk yield, litter size and litter weight of does at birthing. Total protein, albumin, globulin, uric acid and creatinine concentrations as well as T3 and progesterone levels were higher ($p < 0.05$) in does of P-L group (5.70±1 g/dl, 2.98±0.07 g/dl, 1.88±0.06 g/dl, 34.9±3.4 mg/dl, 1.3±0.4 mg/dl, 44.3±0.93 ng/dl, 18.98±1.5ng/ml)

respectively. The physiological status increased significantly ($p < 0.05$) total lipids, triglycerides and total cholesterol in does of P, P-L and L groups compared with their concentrations in E group. The physiological status affected alanine aminotransferase (ALT), aspartate aminotransferase (AST) and Alkaline phosphatase activities in does during pregnancy and suckling period ($5.65 \pm 0.1 \text{ UI/L}$, $22 \pm 1.3 \text{ UI/L}$ vs 5.45 ± 0.22 , $20.35 \pm 4.3 \text{ UI/L}$). Does of P, P-L, and L groups had higher ($p < 0.05$) leptin levels. Insulin and glucose concentrations were increased in P and P-L groups compared to E and L groups.

Mussard Eloïse, Combes Sylvie, Helies Virginie, Aymard Patrick, Beaumont Martin , 2021 . Development of a rabbit caecum organoid model: an innovative *in vitro* tool to study absorptive and barrier functions of epithelial cells. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-23, 4 pp.*

The intestinal epithelium plays a key role in digestion, nutrients absorption and in the gut barrier function. However, an *in vitro* model of rabbit epithelial cell is not available to study these functions. In this context, we tested three methods to grow organoids from epithelial crypts (containing stem cells) isolated from rabbit caecum ($n=4$). Key epithelial signaling pathways (Wnt and BMP) were modulated either by (i) pharmacological inhibitors (2Ki medium) or with mouse recombinant growth factors used at (ii) 50 % (WRN 50%) or (iii) 5% (WRN 5%). In the three growth conditions, organoids were formed by a monolayer of epithelial cells with the apical side enclosed towards the lumen. Organoids grown in 2Ki condition had a large diameter and a spherical morphology while organoids cultured in WRN 50% and WRN 5% conditions were smaller (-20.4% and -25.6% vs 2Ki, respectively, $P < 0.05$) and some of them were non-spherical (11.2 and 12.7%, respectively), these features being suggestive of a higher differentiation level in WRN conditions. Indeed, organoids cultured in WRN 5% expressed significantly higher levels of genes markers of absorptive and secretory epithelial cells when compared to the 2Ki condition ($P < 0.05$). This higher differentiation level was associated with an upregulation of antimicrobial peptides expression ($P < 0.05$), an important component of the epithelial barrier function. In summary, we report for the first time a method to grow rabbit caecum organoids with a high epithelial differentiation level. This innovative *in vitro* model is a valuable tool to study the effects of nutrients or microorganisms on rabbit intestinal epithelium.

Paës C., Gidenne T., Barilly C., Bébin K., Duperray J., Gohier C., Guené-Grand E., Rebours G., Aymard P., Beaumont M., Combes S., 2021. Stimulation of early solid feed ingestion in the nest accelerates the maturation of the rabbits caecal microbiota. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-25, 4 pp.*

This study evaluated the relevancy of early life nutritional intervention for shaping the rabbit caecal microbiota. Thirty-two litters had free access to a pelleted feed from 15 days in addition with doe milk. In the early feeding group (EF), a starter feed in a gel form was added in the nest from 3 to 17 days, while rabbits from the control group (C) only had access to milk until 15 days. Caecal bacterial communities of 10 rabbits per group were assessed at 18, 25, 30, 38 and 58 days of age, by 16S rDNA sequencing. The intake of starter feed in the nest ($1.1 \pm 0.4 \text{ g of DM/rabbit}$) had subsequent effects on alpha- and betadiversities (+17 points for InvSimpson index at 30 days of age, $P=0.018$). From 18 days onwards, the structure of EF rabbit caecum bacterial communities was closer to the microbiota structure observed at 58 days than in C group, suggesting a higher maturity state at each age. With starter feeding, the microbiota acquired greater proportions of Ruminococcaceae at d18 ($P=0.043$, +5%) and it sped up the expected decrease of Bacteroidaceae at 25 and 30 days (-9% and -8% resp. $P < 0.05$). Concomitantly, an increased production of volatile fatty acids was observed before weaning in EF group (+25% at 30 days). Our results suggest that early feeding can promote the maturity of the rabbit caecal ecosystem with long-term effects. A faster establishment of a stable microbiota would favor the maturation of rabbit's immune system and thus would reduce the risk of dysbiosis. Those effects will be investigated in the future to determine if early feeding strategy represents an effective tool to reduce the occurrence of enteritis around weaning.

Settar A., Khaldoun Oularbi H., Tarzaali D., Mekhaldi F. , 2021. Ameliorative effect of vitamins A, E, D & C on ampligo a synthetic insecticide inducing toxicity on rabbit adrenal gland. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France Communication BP-27, 4 pp.*

In order to evaluate the toxic effect of Ampligo® 150 ZC on the rabbit adrenal gland and the probable ameliorative effect of vitamins A, E, D and C association. Fifteen male rabbits "*Oryctolagus cuniculus*" were divided into three groups: control; Ampligo (AP) and Ampligo+ vitamins (AP+VIT). The toxic effect of Ampligo was measured on body and adrenal weights, cortisol plasma level and adrenal tissues. Results shows an increase in body weight gain in all groups and the higher body weight gain was noticed in the AP group. A notable increase in adrenal weight in AP treated group was observed, and cortisol plasma level was significantly increased in AP+VIT group. The histological study revealed a disorganization of the adrenal tissues in rabbits treated with Ampligo and a notable amelioration of the adrenal parenchyma was observed in the

AP+VIT treated rabbits. The present results indicate that Ampligo® 150 ZC cause various alterations in adrenal male rabbits and supplementation with a combination of vitamins A,E,D and C induce beneficial effect in reducing the insecticide toxicity.

Silva S.R., Guedes C.M., Almeida, M., Mourão L.M., Pinheiro V., 2021. Prediction of rabbit body fat deposits from perirenal fat measurements obtained with real-time ultrasonography. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP 28, 4 pp.*

This study aimed to predict fat depots in rabbit does using perirenal fat measurements obtained with real-time ultrasonography (RTU). From RTU images, the depth and area measurements of perirenal fat were determined to have the kidney as an anatomical reference. Forty-two New Zealand × Californian rabbit does with a live weight of 4.5 ± 0.57 kg were studied. Body weight (BW), body condition score (BCS) and RTU measurements were determined in vivo, whereas the fat depots (scapular, perirenal, inguinal fat, carcass and body fat depots) were determined post mortem. For RTU measurements an Aloka 500V equipped with a linear probe of 7.5 MHz was used. The results show that the most significant correlations were observed between body fat and BW, BCS and RTU measurements (r between 0.517 to 0.923; $P < 0.01$). It was also observed that all other fat depots, with the exception of inguinal fat, showed significant correlations with BW, BCS and RTU measurements (r between 0.472 to 0.867; $P < 0.01$). In conclusion, the results of the present work indicate that the perirenal fat measurements obtained by RTU can be taken into account to predict fat depots of rabbits does.

Mattioli S., Cartoni Mancinelli A., Cotozzolo E., Mancini S. Castellini C., Dal Bosco A., 2021. Comparison of an estimated index of fatty acid metabolism and liver $\Delta 6$ -desaturase activity in rabbit. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-29, 4 pp.*

The aim of this study was to verify the accuracy of $\Delta 6$ -desaturase ($\Delta 6D$) index estimated from fatty acid profile of liver and meat of rabbit in comparison with its real metabolic activity directly evaluated in the liver microsomes. Two experiments were carried out using different diets (Control vs Linolenic diets) and genotypes (selected vs local breeds) for the comparison of $\Delta 6D$ index and enzyme activity assay. Concerning the feed effect, a lower estimated index was found in Linolenic samples, both in liver and muscle, and this trend was only confirmed by the desaturase activity towards the n-3 fatty acids. The total and n-6 fatty acid-enzyme activity did not show significant differences between groups, as well as any correspondences with the indexes. The "selected" rabbits showed lower indexes respect to the local ones. The activity of the enzymatic complex has instead highlighted an opposite trend for the n-3 and the n-6 series and total one. In particular, the enzyme activity toward n-3 followed the same tendency of the index, whereas the other two determinations showed an opposite trend. The results of this comparison demonstrate that the calculation of the proposed index could be used as surrogates of the measure of liver $\Delta 6$ -desaturase activity in lipid metabolism of rabbit, but only if specific n-3 pathway is considered.

Song B., Zhao J.P., Ren Z.J., 2021. The differences of caecal communities in rabbits and hares. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-30, 3 pp*

Rabbits and hares belong to the Leporidae family of the order Lagomorpha, though they are different in biology and feeding. Moreover, the caecal fermentation pattern of the hare is characterised by higher molar proportions of propionate and isobutyrate compared to those observed in rabbit caecum. But little is known about whether the species differences or healthy status differences contribute to their different caecal communities or not. The aim of this project is to estimate and compare the differences of caecal communities among healthy and diarrheal rex rabbits and hares by sequencing the V4 hypervariable region of the 16S rDNA using the Illumina MiSeq platform. Preliminary results showed that in the phylum level, Firmicutes dominated in the ceca of healthy and diarrheal rex rabbits, and Sphaerochaeta was the most dominant genus in hares; in the genera level, Christensenellaceae R-7 group and Ruminococcaceae unclassified genus were the most abundant genera in healthy rex rabbits, Escherichia-Shigella, Bacteroides, Bacteroidales S24-7 group norank and Ruminococcaceae unclassified genus were enriched in diarrheal rex rabbits, and Sphaerochaeta was the most dominant genus in hares. Our study demonstrated the features of caecal communities of healthy and diarrheal rex rabbits and hares, which have important implications for furthering the study of the caecal communities of Leporidae.

Tlili Thiziri, Aroun Rabiha, Benamara Liza, Khaldoun-Oularbi Hassina, Daoudi Zerrouki Nacira, 2021. Study of the histofunctional characteristics of the ovarian structures of rabbits of the synthetic strain in the state of pregnancy. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-31, 4 pp.*

The objective of our study is to determine the modifications of ovarian structures in rabbits belonging to the synthetic strain "SS" at the end of pregnancy, in order to evaluate the prolificity and its main biological components. A total of thirty (30) 4-month-old females (nulliparous) with an average weight of 3300 ± 141 g were inseminated, twenty-six (26) of them were positive on palpation (12th day of gestation), and six (6) of them were sacrificed by decapitation on the 24th day of gestation. The ovaries were removed and fixed in 10% formaldehyde and then treated for histological study with a standard topographical haematoxylin-eosin stain. A morphometric study was carried out using AxioVision software to measure the different structures of the ovary (follicular populations). The classification of fetuses of the synthetic strain according to their status (dead, alive, resorbed) showed that of the total number of fetuses implanted at the end of pregnancy (195 in total), the average number of live births determined in live females (20) was 8.2 per rabbit and the number of resorbed fetuses was almost nil. The number and measurements of follicular and oocyte components (diameters) revealed that rabbits of the synthetic strain in terms of fertility, productivity and ovulatory potential are better compared to local populations.

Velasco-Galilea M., Piles M., Viñas M., Rafel O., Ramayo-Caldas Y., González-Rodríguez O., Guivernau M., Sánchez J.P., 2021. Prediction of growth and feed efficiency performances in growing rabbits from their gut microbiota. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-32, 4 pp*

Selecting for feed efficiency (FE) is challenging in rabbit breeding programs since individual feed intake (FI) of animals is not usually available. The current study raises the possibility that rabbits' cecal microbiota could be considered to predict FE and its component traits, i.e., growth and FI. Our dataset comprised the individual average daily gain (ADG) and cage FI records of 425 kits raised in two farms and fed with the same diet supplemented or not with antibiotics but under different feeding regimes. A 16S rRNA gene amplicons MiSeq sequencing assessment was conducted on cecal samples collected from those kits at 66 days. Paired-end sequences were processed with QIIME2 software resulting in a final table of 2,638 sequence variants for 424 samples. We run cross-validations fitting a sparse partial least squares regression (sPLSR) model with a microbial effect to assess its predictive ability on phenotypic ADG of animals fed V (ADGv) and on animals fed R (ADGR), and on their residuals after correction by management factors. For traits ADG, FI and FE, we run cross-validations to compare two models differing by including or not the cecal microbial information. Our sPLSR model showed some predictive capacity for phenotypic ADGV (0.40) and ADGR (0.09), but this capacity becomes null for the prediction of the residuals of these traits. Although cecal microbiota explained more than 50% of the variation of ADG, fitting the microbial effect in the model did not improve the predictive accuracy of the recorded values. Cecal microbiota explained 51 and 59% of the variation of FI and FCR, respectively. Unlike growth, models that considered the microbial information improved the predictive accuracy for FI and FCR recorded performance values in 3 and 10%, respectively.

Zhang Bin, Shen Lei, Liu Lei, Li Fuchang, 2021. Effects of different iodine contents in diets on growth and development of growing rex rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-04, 4 pp.*

Iodine deficiency can reduce the synthesis of thyroid hormones, leading to neurological and intellectual development disorders in fetuses and children. Iodine excess can inhibit the synthesis and release of thyroid hormones and induce and aggravate thyroid autoimmune injury. Therefore, maintaining iodine nutrition microenvironment is very important for improving animal health and promoting growth and development. In order to determine the optimum iodine level in feed, the effects of different iodine levels on the growth and production performance of Rex rabbits were studied by single factor design method. 200 healthy Rex Rabbits of 3 months old and similar physique were randomly divided into 5 groups (40 replicates in each group and 1 in each replicate). The experimental diets were supplemented with 0, 0.2, 0.4, 0.8 and 1.6 mg/kg iodine (potassium iodide) respectively. The preliminary period is 7 days and the positive period is 53 days. During the experiment, routine feeding management and immunization procedures were adopted. Two feedings were given at 08:00 a.m. and 17:00 p.m. daily to ensure free feeding and drinking water, natural ventilation and day-lighting. Test result: On the premise that the initial body weight (IBW) had no significant difference ($P > 0.05$), the final body weight (FBW) of 4 month old Rex rabbits was significantly affected by dietary iodine levels ($P < 0.05$), and the final body weight of Rex Rabbits reached the maximum value of 2.63 kg when the dietary iodine content was 0.8 mg/kg. Meanwhile, when 0.8 mg/kg iodine was added to the basic diet, the average daily intake (ADI) was significantly affected ($P=0.0001$). Dietary iodine supplementation significant effect on the hind leg muscle rate and muscle redness ($P < 0.05$), and had significant effect on the anterior leg muscle rate ($P < 0.01$). Dietary iodine supplementation with different amounts had significant effects on thyroid stimulating hormone (TSH), tetraiodothyronine (T4) and free tetraiodothyronine (FT4) in Growing Rex Rabbits ($P < 0.01$), and on triiodothyronine (T3) ($P < 0.05$). Dietary iodine levels had significant effects on Noggin mRNA expression in Growing Rex Rabbits ($P < 0.05$), but had no significant effects on versican (Ver), Hepatocyte growth factor (HGF), Alkaline phosphatase (ALP), Bone morphogenetic proteins BMP2 and (BMP4) mRNA expression ($P > 0.05$). Different iodine content in diet can affect the feed intake and growth level of Rex rabbits. In conclusion, 0.8mg/kg iodine is the most suitable supplementation in the diet of Growing Rex rabbits (The measured value of iodine in basic diet was 0.92 mg).

Zhang Xiangyu, Li Congyan, Kuang Liangde, Zhen Jie, Zhang Cuixia, Yang Chao, Ren Yongjun, Guo Zhiqiang, Yang Rui, Tang Li, Ji Yang, Lei Min, Mei Xiuli, Huang Dengpin, Xie Xiaohong, 2021. Solexa sequencing and bioinformatics analysis on micro-RNA from the rabbit muscle . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-34, 4 pp.*

As a new regulatory factor, miRNA is involved in the growth and development of skeletal muscle and the differentiation of muscle cells through specific binding with target genes. In this study, miRNA-sequencing was performed on the longissimus dorsi muscle of three 30-day-old male rabbits using Solexa platform, aiming to evaluate the data quality of high-throughput sequencing in the systematic identification of miRNA in the muscles of meat rabbits, and analyze the expression profile of miRNA in the muscle tissues of meat rabbits. Only 2.6% of exon and intron sequences were aligned, which fully indicated that the constructed miRNA libraries were of high quality. miR-1, miR-133 and miR-206 were highly expressed in the muscles of meat rabbits. High expression of miRNA might play an important role in myogenic differentiation, muscle repair and energy metabolism of skeletal muscle. The specific highly expressed miRNA in muscle tissues identified in this study can be used as an important reference for further functional studies.

Zubiri-Gaitán A., Martínez-Álvaro M., Ccalta R., Satué K., Blasco A., Hernández, P., 2021. Correlated response to selection for intramuscular fat on the liver fat and its fatty acid profile. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BP-35, 4 pp.*

A divergent selection experiment for intramuscular fat content (IMF) in *longissimus thoracis et lumborum* (LTL) muscles was performed in rabbits during 10 generations at the Universitat Politècnica de València in order to unravel the mechanisms involved in fat deposition. The aim of the present experiment was to study the correlated response to selection on liver fat content and its fatty acid profile, as well as in plasma metabolites related to liver metabolism. A total of 190 rabbits from the 10th generation of selection were used to estimate the direct response to selection. A subsample of 54 animals was selected to study the correlated response to selection on the liver fat, its fatty acid profile and on plasma metabolites related to the liver metabolism. Direct and correlated responses to selection were estimated as the phenotypic differences between high-IMF and low-IMF lines. A relevant value of the difference (r) of 1/3 of the phenotypic standard deviation of the trait was proposed in order to estimate the probability of relevance Pr . Bayesian inference was used. The direct response to selection was 0.49 g/100 g of LTL muscle, which represents a 47% of the mean of the trait and 4.1 of its standard deviation. Higher liver percentage was found in high-IMF line, with relevant differences ($Pr = 0.81$). No evidence of difference between lines was found on their liver fat content ($P0 = 0.65$). Nonetheless, its fatty acid profile was modified. Monounsaturated fatty acids were higher in high-IMF line, whereas polyunsaturated fatty acids were higher in low-IMF line with relevant differences ($Pr = 0.90$ in both cases). Higher plasma concentration of triglycerides and lower of alanine transaminase were found in the low-IMF line, with relevant differences ($Pr = 0.97$ and 0.92 respectively). Selection for IMF led to a correlated response on the liver percentage and on its fatty acid composition, indicating a genetic relationship between those traits. The higher concentration of triglycerides found in L suggests that differences in IMF at 9 wks of age may be due to a reduced capacity of lipid uptake from the plasma.

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BREEDING & GENETICS

Invited paper

[García M.L.](#), [Gunia M.](#), [Argente M.J.](#), 2021. Genetic factors of functional traits (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, communication BG-00, 16 pp.*

Selection of functional traits is a challenge for researchers, but an increasingly necessary objective due to the growing concern regarding animal welfare and overcoming the problems of reducing antibiotic use in rabbit production without undermining the animals' productivity. The aim of this review is to discuss the genetic control of resistance to diseases, longevity and variability of birth weight within a litter, or litter size variability at birth within doe, and describing the selection programmes and the first results from a multi-omics analysis of resistance/susceptibility to diseases. The heritability is around 0.13 for longevity, 0.01 for uniformity in birth weight, 0.09 for litter size variability and around 0.11 for disease resistance. Genetic correlations between functional traits and production traits are mostly no different from zero, or are moderately favourable in some cases. Six selection programmes developed in three countries are reviewed. Line foundation with high pressure for selection or divergent selection experiments are different methodologies used, and favourable responses to selection have been obtained. Genomics studies have revealed associations in regions related to immune system functionality and stress in lines selected for litter size variability. Knowledge of gut microbiota role on the rabbit's immune response is very limited. A multi-omics approach can help to know microbial mechanisms on regulation immunity genes of the host.

Short communications

[Agea I.](#), [Muelas R.](#), [García M.L.](#), [Hernández P.](#), [Santacreu M.A.](#), [Armero E.](#), [Blasco A.](#), [Argente M.J.](#), 2021. Correlated response in plasma fatty acids profile in rabbits selected for environmental sensitivity. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, communication BG-02, 4 pp.*

Two rabbit lines were divergently selected for increasing and decreasing environmental variability of litter size at birth. Decreasing litter size variability generates more resilient females with less sensitivity to stress and diseases, being a useful selection criterion to improve environmental sensitivity. Fatty acids modulate the immune cell function. Saturated fatty acids (SFAs) have an inhibitory effect on lymphocyte proliferation, monounsaturated fatty acids (MUFAs) exerts a protective and anti-inflammatory effect on macrophages, and n-3 polyunsaturated fatty acids (PUFAs) affect response of lymphocytes by mean of IL-1, IL-2, IL-6, TNF as well as prostaglandin E2 and leukotriene B4. Plasma fatty acids profile was assessed in 10 females from the homogeneous line and 12 females from the heterogeneous line from the 12th generation of selection. The homogeneous line showed higher levels of SFAs (+3.98 ng/ml P=0.90 for C14:0; +2.30 ng/ml P=0.98 for C15:0; +54 ng/ml P=0.90 for C16:0 and +29 ng/ml P=0.90 for C18:0) and MUFAs (+12.0 ng/ml P=0.98 for C16:1 and +53 ng/ml P=0.90 for C18:1n9c) than the heterogeneous line. Besides, this line had also a higher amount of n-3 PUFAs (+2.18 ng/ml P=0.90 for C18:3n3 and +1.91 ng/ml P=0.90 for C20:5n3) and a lower amount of n-6 PUFAs (-3.66 ng/ml P=0.96 for C20:3n6 and -0.28 ng/ml P=0.90 for C20:4n6) than the heterogeneous one. In conclusion, selection for environmental sensitivity shows a correlated response in the plasma fatty acids profile.

[Casto-Rebollo C.](#), [Argente M.J.](#), [García M.L.](#), [Blasco A.](#), [Ibáñez-Escriche N.](#), 2021. Immunological genes selected for environmental variance could control the animal resilience. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, communication BG-04, 4pp.*

Environmental variance of traits (VE) has recently been related with resilience. Thus, a greater knowledge of the genetic background of VE could help to understand better the animal resilience. A successful selection experiment in rabbits for a high and a low VE of litter size (LS) allowed to identify differences in resilience between animals. The line with a low VE of LS seemed to cope better with the environmental disturbances than the line with a high VE of LS. The aim of this study was to identify genomic regions modified by selection of VE and that could affect the animal resilience. For that, genotypes from 91 does of base population, and 142 of the line with a high VE of LS and 134 of the line with a low VE of LS at generation 11 were used to identify signatures of selection. 93 genotypes at

generation 13 were used to validate the results. The signatures of selection were identified using three complementary analysis: runs of homozygosity (ROH), variations of linkage disequilibrium (VarLD) and fixation index (FST). A whole-genome sequencing (WGS) analysis was performed on 54 animals at generation 10 to highlight the genes with functional mutations. We identified 311 candidate genes with relevant functional mutation in their transcription unit. 107 of them had functions related to the stress response, reproduction and embryo development, carbohydrate and lipid metabolism, and/or immune system. Functional mutations fixed in one of the rabbit lines and absent in the other were identified in the genes C3orf20, GRN, EPCAM, ENSOCUG00000017494, ENSOCUG00000024926, ENSOCUG00000026560, MYLK, HECA and NMNAT3. The biological pathways of candidate genes explain the differences found between the rabbit lines in immune response biomarkers (plasma cortisol, leukocytes, and acute-phase protein levels), in plasma concentrations of cholesterol and triglycerides, mortality and resilience. Also, these results could explain the correlated response of the VE of LS with embryo implantation, embryo survival and LS. However, the real implications of these genes for VE and animal resilience must still be unravelled through their functional analysis.

Demars J., Labrune Y., Iannuccelli N., Aymard P., Benitez F., Leroux S., Gilbert H., Riquet J., 2021. Deciphering the molecular architecture of the coat colour variability in a European rabbit population. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, communication BG-05, 4 pp.*

Understanding the molecular mechanism of coloration has been the goal of many genetic and evolutionary studies in a broad number of species. Nevertheless, most of our current knowledge is restricted to colour traits exhibiting relatively simple discrete variation and inheritance patterns. More than a hundred of genes are involved in coloration traits in rodents and many mutations have been identified. In the European rabbit (*Oryctolagus cuniculus*), different coat colours have been selected through domestication and are nowadays fixed in specific breeds. Although numerous mutations affecting coat colour have been discovered in various rabbit breeds, additional variants have still to be identified. Despite the evolution of technologies through the genomics era, understanding the molecular architecture of such complex phenotypes still remains a challenge. Here, we propose a genome-wide investigation of coat colour using rabbit high-density SNP array. We performed genome-wide association studies (GWAS) considering the variation of coat colour as quantitative and binary phenotypes. We identified several significant SNPs marking loci already known to affect coat colour as well as in a few other chromosome regions not yet described to affect this phenotype in rabbits (e.g. a genomic region on chromosome 14). Moreover, we determined the best model of inheritance for each region associated to coat colour. Our results bring new insights into the molecular architecture of the coloration phenotype pinpointing its oligogenic determinism.

Eiben Cs., Mészáros M., Gulyás B., Végi B., Drobnyák Á., Barna J. Molnár T., Szalay I.T., Liptói K., 2021. Conservation and performance of the native Hungarian Giant rabbit breed. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, communication BG-06, 4 pp.*

There are few reliable data on the production of purebred Hungarian Giant (HG) rabbit breed. HG is endangered based on its population size. The aim of this study was to present the reproduction and growth of the small HG nucleus population formed in Gödöllő. Kindling rate was 68% in pens and 76% in large cages with natural mating and extensive reproductive rhythm. The number of live born kits was 8.0-8.6 and the number of weaned kits was 6.7-6.9. Kit live weights between 3 and 16 week of age and growth rates between 7 and 13 wk of age were significantly affected by season ($P < 0,01$) weights were 948, 2279 and 4141 g while the 5-10 and 10-16 wk growth rates 40.0 and 44.1 g/d, respectively. In large cages the 7, 10, 13 and 16 wk live weights were 1612, 2433, 3349 and 4089 g and the 7-10 and 7-13 wk growth rates 48.0 and 45.0 g/d, respectively. Doe live weight in cages varied between 6159 and 6404 g. There are no published data on the teat number in HG rabbits. The proportion of nucleus-founder rabbit does according to 6, 7, 8, 9, 10 and 11 teat number was 8, 8, 60, 8, 12 and 4%, respectively. Information on HG does' teat number can help at fostering and improve the success of rearing. Ear length was tested in some cases that were 15.4-15.6 cm in 10-26 wk old female rabbits.

Garreau H., Labrune Y., Chapuis H., Ruesche J., Riquet J., Demars J., Benitez F., Richard F., Drouilhet L., Zemb O., Gilbert H., 2021. Genome wide association study of growth and feed efficiency traits in rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-07,4 pp*

We performed a genome wide association study for six traits related to growth and feed efficiency on 679 rabbits genotyped with the Rabbit 200K Genotyping Array. No significant SNP was found for growth traits or feed intake. Two and 89 chromosome-wide significant SNPs were detected for feed conversion ratio and residual feed intake, respectively. The 89 significant SNPs for residual feed intake were all located on chromosome 18, where the putative functional candidate gene GOT1 could be identified.

Girardie O., Robert R., Maupin M., Hurtaud J., Joly T., Ruesche J., David I., Garreau H., Canario L., 2021. Genetic trends in doe and kit behaviour and performances assessed with comparison of old and modern-type lines in a crossfostering design. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-08, 4 pp.*

The study focused on the estimation of genetic trends for behavior and performances of does and kits during lactation in parallel to 22 generations of selective breeding for litter size and kit growth. The direct effects from the kit (kit line) were separated from the maternal effects of the doe (doe line) with use of a crossfostering design between the old-type (L0) and the modern-type (L22) lines. Does were studied over the two first parities. They raised rabbits from a single kit line. None kit was raised by its biological mother. At d21, L22 females produced more milk than L0 females (250 g vs 206 g, $p=0.0003$) which resulted in a higher weight of the kits at d21 (378 g vs 340 g, $p<0.001$). L22 does had better maternal abilities than L0 does as referred to nest quality ($p=0.06$), fur puckling ($p<0.0001$), milk production ($p=0.0003$) and willingness to nurse ($p=0.007$). At most dates, more L22 kits were observed out of the nest than L0 kits, whether they were raised by L0 or L22 does. L22 kits exited the nest earlier during lactation and were bolder in an emergence test than L0 kits. Trends in doe behaviour were positive and favorable to litter performance. In advanced lactation, genetics of the kit influenced kit behaviour more than genetics of the nursing dam.

Gunia M., Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Riou M., Robert R., Shrestha M., Garreau H., 2021. *Pasteurella multocida* experimental infection 2): Genetic parameters. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-09, 4 pp.*

In this study, we experimentally infected 953 crossbred rabbits from 6 sire lines with *Pasteurella multocida*, and diagnosed their response to Pasteurellosis. We recorded abscess and bacterial dissemination, growth before and after inoculation, and performed blood cell counts 14 days post inoculation. The heritabilities were low to moderate for all traits, except for the eosinophils percentage, which does not seem to be heritable. There were positive genetic correlations between the Resistance score and the red blood cell count, the hematocrit, hemoglobin and lymphocyte percentages. On the opposite, there were negative genetic correlations between the Resistance score and the platelets, the white blood cells, the neutrophil and monocytes percentages. Among the hematological traits, lymphocyte percentage could be a potential selection criterion to breed for Pasteurellosis resistance. Its heritability was relatively high (0.24 ± 0.09) compared to the other traits and its correlation with the Resistance score was also high (0.83). This is the first analyses of the genetic parameters of hematological traits in experimentally infected rabbits.

Herbert C., Yviquel J., Flatres-Grall L., Pong-Wong R., Lenoir G., 2021. Optimal contribution selection in C line Hycole: prospect for genetic gain. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-10, 4 pp.*

One of the consequences of breeding programs is the increase in inbreeding. The control of inbreeding avoids the occurrence of problems such as inbreeding depression or reproductive problems. Some alternatives, as mating plans, can be used to limit inbreeding progression. However, these alternatives slow down the genetic progress and do not make it possible to anticipate with precision the increase of inbreeding. The Optimum Contribution Selection (OCS) method maximizes the genetic gain while limiting the increase in inbreeding via an optimization equation. This optimization is done when selecting candidates at weaning and takes into account their degree of relationship, their contribution to the population, and their genetic value. The OCS method has been tested for routine application on the C line to measure the impact on genetic gain and livestock management. A comparison of the genetic gain was performed with the current truncation method of selection and the OCS method. A genetic gain up to 10 times higher is obtained using OCS method with a decrease of inbreeding. The implementation of this tool would not result in any significant change in livestock management, and would remove some constraints related to the management of inbreeding.

Iannucelli N., Cabau C., Sarry J., Bouchez O., Billon Y., Riquet J., Allain D., Demars J., 2021. Heterologous hybridization using the human exome - A molecular tool to target and identify major genes. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-11, 4 pp.*

Identifying causal mutations responsible of phenotypes in a time and cost-effective manner remains a challenge still for all species. Although the portfolio of next-generation sequencing methodologies offers a broad range of opportunities nowadays, having the right and suitable molecular genetic tools in non-model organisms is often an issue. For the European

rabbit (*Oryctolagus cuniculus*), considered as an animal model for experimental research, the OryCun2.0 reference genome was released in 2009 and the Affymetrix AxiomOrcun SNP Array was made available in 2016. This novel beadchip gives the possibility to develop conveniently genome-wide association studies (GWAS) in rabbits without however freeing itself from the subsequent steps of causal mutation characterization. Whole exome sequencing (WES) appears as a direct and suitable strategy to target and sequence variants all at once. Unfortunately, no exome enrichment tool exist for rabbits. Here, we proposed to capture the rabbit exome using the marketed human panel since human and rabbit genomes are closely related on the phylogenetic tree of species. We performed heterologous hybridization for 48 rabbits from 7 different populations and generated 2 billion sequencing reads for the whole dataset. The quality of the heterologous hybridization allowed the capture of the rabbit exome and enabled a dataset of 40,000 confident variants that specifically target both protein-coding and extended exons. This method also presents a unique opportunity to investigate both (i) the genetic diversity of different rabbits' breeds and (ii) the mendelian determinism of specific phenotypes in rabbits without resorting to costly customized tools.

Kasza R., Matics Zs., Gerencsér Zs., Szendrő Zs., Nagy I., Csóka Á., Donkó T., 2021. Connection between the computed tomography (CT) estimated total body fat content of rabbits at 10 weeks of age and before the first insemination. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-12, 4 pp.*

The experiment was conducted at Kaposvár University with Pannon Ka rabbits. Divergent selection process was made during four generations for estimated total body fat content. Fat index was calculated at 10 weeks of age by determining the ratio of the total body fat volume (cm³) estimated by computer tomography (CT) to the body weight (kg). Based on the fat index two lines were formed: the rabbits with the lowest fat index belonged to the Lean selected and that of the highest values belonged to the Fat selected lines. The fat index of rabbit does was checked before the first artificial insemination at the same way. In the 1st and 2nd generations there were low positive correlations found between the fat indexes at 10 weeks and before the first AI (R = 0.570 and 0.510 respectively; P<0.001). In the 3rd and 4th generations correlations were medium (R = 0.740 and 0.830 respectively; P<0.001). According to the results obtained, the selection method based on 10-week-old fat indexes is suitable for selecting rabbits for breeding. It may be worthwhile to carry out the selection in two steps, by filtering out the "outlier" individuals based on the estimated body fat content before breeding.

Laghouaouta H., Sosa-Madrid B.S., Zubiri-Gaitán A., Blasco A., Hernández P., 2021. Genome-wide association study for fatty acid composition in rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communiucatiob BG-14, 4pp.*

Fatty acid composition is a key trait influencing the nutritional and organoleptic quality of meat. A divergent selection experiment for intramuscular fat content in rabbits was performed during nine generations, showing a correlated response on the fatty acids profile. A genome-wide association study was carried out on the selected lines in order to identify genomic regions associated with the fatty acid composition. The studied traits were saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and the ratios PUFA/SFA, MUFA/SFA, and N6/N3. Bayesian statistics under the Bayes B model were used to analyze the genomic data of 475 rabbits from the two lines. Main genomic regions harboring genes related to lipid metabolism were identified in rabbit chromosomes (OCU) OCU1, OCU3, OCU8, OCU9, OCU17, and OCU18. A relevant region at 46.0-49.2 Mb on OCU18 overlapped for SFA, MUFA, and the ratio MUFA/SFA. This region explained 7.91%, 1.90%, and 0.55% of the genomic variances of MUFA/SFA, MUFA, and SFA, respectively. In addition, an important genomic region at 34-37.9 Mb on OCU1 overlapped for SFA, PUFA, PUFA/SFA, and N6/N3. This region explained up to 11.32 %, 1.89%, 2.78%, and 1.26% of the genomic variance of SFA, PUFA, PUFA/SFA, and N6/N3, respectively. Main genes retrieved by functional analyses were: SCD, PLIN2, ERLIN1, and LIPC. These genes bear a crucial role in lipid metabolism. The main genomic regions in which we found genes related to lipid metabolism were not previously detected in our experiment for IMF. MTMR2 is the only gene that was associated with both the fatty acid composition and the IMF content. Further analyses would be necessary in order to corroborate the associations identified by this study.

Machado L.C., Faria C.G. S., Zeferino C.P., Castilha L.D., Silveira J.M.M., Silva V.G.P., Pereira D.L., 2021. Productive performance and mortality in growing rabbits from different genotypes. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-15, 4 pp.*

This study evaluated the effect of genotype on productive performance and mortality in growing rabbits. A total of 192 growing rabbits from New Zealand White, Botucatu genetic group and crossbreeds were used for productive performance (32 to 67 days), and a total of 451 kits from 62 kindlings were used for mortality rate. Although there was no difference in feed intake and feed conversion after weaning, Botucatu and crossbred rabbits were heavier at 18, 32 and 67 days of age (P<0.05) These rabbits also showed greater potential for daily weight gain and lower pre-weaning mortality rate. The present

study contributes indicating the production of crossbred and Botucatu rabbits, however, additional research evaluating alternatives for reduced pre-weaning mortality rate in Brazilian conditions need to be performed .

Nagy I., Farkas J., Atkári T., Kövér Gy., 2021. Estimating lethal equivalent of the Pannon White rabbit population applying generalised linear mixed models. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-17, 4 pp.*

The closed Pannon White rabbit population has long and complete pedigree making it highly suitable for inbreeding studies. Survival of rabbit kits at birth is modelled as a binary variable applying generalised linear mixed models (GLMM) based on the log link function. Modelling was performed taking into account the inbreeding coefficient of the kit, inbreeding coefficient of the dam, season of parturition, parity of the dam and animal. Based on the monthly averages of the survival of rabbit kits at birth the analysed period (1992-2017) was divided to two periods (1992-1997 and 1997-2017). Altogether 22718 kindling records were analysed. The estimated regression coefficients for the inbreeding coefficients of the kits and for the dams were -0.20 ± 0.27 and -0.41 ± 0.36 and 0.05 ± 0.08 and -0.01 ± 0.09 in the first and second periods, respectively. This corresponds to the lethal equivalent of 0.2 in the first period, which disappeared in the second period. Due to the large standard errors, the results were not significant.

Oseni S.O., Bashiru H.A., Atumah C., 2021. *On-farm* phenotypic characterization of heterogeneous rabbits for fertility and reproductive performance in south-western Nigeria. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-18, 4 pp.*

This study assessed the effect of litter size at birth (LSB) class, doe body weight at conception (DWC), sire group (SG) and parity (P) on the fertility and litter performance in a heterogeneous population of rabbits in southwestern Nigeria. Data on 72 litters across 2 parities from 7 bucks and 42 does were analyzed. Fertility and pre-weaning growth performance and survival traits investigated included LSB, number of mating per conception (NMC), litter sizes and weights at 7, 14, 21 and 28 d post-kindling, pre-weaning survival rate (SR) and daily weight gain of kits from kindling to weaning. Data were analyzed using GLM procedure of SAS® . A linear model that included fixed effects of LSB classes (low, medium and large litters) DWC (light vs. heavy does), SG and P (one or two) was used. Results showed that higher performance for LSB and NMC were obtained in the second parity (P0.05). It was concluded that kits born in low-sized litters were observed to have higher weight at kindling and higher daily weight gain at weaning and that does exhibited superior reproductive performance in the second parity.

Piles M., Tusell I., Velasco-Galilea M., Ballester M., Sánchez J.P., 2021. A comparative study of support vector machine and GBLUP to predict average daily gain from single nucleotide polymorphisms. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-19, 4 pp*

This study compares the accuracy of prediction of total genetic effects, i.e. additive and non-additive genetic effects, of average daily gain (ADG) from single-nucleotide polymorphisms (SNPs) using radial basis function Support Vector Machine, (SVM) and a genome-enabled best linear unbiased prediction model (GBLUP) as benchmark. The target examples were 425 ADG records which were previously adjusted for environmental systematic effects. After quality control and selection of one SNP per linkage group 14,710 SNPs were retained. A nested resampling was implemented. For analysis with SVM, in each training set of an outer 6-fold cross-validation, SNPs were first ranked using their rank correlation with the adjusted ADG records. Then, hyper-parameter tuning was performed using an inner 6-fold crossvalidation in each training set for different learner configurations including as predictor variables different subsets with increasing number (50, 100, 200, 300, 500, 1000) of the best ranked SNPs and a set with all of them. Finally, prediction performance was evaluated in the outer testing sets using the median of the Spearman's correlation (SC) between predicted and adjusted phenotypes. Same pairs of training/test sets were used for prediction of adjusted ADG records using GBLUP. The best prediction performance was obtained with SVM with a subset of 1000 SNPs. In this case, the median (Md) of SC was 0.34 with an interquartile range (IQR) of 0.20 for this parameter. When prediction was performed using GBLUP with all SNPs, the Md of the SC was 0.28 with an IQR of 0.12. The selected subset of SNPs that have been identified could be potentially used in selection to boost genetic progress of ADG.

Piles M., Sánchez J. P. , Pascual M., Rodríguez-Ramilo S. T., 2021. Inbreeding depression on growth and prolificacy traits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-20, 4 pp*

This research aims at estimating inbreeding depression for growth and prolificacy traits in a rabbit population selected for growth rate for 60 generations. Data corresponded to 173,485 individuals of the Caldes line founded in 1983. The effects of old, intermediate and new inbreeding (Fold, Fint, Fnew), as well as classical (i.e. total cumulated) inbreeding (F) and 3

measures of ancestral inbreeding (AHC, Fa.K and Fa.B) were estimated for average daily gain (ADG), slaughter weight (SW), number of kits born alive (NA), total number of kits (NT) and number of weaned kits (NW). For growth traits the effect of inbreeding was estimated with a model that included the fixed effects of year of birth, parity order and litter size as well as the corresponding inbreeding coefficient as a covariate (or alternatively the addition of Fold, Fint, Fnew covariates), plus the random effects of litter, batch and additive genetic effects. For the analysis of prolificacy traits, the model included the fixed effects of year of birth, physiological status of the female at mating in addition to the covariate corresponding to the inbreeding coefficient, as for growth traits, and the random effects of dam, batch and additive genetic effects. There was a clear inbreeding depression for all growth and prolificacy traits (-10 g/d, -506 g, -7.4 kits, -6.2 kits and -6.2 kits for ADG, SW, NA, NT and NW, respectively on F). Ancestral inbreeding coefficients Fa.K and Fa.B had also a negative effect on all traits, and results were not significantly different to those obtained with F. However, the effect of Fold and Fint was null whereas it was negative for Fnew, on growth traits but not on prolificacy traits. Similar results to those obtained for Fint and Fold were also observed using AHC, suggesting the possibility of purging by selection of deleterious recessive alleles affecting growth.

Piles M., Tusell L., Velasco-Galilea M., Helies V., Drouilhet L., Zemb O., Sánchez J.P., Garreau H., 2021. Machine learning algorithms for the prediction of feed efficiency based on caecal microbiota. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-21, 4 pp*

This study aimed at predicting feed conversion ratio (FCR) of young rabbits from abundances of amplicon sequence variants (ASVs) to improve this trait by selecting animals with the most favorable microbiota and identifying the most relevant microorganisms involved in feed efficiency. Data come from two rabbit populations coming from paternal INRA 1001 line (the G10, selected for 10 generations for decreased residual feed intake and the G0 control produced from frozen embryos of the common ancestor line). There were 296 and 292 FCR data from G10 and G0 individuals, respectively. Phenotypic data were pre-corrected for the systematic effects of group, batch, litter size and sex and the random litter effect. Sequence quality control and chimera removal were performed with the DADA2 pipeline. Samples with less than 5,000 final sequence counts and doubleton ASV were removed. The ASV counts of the final table (including 918 ASVs) were centered log-ratio transformed and corrected for batch effects with a surrogate variable analysis. Nested resampling for hyper-parameter tuning and prediction validation was implemented leading to 25 pairs of training/test sets. Bayesian regression models (Bayesian Lasso, Bayesian Ridge Regression and Reproducing Kernel Hilbert Spaces) and machine learning algorithms (Support vector machine and Elastic net) were fitted to all ASVs leading to an almost null prediction accuracy in all cases. Then, ASVs were ranked for their prediction importance using the permutation accuracy importance score in a Random Forest algorithm based on conditional inference and, different subsets of increasing size (50, 100, 150, 200, 300, 400, 500, All) of the most important ASVs and surrogate variables were used as predictors in the machine learning algorithms. The best performance and the most stable results were obtained with machine learning using the 100 most important ASVs being most of them assigned to order Clostridiales. The medians of the Spearman correlation (interquartile range) were 0.33 (0.09) and 0.32 (0.06) for SVM and ENET, respectively.

Savietto D., Debrusse A.M., Bonnemère J.M., Labatut D., Aymard P., Fortun-Lamothe L., Gunia M., 2021. Characterization of the French rabbit breed Fauve-de-Bourgogne in an intensive system. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-22, 4 pp*

A characterization of the French local breed Fauve-de-Bourgogne was realized on a population of 48 rabbits (11 males and 37 females) gathered from five different amateur farms located in the French regions of Alsace, Lorraine and Bourgogne. We checked the growth of future breeders, the female reproductive performances and their feed intake during the first 10 days of lactation, as well as the kit survival and growth. Fauve-de-Bourgogne female rabbits have an adult weight of about 4.3 (± 0.43) kg and reached 84% of the adult weight around 5 months old. Under a reproductive rhythm of 42 days, reproductive performances were low. Fertility rates averaged 60% and litter sizes at birth averaged 4.3 (± 2.7) newborn. On average, females weaned (at 35 days) 3.4 (± 2.4) kits weighing 720 (± 170) g. In the absence of antibiotics supplementation, kit survival was as high as 83% and growing animals reached 1649 (± 192) g at 65 days old.

Utzeri V.J., Ribani A., Fontanesi L., 2021. Variability in the tyrosinase (TYR) gene (the albino locus) in domestic and wild rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-23, 4 pp.*

Disrupting mutations affecting the TYR gene cause different forms of albinism in mice, humans, and several other mammals. Classical genetic studies have already reported five alleles at the rabbit Albino locus, indicated to be part of the C series, each of them with different actions on pheomelanin and eumelanin production, as well as on the eyes. A few of these alleles

have been already characterized at the DNA level by sequencing the coding region of the rabbit TYR gene in a few breeds or strains with specific alleles at this locus. In this study, we further characterized the TYR gene in rabbits by sequencing about 2000 bp encompassing all coding regions and flanking regions in a total of 25 rabbits from 11 domestic breeds (2 Belgian Hare, 2 Burgundy Fawn, 3 Californian, 3 Champagne d'Argent, 2 Giant Chinchilla, 1 Giant Grey, 1 Havana, 2 Lepirino di Viterbo, 4 New Zealand White, 2 Silver and 3 White Vienna) and other 11 wild rabbits hunted in Sardinia. Sequencing data identified a total of 15 mutations. We confirmed five missense mutations already detected by other studies, three of which associated with different coat colour phenotypes: p.T373K determining the albino allele; p.E294G causing the Himalayan and the chinchilla allele; p.T358I observed only in Chinchilla rabbits. In addition to seven other synonymous mutations and one polymorphism in the 3'-untranslated region (UTR), two novel missense mutations (one identified only in wild rabbits), were identified. This study further contributed to disclose the variability in the TYR gene in different rabbit populations and confirmed the effect of functional mutations at this locus.

[Zhang Kai](#), Fu Xiangchao, Liu Ning, Wen Bin, Xu Changwen, Du Dan, Yu Zhiju, Jian Wensu, Wang Ping, Guo Xiaolin, Wang Lihuan, Liu Hanzhong, 2021. Rex rabbit illumina sequencing and bioinformatics analysis on miRNA in testes. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-24, 3 pp.*

miRNA as a kind of micromolecule non-coding RNA with the length of about 22 bp plays an important regulatory role in reproductive biology and spermatogenesis. This research uses Illumina sequencing technology to conduct miRNA sequencing on three seven-month adult male rabbits, aiming at evaluating the quality of high throughput sequencing in testes rabbit miRNA data mining, and exploring the biological characteristics of miRNA in testes tissues. Results show that, the quality, the purity of total RNA and integrity of the total RNA were good, which can meet the requirements of construction of small RNA library and the applicability of obtained sequence in subsequent miRNA identification analysis. Uniq reads accounted for 24.17 % of the total sequences. The length of RNA was mostly between 22 - 31 nt, which takes up more than 89.32 % of pure sequences. Nonetheless, 82.86 % of cleaned sequence were not mapping to previously known long and short RNA. miRNA sequence length imbalance may be related to the action mechanism and specific functions of miRNA in testes tissues.

[Zubiri-Gaitán A.](#), Martínez-Álvaro, M., Hernández P., Blasco A., 2021. Correlated response to selection for intramuscular fat on the gut metagenomic profile. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication BG-25, 4 pp.*

A divergent selection experiment for intramuscular fat content (IMF) in Longissimus Thoracis et Lumborum muscle was performed in rabbits during 10 generations at the Universitat Politècnica de València, to study the mechanisms involved in the intramuscular fat deposition. The scope of this experiment was to analyze the correlated response to selection on the gut metagenome, in order to try to elucidate the role of the microbiota and its genes on the mentioned mechanisms. A total of 89 rabbits from the 10th generation of selection were used to estimate the correlated response to selection on the gut metagenome. Once the metagenome dataset was obtained, the data was transformed using compositional data analysis techniques in order to deal with its compositional nature. Projection to latent structures (PLS) and discriminant PLS (PLS-DA) analyses were used to find the microbial genes affected by selection. The most important variables for both models were those that had a variable importance in projection (VIP) ≥ 0.80 and a confidence interval of the Jack Knife regression coefficient did not include the zero. The PLS-DA model included 240 microbial genes and was able to correctly classify all the samples after a cross-validation procedure. The PLS regression model, on the other hand, included 230 microbial genes with a linear prediction ability of IMF content of 79% after cross-validation (Q₂). Only 122 microbial genes that overlapped between the results of PLS-DA (240) and PLS (230) were considered, helping to differentiate the ones actually related with IMF from those that were fixed due to genetic drift. The sign and magnitude of the correlated response to selection on each microbial gene were estimated as the difference of the relative abundance between the lines, in a linear model that included the line effect. The model was solved using Bayesian inference, and assuming flat priors for all unknowns. The marginal posterior distributions of the mentioned differences were described by the median, highest posterior density interval at 95% probability, and the probability of these differences of being higher or lower than 0. Finally, the metabolic routes affected by those genes were identified thanks to the information provided by the KEGG database. The majority of them were involved in cell wall membrane synthesis, energy production and conversion, and transport and metabolism of lipids, amino acids and coenzymes. Divergent selection for IMF led to a modification of the gut metagenome, confirming the existence of a link between the host genome and its metagenome. However, a more exhaustive analysis of the genes and the metabolic routes, together with the study of the microbial taxa involved, is necessary to fully understand the role of the microbiome in the intramuscular fat deposition.

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Invited paper

Rödel H.G., 2021. Aspects of social behavior and reproduction in the wild rabbit – implications for rabbit breeding ? (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-00, 15 pp*

Further knowledge on aspects of social behavior in the wild rabbit (*Oryctolagus cuniculus*) including the link to reproduction could possibly point to new ways how to improve housing and breeding conditions in rabbit farming. In our long-term study on a 2-hectare field enclosure population of wild rabbits, we explored group-level and individual-level differences in agonistic behavior of females and their potential associations to reproductive traits including offspring survival. The frequency of agonistic behavior in which females were involved increased with increasing group size, and was lower in groups with a more heterogeneous age-structure. At the individual level, reproducing females were involved in more agonistic interactions when groupmates gave birth and thus built their burrows and nests at around the same time, and higher-ranking mothers were particularly aggressive when other females approached close to their nursery burrows. Associations between females' social environment and reproduction were evident as the numbers of litters and offspring per female were lower at higher female densities, high-ranking females produced more offspring and had a lower offspring mortality than low-ranking ones, and cases of infanticide were lower in more stable groups which we quantified by the more heterogeneous age structure of the females' rank hierarchy in such groups. Furthermore, perinatal offspring mortality was increased in females with a delayed burrow and nest building activity, i.e. which dug their nursery burrow and built their nest only during the last 24 h prepartum, possibly driven by the more unfavorable social environment experienced by such females. Most importantly, our studies highlight the importance of the presence of litter siblings in improving an individual's social environment, which resulted in an earlier onset of breeding in such females. Higher levels of positive social interactions with litter siblings were also associated with lower stress hormone (corticosterone) levels and with a better health status in terms of lower loads with an intestinal nematode. These findings on ameliorating effects of litter sibling presence in growing rabbits as well as in reproducing females may be a promising starting point worth further exploration in the context of group housing of domestic rabbits.

Short communications

de Greef K.H., Rommers J.M., 2021. The Dutch route to improve commercial rabbit welfare – rather collectively than by law enforcement. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-01, 4 pp.*

A desk study was performed to study welfare directed innovations in the Dutch Rabbit sector. Four innovations in the last two decades that have considerably affected the animal welfare conditions in commercial rabbit farms were identified. Introduction of a simple plastic mat to reduce painful foot lesions, and three housing systems adaptations (welfare cage, parks, and part-time group housing of does) have brought the animal welfare of all commercial rabbits in The Netherlands well above European standard levels. The key message is that, strikingly, the major welfare directed improvements were not primarily developed by science, and not primarily enforced by law. Rather, practical initiatives of farmers were the essential steps. Self-imposed regulation was used to maintain collectivity (prevention of free riding) and successes were enhanced by technical advantages and market benefits.

Dutra D., Villegas-Cayllahua E., Ferrari F., Costa M., Rein A., Silva A., Moraes P., Borba H., 2021. Cage floor enrichment contributes to physical and thermal comfort of fattening rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-02, 4 pp*

The aim of the study was to evaluate the effect of enriched cage floor on behavioral and physiological traits of 90-d fattening rabbits. A total of 45 males were individually housed in wire cages. Two types of cage floor enrichment were compared (clay tile vs porcelain tile), whereas 15 all-wire floors were assigned as control. Animals could freely choose between tile floor or wire-mesh. Rabbit behavior was observed through 3 days and scanned every 15 minutes, 8 hours daily. Superficial body temperature was determined hourly and respiratory frequency (fR) 3 times a day. Time budgets showed that activity and posture categories were poorly influenced by the type of floor and had no effect on behavior. Although the choice between clay and porcelain tile did not differ significantly, the animals spent more time on the floor tile than on wire-mesh (66% vs 34% observation time; $P < 0.001$). Overall fR decreased by 10.7% in rabbits kept on the porcelain tile compared to the others ($P < 0.01$). In addition, ears and muzzle temperatures were higher ($P < 0.01$) in rabbits with no floor enrichment in their cages (ears: +3.1 °C; muzzle: +1.9 °C). These results demonstrated that cage floor enriched with tiles, especially porcelain tile, affects positively the thermoregulation and can be used to improve physical and thermal comfort of fattening rabbits.

Fetiveau M., Savietto D., Warin L., Pujol S., Gidenne T., Huang Y., Fortun-Lamothe L., 2021. Outdoor access for growing rabbits: effect of stocking rate on behaviour and performance. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-03, 4 pp.*

The aim of this work was to study the effects of stocking rate and outdoor access on the spatial distribution, the reactivity to a new environment, behaviour and performance of growing rabbits between 31 (D31) and 73 days of life. Two hundred and ninety nine weaned rabbits were distributed into four groups according to a 2 × 2 factorial design including the access (O group) or not (N group) to an outdoor range of 23.2 m² and the indoor stocking rate (high or low: 17 or 9 rabbits / m²; H or L groups, respectively), leading to 4 groups: OH (n=100), NH (n=99), OL (n=50) and NL (n=50). Every week, live weight and health status were checked on each rabbit. The rabbits' behaviour was assessed at D57 and D71 at 07h00, 14h00 and 19h00. Reactivity to a new environment (access to the range) was assessed during 20 min at D34, D51 and D62. Stocking rate had no effect on mortality, however outdoor access tended to increase mortality rate (7.3 vs 2.7 %, P<0.10). Average daily weight gain was higher in N compared to the O groups (+3.6 g/day; P<0.001) and L compared to H groups (+1.2 g/day; P<0.05). The latency time for the rabbits to access outdoor area for the first time increased with age (50 seconds at D34 against 10 min at D62; P<0.001), without effect of stocking rate. Regarding activity and space use, rabbits were more often active in the outdoor area than in the indoor pens (39% vs 18% at D57, P<0.001, and 34% vs 21% at D71, P<0.05). Stocking rate did not impact behaviour traits measured at D57 and D71. In conclusion, outdoor access increased the diversity of the behavioural repertoire of growing rabbits, but slightly reduced health status and growth without interaction with stocking rate.

Fortun-Lamothe L., Breda J., Savietto D., Aymard P., Combes S., Gidenne T., Warin L., Huang Y., 2021. Space use and exploratory behaviour in growing rabbit housed in large partitioned pens . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-04, 4 pp.*

Housing rabbits in large groups is believed to improve their welfare. We designed large partitioned pens by connecting 4 individual enriched cages (elevated platform, burrow and gnawing wood) through a hatch located at the platform level. The aim of this work was to study the space use, exploring behaviour and mixing of rabbits from different litters in such large partitioned housing system. A total of 222 growing rabbits, from 28 litters of 8 rabbits, were used from 35 (weaning; D35) to 63 days of age. Litters were housed separately with their does in individual cages until weaning. At D35, does were removed and each four adjacent cages were connected together opening the hatches between them. The use of space allowance, burrow and platform as well as mixing of litters within a pen were measured through direct observations made several times a week and a video recording (40 min at D62). The proportion of rabbits staying within their birth cage decreased with time (56% vs 30% in week 1 vs week 5; P < 0.001). At D62, 56% of rabbits were in contact in groups of two or more congeners, of which 26% within groups containing 4 or more rabbits. The proportion of rabbits in the burrow increased from 2% (week 1) to 12% (week 5; P < 0.001) and at D62 a rabbit entered or left the burrow on average every 15 min. The proportion of rabbits on the platform was stable along the experiment (19%) and at D62, a rabbit reach or left the platform on average every 11 min. These results illustrated the gregarious and exploratory behaviour of growing rabbits. Such a housing system offered perspectives to design new housing that would improve the welfare of growing rabbits while remaining compatible with all-in all-out rabbit farming system.

Gerencsér Zs., Farkas T.P., Nagy I., Odermatt M., Radnai I., Kasza R., Matics Zs., Szendrő Zs., 2021. Location preference of rabbit does in a pen system combining group and individual housing. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-05, 4 pp.*

The aim of the experiment was to test the preference of rabbit does in a special pen system of combination of group and individual housing. The experiment was conducted at Kaposvár University with multiparous pregnant and lactating Pannon White rabbit does (n=48). The 1.83 x 2.00 m open top pen consisted of four individual cages (0.5 x 0.91 m) which were connected to the 1.83 x 1.00 m common area throughout a 0.25 m long and 0.20 m wide lockable corridor. The rabbit does were randomly divided into three groups (3 experimental units per group). The groups differed in the material of walls of the individual cages: pen with solid wall cages (Solid, n=16); pen with wire-mesh wall cages (Wire, n=16) and pen with two solid and two wire-mesh wall cages (Mix, MP, n=16). Four rabbit does were placed into one of the closed individual cages 3 days before the expected parturition for 21 days. Day 18 after kindling the entrances of the individual cages were opened, and a 21-day group-housing started. During this period, 4 does and their kits in each pen could use all individual cages and the common area freely. The kits were weaned at 35 days of age. The injuries on ears, and body of does were checked on days 2, 4, 8, 14 and 22 after grouping. The 24-h video recordings were made on days 1, 2, 3, 7 and 13 after opening the doors,

and location of does was registered at every 15 min. On day 1, rabbit does preferred to stay alone than together (Solid: 62.3%; Wire: 64.3%; Mix: 82.8%). Later on, less rabbit does located alone (on day 13: Solid: 30.8%; Wire: 51.0%; Mix: 39.2%). On day 1 in all pens the majority of the does located in the individual cages (Solid: 77.3%; Wire: 76.8%; Mix: 83.9%), however later the percentage of does in the individual cages decreased until day 13. At almost every day less rabbit does preferred the individual cages in the Solid than in Wire or Mix group. The ratio of injured rabbits was higher than 50% in each system. Based on the results it can be concluded that the main problems of group housing of does (aggressiveness, injuries) have not been solved in this system.

Guené-Grand E., Davoust C., Launay C., 2021. A new alternative outdoor housing method (Wellap®) for fattening rabbits: first results. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-06, 4 pp.*

Animal welfare has become a very important theme for animal production, including rabbits. A new project for alternative housing system, named Wellap®, has been set with several elements: behavior, feeding, know how on farming and building. The aim of the present trial is focused on the behavior of rabbits, housed in pens, having free access to the outside 24/24 h, 7/7 d, and exposed only to natural light. Half of the pens (n= 3 pens of 50 rabbits per group, 4m² inside and 8m² outside,) contained dusty wood chips and the other half contained duck board on the entire surface of the inside pen. Pens were enriched with gnawing blocks and double-level platform. Sanitary status, intake of gnawing blocks were recorded and behavior of rabbits was evaluated 3 times a day, 5 d/7 during the whole period of fattening . Rabbits were fed restricted during the fattening period (100, 120, 134, 150 and 170 g/day for the 5 weeks of the trial). At the end of the trial, the sanitary status was better for rabbits from the pens with duck board compared to pens with wood chips; 0 dead vs. 4 respectively (p=0.04). The percentage of rabbits outside was 30% of the total at 8:30 in the morning; 4.9% at 11:00 am, and 15.6% at 3:00 pm. Growth performance are penalized by the very strict feed restriction (body weight at 70 days of age was 2.341 kg, lower than the Hyplus PS19xPS59 standard that mentions 2,560 kg) and by the feed which is deliberately not very energetic in order to secure the sanitary status. This very innovative system demonstrates that raising rabbits with access to the outside is possible, even if arrangements concerning feeding are necessary and are in progress.

Guené-Grand E., Davoust C., Launay C., 2021. A new alternative outdoor housing method (Wellap®) for fattening rabbits: behavior and space use. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-07, 4 pp.*

Animal welfare has become a very important topic for animal production, including rabbits. A new project for alternative housing system, named Wellap®, has been set with several elements: behavior, feeding, know-how on farming and building. The aim of the present trial is to characterize the behavior of rabbits, housed in pens, having free access to the outside 24/24 h, 7/7 d, and exposed only to natural light. Half of the pens (n=3 pens of 50 rabbits per group, 4 m² inside and 8 m² outside) contained dusty wood chips and the other half (n=3) contained duck board on the entire surface of the inside pen. Pens were enriched with gnawing blocks and double-level platforms. Video-recordings were made every day, for 30 minutes at 3:00 am, 7:30 am, 12:30 pm, 06:00 pm and 11:00 pm. Then, the number of rabbits outside was assessed as well as some behaviors of rabbits (interactions, number of straightened rabbits, action of gnawing). An adaptation period to their new environment, the separation from the doe and the presence of others congeners was observed and lasted 10 days. The average percentage of rabbits outside was 13%, and rabbits went outside more during the day. There was no effect of the floor type inside the pen on the number of rabbits outside. It seems that rabbits accessed the outdoor area more when inside temperature increased, whereas there was no relationship between humidity and the number of rabbits outside. The interactions among rabbits were distributed throughout the day. The highest number of straightened rabbits was recorded at 3:00 am and at 11:00 p.m. possibly linked to a vigilance behavior. The action of gnawing the blocks was very low at 6:00 pm and 12:30 pm, likely because this was just after the distribution of the feed and rabbits were no longer hungry, so they didn't gnaw. These results are the first evaluating the space use of rabbits and their behavior in the Wellap® concept, where rabbits are free to go out when they want.

Huang Y., Breda J., Savietto D., Labatut D., Pujol S., Combes S., Gidenne T., Warin L., Fortun-Lamothe L., 2021. Effect of housing and enrichment on behaviour and performance of growing and reproducing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-08, 4 pp.*

One way to improve rabbit welfare is to enable rabbits to express their natural behaviours. The aim of this study was to investigate the effect of housing and enrichments on behaviour, performance and mortality of growing rabbits (trial 1, n = 294), does and their kits (trial 2, n = 40 females over 2 cycles). The modifications concerned size of housing (length to allow jumping, height to allow standing up), enrichment (gnawing or scratching materials, platform for jumping, burrow for hiding),

floor type (wire or plastic mesh) and/or group size. These modifications were implemented separately each other or together. The productive performance of growing rabbits and reproductive does was not influenced by the housing system. In trial 1, behaviours such as standing up, gnawing, jumping and walking were rarely observed (< 5%), but the burrow was frequently occupied (35%). In trial 2, inclusion of gnawing blocks increased gnawing activity. The platform permitted standing and jumping of does, but the proportion of time spent for this activity remained low (0.1%). On the floor, does were more often on plastic-mesh than on wire-mesh (62 vs. 38 % of observations; $P < 0.001$). The frequency of does on plastic-mesh decreased from 68% the week of parturition to 60% at weaning ($P < 0.05$), related to increased area occupation by suckling kits ($P < 0.001$). We confirmed that the enrichments tested allow rabbits to express or increase the frequency of natural behaviour

Huang Y., Breda J., Savietto D., Debrusse A., Combes S., Gidenne T., Warin L., Fortun-Lamothe L., 2021. Part-time grouping of rabbit does in enriched housing: effects on spatial position, performance and lesions. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-09, 4 p.*

Group housing of does is hypothesized to improve animal welfare through favouring positive social interactions. We built a part-time group housing system for does by connecting 4 individual housing units through hatches. The part-time group housing system included a platform, a gnawing block, and a burrow. Spatial position, health and injury frequency of does and kits were evaluated for 32 females and their litters housed in 8 part-time group housing systems. Reproductive performance were compared to a control group ($n = 8$ females housed individually). The grouping started at D12 (D1 = artificial insemination), it was interrupted after 10 days (at D22) due to increased injuries rates and severity caused by fighting: injured does increased from 25% (D13) to 63% (D22), and severely injured does increased from 0% (D13) to 28% (D22). The weight gain during the experiment was similar between groups. The litter size at weaning was lower in the part-time group housing system than in individual housing (9.2 vs. 10.0, $P < 0.01$). At D22, the proportion of does having injuries was high in part-time housing group (53% of 32 does). The platform were used for 32% of the observation time. Does were observed more frequently on the platform during the last two weeks of the experiment just before weaning their litter (66% and 47% of the total observation, $P < 0.05$), confirming that the platform offered does the possibility of escaping from their kits once they leave the nest box. In conclusion, a partitioned enriched housing with burrow for animal refuge did not permit to reduce fighting between group-housed does, it caused high level of injuries and reduced reproductive performance.

Laclef E., Savietto D., Warin L., Huang Y., Bonnemère J.M., Combes S., Gidenne T., Fortun-Lamothe L., 2021. Part-time group housing of familiar rabbit does in large partitionned space: effects on performance and behaviour . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E 10, 4 pp*

The aim of this work was to study the effect of a part-time collective housing of females raised together since their birth on their performance, use of space and behaviour. We used 40 females born on the same day (D0) and being suckled by 8 females until D35 (8 litters of 5 'sisters of milk'). The 'sisters of milk' were housed together, by litter, in the same housing until D84 and were followed during two reproductive cycles (from D84 to D245). At D84, 8 young females (1 per litter) were separated to be individually housed until D245 (I group; $n=8$ females). The others 32 females were housed in 8 modules of 4 individual housing that could be linked together via connection hatches between two housing (G group), inducing a large and partitioned habitat (36 388 cm² against 9 097 cm²). In G group, females were isolated from 4 days before to 17 days after the birth (D171 to D191 and D213 à D233 in 1st and 2nd cycle) and were grouped the rest of the time. Space use and social interactions were measured by direct observation twice a day and two days a week from D84 to D245 and by 40-min video recordings at D120 and D168. Behaviour along the day was measured at D151 by 26 direct observations throughout the day. Housing system had no effect on live weight nor fertility, but female mortality was higher in the G compared to I group (34 vs 0%; $P < 0.05$). Group housing allowed the observation of positive social interactions (11% of total behavioural observations) but we also observed injuries (68% of females of G females throughout the experiment of which 19% had middle or severe injury scores). The number of positive interactions was high and the number of injuries low at young ages (from D84 to D170; $P < 0.05$). On the opposite, the number of injuries in grouped females was higher during reproductive life than before first kindling (27 and 19% of severe wounds in 1st and 2nd cycle vs 2% before D170; $P > 0.05$). Although in both groups, females were observed mainly on the floor (70% of observations), the number of vertical movements of grouped females was 3 times higher than isolated ones (1.8 and 1.2 vs 0.6 and 0.4 no./h in G vs I group at D120 and D168; $P < 0.05$). These results suggested that the group housing of young females that knows each other in a large partitioned space before their first kindling is a promising way to improve animal welfare. On the opposite, collective housing in lactating does is detrimental to animal health and should be avoided, even among females raised together since birth.

Pasqualin D., Zomeño C. Santagiuliana M., Dalla Costa A., Trocino A., Lavazza A., Dorigo F., Bonfanti L., Birolo M., Xiccato G., Menegon F., Di Martino G., 2021. A protocol for measuring health and welfare of reproducing does and litters in rabbit farms. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-11, 4 pp*

A standardised protocol was used to evaluate health and welfare of lactating does and their litters on 12 commercial farms of the North of Italy in 36 visits (three per farm) during three productive cycles (autumn, winter, and summer) over one year. Farms used four different housing systems (standard breeding cages, dualpurpose breeding cages, enriched cages, and parks). At late lactation (27-31 d after kindling), 82% of does had adequate body condition score (BCS). The main health concerns were diarrhoea (mean prevalence: 6.6%), ulcerative pododermatitis (3.4%), mastitis (3.0%), and dermatomycosis (2.8%) in does; dermatomycosis (1.6%) and diarrhoea (1.1%) in litters. Regarding the housing system, the females kept in parks and enriched cages were heavier (4968 g and 4914 g vs. 4431 and 4765 g) and had a higher BCS than those in standard and dual-purpose cages ($0.001 < P < 0.01$). Litter size was higher in parks and enriched cages (9.18 and 8.61) than in standard and dual-purpose cages (8.08 and 8.21); kit weight was higher in dual-purpose cages (575 g) and lower in standard and enriched cages (541 g and 540 g) ($P < 0.001$). The prevalence of health concerns in does and litters was similar across all housing systems. Performance and health of the animals also changed according to the productive cycle: doe and kit weight were higher in the autumn and winter cycles than in summer, BCS was higher in the winter and summer cycles than in autumn (1.98 and 2.01 vs. 1.92), and litter size was higher in the winter cycle than in the autumn and summer ones (8.83 vs. 8.24 and 8.19; $P < 0.001$). Lastly, a higher prevalence of diarrhoea in does was recorded in autumn and summer than in winter (9.3% and 6.7% vs. 3.5%; $P < 0.001$).

Ramón-Moragues A., Martínez-Paredes E., Villagrà A., 2021. Differences in milk production and lactation-related behaviours in breeding does housed in individual enriched cages and part-time systems. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-12, 4 pp.*

The effect of collective rearing of breeding does was assessed in terms of milk yield and behavioural patterns. A total of 40 breeding does were used, 20 of them housed in individual cages (50x90x50 cm) and 20 in a collective system in groups of 4 rabbits (200x90x50 cm) since 14 days post-partum until 28 days, in which weaning took place. Milk production was assessed during the 1st and 2nd parturition, finding differences between groups only in the second one, when does from the part-time system produced less milk. Straw was offered to animals as environmental enrichment and its consumption was assessed, finding that does reduced straw consumption in the part-time system compared to individual cages. This effect might be related to the presence of social stimuli. In addition, the number of kits stolen by does from alien nests was higher during the first days after grouping, achieving 60% of the kits.

Rommers J., de Greef K., 2021. Are plastic mats effective for diminishing footpad lesions of rabbit does? – survey after 10 years in The Netherlands. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-13, 4 pp.*

At four farms in The Netherlands (10% of all farms), footpad injuries were scored to evaluate whether a plastic mat attached to the wire mesh floor is effective in diminishing serious footpad lesions in rabbit does, 10 years after the plastic mat was made mandatory in rabbit does cages in The Netherlands. Footpad injuries were scored once (scoring 0-3) in 100 does at each farm. Parity and footpad score were registered. The number of young does (≤ 2 litters) was limited to 25% per farm, as footpad injuries are mostly seen in older does. Farms were quite comparable in footpad scores, the average footpad score ranged from 0.8 to 1.1. On average 43% of the does had intact footpads, 55% had a callus and 2.5% had cracks in the callus, no wounds were observed. Based on the results, rabbit does housed in the wire floor cages furnished with plastic mats show no serious injuries to the footpads. The earlier expectation and the ambition of the regulation that the plastic mat prevents pododermatitis is clearly met.

Trocino A., Zomeño C., Birolo M., Pirrone F., Xiccato G., 2021. Effect of grouping time and group stability on behavior and aggression among rabbit does in a part-time housing system. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-14, 4 pp.*

To evaluate aggression and behaviour of reproducing does in a part-time system, 48 crossbred multiparous rabbit does were housed in individual modules of a park system. A total of 12 parks with 4 does were formed by joining adjacent modules from 9 d before kindling until 2 d before kindling and from 2 d or 12 d after kindling (early or late grouping time, respectively) until weaning. Within grouping time, half of the parks maintained a stable group; the other half changed one doe every week. Behaviour in all parks was videorecorded for 24 h at 2 d, 12 d and 19 d after kindling. The number of total aggressive

interactions significantly decreased from the grouping day to the 19th d of lactation ($P < 0.001$), and was lower in late-grouped does compared to early-grouped ones ($P < 0.01$) and in stable groups compared to variable groups ($0.001 < P < 0.01$). Regarding the time spent resting, feeding, drinking and self-grooming, the observation day always had a significant effect, whereas the group stability was less relevant. Finally, at 19 d, on average, does rested individually for a 45.3% of the observation time and in contact with a mate for a 17.2% of the observation time, without significant differences according to the grouping time or the group stability ($P > 0.05$).

[Van Damme L., Delezie E., Tuytens F. A. M., Maertens L., 2021.](#) Advances in part-time group housing systems for does: an overview of reproductive performances . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication, E-15, 4 pp.*

Part-time group housing of farmed rabbits does has gained increasing attention over the last years. Based on recent published literature, this paper aims to provide a brief overview of the reproductive performances and highlights problems and perspectives concerning part-time group housing systems. From a welfare point of view, group housing of does seems desirable because of the increased possibilities for social interactions and the larger absolute space available (facilitating the creation of functional areas and expression of certain behaviours that require adequate freedom of movement). Experiments on continuous group housing systems for does, however, have shown poor reproductive performance mainly caused by aggression, skin injuries, pseudo-pregnancies and competition for nests. In order to tackle these problems several researchers are investigating so-called part-time group housing systems in which does are grouped for some duration in the reproduction cycle. Does in parttime group housing, however, do not fully meet the reproductive performances compared with individually housed does. A lower litter size at weaning, higher pre-weaning losses and less weaned kits per doe are reported compared with individual housing. Furthermore, group housing seems to affect the body condition of does due to social stress. Aggressive behaviour has been reported among does and does towards alien kits. Therefore, in order to tackle the remaining aggression problems in part-time group-housed does and to fill the gap in production performances with individually housed does, efforts have to be focused to better understand the social interactions among does

[Villegas-Cayllahua E., Dutra D., Cavalcanti E., Fidelis H., Montanhim G., Silva A., Moraes P., Borba H., 2021.](#) Assessment of stress during handling of commercial rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication E-16, 3 pp*

In order to ensure the animal welfare of meat rabbits, our study evaluated the effect of handling on peripheral temperature as a physiological indicator of stress. A total of 21 adult male rabbits were distributed in individual cages and assigned to three treatments. Each treatment consisted of a different method of handling (type 1: rabbit lifted with one hand across the shoulders, rump supported; 2: rabbit tucked under handler's arm; 3: rabbit carried in the box). Superficial body temperature of the rabbits was taken in different areas (muzzle, eye and ear) and two times (pre and post-handling). Superficial temperature was collected in three points of the internal auricle pavilion (tip, middle and base). Overall, the results showed a temperature fluctuation between pre and post-handling ($p < 0.05$), except for the eyes ($p > 0.05$), with lower temperatures post-handling (ear tip: - 8.5%; middle ear: - 4.6%; ear base: - 3.2%; muzzle: - 3.9 %). There was no significant difference between treatments ($p > 0.05$). In conclusion, these results suggest that the three types of handling applied in this study induce the same level of stress in meat rabbits.

[Warin L., Mika A., Souchet C., Bouvarel I., 2021.](#) Feasibility and repeatability of the EBENE® welfare assessment measures for rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communicatio E-17, 4 pp.*

The welfare of farm animals is a daily concern for farmers and its standardized assessment constitutes an important lever for progress. The EBENE method was developed to self-assess the welfare of poultry and rabbits. After many discussions and several on-farm trials, 15 indicators were selected for rabbit does (6 sanitary and 9 behavioural indicators) and 13 indicators were selected for fattening rabbits (5 sanitary and 8 behavioural indicators). This paper aimed to test the feasibility and the repeatability of the EBENE® welfare assessment measures for rabbit does and fattening rabbits. Eight assessments were carried out on rabbit does and fattening rabbits raised in cages. To assess the feasibility of the method, the assessment duration was calculated. To assess the repeatability of the welfare indicators, 2 assessors carried out the measures, initially together on the same population sample and then a second time the following day. The results were analysed with Spearman correlation tests. Indicators were said to be repeatable when the correlation coefficient $r > 0.40$ and $P \text{value} < 0.10$. The duration of the assessment was 83 ± 8 min which means the method is feasible. All the indicators except *Injury* and *Activity* were repeatable for rabbit does. All the sanitary indicators except *Dirty* were repeatable and most of the behavioural indicators were not repeatable for fattening rabbits. A new method to observe behaviours of fattening rabbits was proposed to improve these results. A smartphone application was then developed and is currently available to facilitate the use of the method by farmers, technicians and veterinarians.

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FARMING & ECONOMY

Invited Paper

Wu L.P., Lukefahr S.D., 2021. Rabbit meat trade of major countries: regional patterns and influencing factors (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-00, 15 pp*

In the past 60 years, the global rabbit industry has been growing steadily. This paper studies global rabbit meat trade by focusing on trade growth and regional patterns. First, rabbit meat production and regional structure are introduced, as the basis of trade. Then, global rabbit meat trade is studied in details, including trade growth, regional structural changes, comparative advantages and competitiveness of major countries. Finally, a Gravity model is built to test major factors affecting rabbit meat trade and to explore the behind the trade scenes. The data were collected from different channels, including the UN FAO, the World Bank, the WTO and related government statistics. The results show that: (1) In past 60 years, global rabbit industry has achieved great progress. In the first half period, rabbit meat was mainly produced in Europe, but in the second half period the meat production level in the Asian countries increased steadily and rapidly, and the producing center moves from Europe to Asia; (2) Rabbit meat trade had been increasing for about 20 years from 1961 to 1979, then it fluctuated for another 20 years. However, since 2001 it has been stable with only small fluctuations, the average output being around 37 thousand tonnes. The trade pattern currently is from the Asian area (mainly China) to European countries. In 2019, the top 5 export destinations were Germany, Belgium, Italy, France and Spain; (3) Hungary has been a strong competitor, Spain and Belgium are two new promising countries in rabbit meat trade. Though the rabbit meat output in China is still increasing, exports have been decreasing in recent decades. China is gradually losing its comparative advantages in rabbit meat trade; (4) The Gravity model results show that the rabbit meat trade is driven mainly by demand. The countries with high GDPs tend to increase imports more, but decrease exports. Countries with a higher population exports more rabbit meat, but import less. Common language and common border of two countries have significant impacts on rabbit meat trade. In this way, some suggestions and policy implications are provided. Rabbit farmers or processing companies should pay more attention to domestic consumers or neighboring countries to exploit the potential markets; traders should explore more markets so as to reduce trade concentration degree and reduce risks; Government should popularize the nutrition knowledge of rabbit meat so as to encourage people (especially young people) to consume more healthy rabbit meat instead of pork and beef, and finally reduce obesity and heart diseases associated with unhealthy diets.

Short Communications

Arнау-Bonachera A., Blas E., Cervera C., Ródenas L. , Martínez-Paredes E., Pascual J.J., 2021. Towards a sustainable rabbit production system combining genetic type and weaning strategy. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-01, 4 pp.*

Current rabbit farming is highly dependent on antibiotics mainly due to digestive disorders during the growing period. To search for more sustainable strategies, in this work we explored the development of growing rabbits from two different genetic types (GTP, characterised by productivity; GTR, characterised by robustness) and two different weaning strategies (weaning at 28 days after parturition plus a solid milk replacer until 49 days, W28; weaning at 49 days, W49). Total milk intake, solid intake, as well as litter size and litter weight were recorded at standardization, 17, 28, 49 and 56 days after parturition on 502 litters. Rabbits weaned at 49 days had higher milk intake than those weaned at 28 days (+197±14 g, P<0.001). From day 49 on, litter size in W49 groups was higher than in W28 groups (+0.35±0.17 at 49 days, P<0.05 and +0.33±0.17 at 56 days, P=0.054). This result suggests that the solid milk replacer had not the same protective role as milk. Young rabbits from GTP had higher milk intake than those from GTR type (+32±14 g, P<0.05) but did not differ on solid intake or body weight at any day. Interestingly, litter size at 56 days of GTR was 0.36±0.17 young rabbits higher than GTP (P<0.05). Moreover, despite interaction was not significant, litter size was higher in W49 animals than in W28 animals at 49 days (+0.48±0.24, (P<0.05) and at 56 days (+0.45±0.24, P=0.066). On the contrary, no differences on litter size depending on the weaning system were observed for GTR animals. This result suggests that GTP was less robust than GTR and was benefited by delaying weaning. On the contrary, GTR presented good performance in both weaning strategies as a consequence of their higher robustness. Therefore, combining a low risk diet with early weaning plus a solid milk replacer and GTR crossbreeding scheme could be an interesting strategy to decrease dependence on antibiotics as it balances sanitary risk and productivity .

Birolo M., Trocino A., Zuffellato A., Xiccato G., 2021. Performance, mortality and slaughter traits of group-housed rabbits submitted to different time-based feed restriction programs. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-02, 4 pp.*

Growth performance, health and slaughter traits were measured in 320 crossbreed rabbits housed in 40 open-top pens (8 rabbits/pen) from weaning to slaughter (34–70 d of age) to evaluate the effects of the different feeding programs: AL, ad libitum feeding; DF, daylight access to feed with fast and complete refeeding; NF, night access to feed with fast and complete refeeding; NS, night access to feed with slow and complete refeeding; NI, night access to feed with very slow and incomplete refeeding. In restricted rabbits, the feeding time decreased from 14 to 9 h/d during the 1st week, remained stable (8 h/d) during the 2nd week, and increased from the beginning of the 3rd week according to three refeeding programs: i) fast until ad libitum (+4 h/d until 24 h/d); ii) slow until ad libitum (+1 h/d until 24 h/d); iii) very slow and still restricted until the end of fattening (+30 min/d until 12 h/d). In the restricted rabbits, feed intake (-3.7%) and feed conversion (-5.6%) were lower compared to AL ones ($P<0.001$) with the minimum values in the NI group. Diet digestibility increased in the restricted groups compared to AL and in the NI group compared to other restricted groups. Mortality was lower in AL rabbits compared to restricted ones (1.6% vs. 9.0% on average; $P=0.04$), whereas morbidity and health risk index did not change. Slaughter weight (2608 g), dressing percentage (60.2%), and carcass muscularity were not affected by the feeding program. In conclusion, the NI program represented the best strategy to optimize feed efficiency without impairing, growth, slaughter results and carcass traits in growing rabbits. The tested feed restriction programs did not succeed in enhancing rabbit health.

Gerencsér Zs., Kasza R., Radnai I., Matics Zs., Dalle Zotte A., Cullere M., Szendrő Zs., 2021. Effects of hair shearing on production performance and carcass traits of growing rabbits in high ambient temperature. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-03, 4 pp.*

The aim of the study was to examine the effect of hair shearing of growing rabbits reared in high temperatures. For this purpose, a total of 150 five weeks old rabbits were assigned to three experimental groups: rabbits reared at 20 °C and not sheared (N, n= 50), at 28 °C and not sheared (W, n= 50), and at 28 °C and sheared at week 5, 7 and 9 (WS, n= 50). The experiment was conducted over 7 weeks, during which performance data was recorded. At the end of the experiment, the rabbits were slaughtered and carcass traits were evaluated. Feed intake of groups W and WS decreased by 29.0% and 20.4%, respectively, when compared to N rabbits. A similar trend was observed for live weight gain (24.6% and 16.9%) and for body weight at 12 weeks (16.8% and 11.5%). Concurrently, feed conversion rate improved in groups W and WS compared to group N (N: 3.53, W: 3.34, WS: 3.31; $P<0.001$). The mortality of groups remained unaffected by treatments. Under heat stress conditions, rabbit shearing improved slaughter weight ($P<0.001$) and reference carcass weight ($P<0.001$) compared to W rabbits; N rabbits, however, always showed the highest values for those traits. It can be concluded that the effect of high temperatures on growing rabbits can be significantly mitigated by hair shearing, suggesting that it is a possible strategy for improving animal welfare. However, as this method is time- and money-consuming (cost of labour), this method could be used mainly on small farms located in tropical areas or in temperate zones during summer peak season.

Gidenne T., 2021. Feed intake regulation strategies for the growing rabbit: a 2005-2015 retrospective on economic and environmental impact in France. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-04, 4 pp.*

INRAE has conducted from 2002 a research program to improve the feeding strategies for the growing rabbit, aiming to reduce the risk of digestive disorders (diarrhoea) without using drugs. Studies demonstrated that an adequate control of the post-weaning feed intake reduces the risk of digestive diseases while improving feed efficiency. INRAE performs thus an impact analysis of this innovation over the past ten years. Results showed that feed intake regulation strategies (FIRS) have led to both a reduction in the losses of growing rabbits (720000 rabbits saved/year, 30M€ over 2005-2015) a reduction in the use of drugs (-50% antibiotics used for digestive disorders) and a reduction in feed costs (+ 5% of feed efficiency, 40M€ saved). FIRS also impacted favourably the environment (-9% of global warming potential, -11% of eutrophication potentials). FIRS therefore combines economic (10M€/year), environmental and social benefits for French conventional rabbit farming systems.

Goby J.P., Chevallier L., Gidenne T., 2021. Organic rabbit pasturing: effect of grazing density on grass intake and growth of the rabbit. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-05, 4 pp.*

Two grazing densities ($D1=0.4\text{m}^2$ and $D3=1.2\text{m}^2/\text{rabbit/day}$) were compared using two groups of 5 movable cages on pasture, housing 1 or 3 rabbits for the same grazing area of 1.2m^2). Rabbits were fed only by grazing, from weaning (45 days old) for 36 days. Herbage allowance and intake was measured by sampling the pasture before and after grazing, every

week. The pasture allowance pasture averaged 6.6 t DM/ ha, for a herbage height ranging from 60 to 78 cm. The grass height meanly consumed ranged between 20 and 35 cm, and group D3 consumed a twice higher height compared to group D1 (30 vs 16 cm consumed, $P<0.05$). For D1 group, the pasture intake increased from 40 to 100 g DM/d/ rab. between day 1 and day 36, while it ranged from 25 to 60 g DM/d/rabbit fro D3 group. The pasture intake capacity of the rabbit averaged 75 and 38 g DM/d respectively for group D1 and D3 ($P<0.01$). Rabbits of D1 group consumed 9.38 kg of fresh matter (260g /day) over the 5 weeks of fattening, while those of group D3 consumed 4.76 kg ($P<0.05$). The growth rate was poor (meanly : 12 g/d), and lower for D3 compared to D1 group (8.4 vs 15.5 g/day, $P=0.051$). In conclusion, at the standard grazing density (0.4m²/rab./day) the pasturing capacity of the rabbit was not covered. According to the pasture quality, a complementary concentrated feed may be recommended to reach a commercial weight (2.4 kg) within 5 or 6 weeks after weaning.

Huang Y., Gigou M., Goby J.P., Roinsard A., Savietto D., Gidenne T., 2021. Digital breeding and assisted management in organic rabbit farming: the first results. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-06, 4 pp.*

A smartphone application GAELA combining decision support (breeding management) and performance recording (single, direct and secure entry on a public server) for rabbit farming using individual monitoring of breeders was created. Performance of reproduction were compiled for 6 farms over 2 years of production (2018-2020). The livestock size averaged 30 does and varied largely among the farms. With 3.9 matings, 2.6 parturitions per female/year were obtained (66.8% fertility rate). Total number of kits born by parturition averaged 7.8 and total number of kits born alive averaged 7.1. The present study validated the utility of GAELA application and confirmed the modest performances in organic rabbit farming. The new version of GAELA application is available since the end of 2020. It provides new functions facilitating daily management and is improved to avoid entering incorrect information. New functions such as "Pregnancy Palpation", "Adoption" and "Fattening Management" are also available in this version. The future version of GAELA will further provide the calculation and analysis of performances of breeders or of the flock, and it will build a national reference system for "non-conventional" rabbit farming.

Li D.Y., Wu L.P., 2021. Analysis of the competitiveness of Chinese rabbit industry. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-08, 4 pp*

This paper analyzes the competitiveness of Chinese rabbit industry since 2000 from both China domestic and global perspectives. From domestic view, we mainly study the comparative advantages, production trend and consumption potential of rabbit products, and from global perspective, the indicators such as international market share, Revealed Comparative Advantage (RCA) and Trade Competitiveness Index are used to measure the competitiveness in international market. It is found that in the domestic market, rabbit products have comparative advantages with good performance, rapid growth in output and great consumption potential. In the international market, the competitiveness of Chinese rabbit industry is strong, but in recent years, its advantage has weakened because of the competition from other countries. In general, the competitiveness of Chinese rabbit industry is strong in both China and world markets.

Nate J.A., Natividad E.D.C., Lavarias J.A., Gavino R.B., Castillo C.C., 2021. Optimization of biofeed plan and space requirement for rabbit (*Oryctolagus cuniculus* L.). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-10, 4 pp.*

Rabbits has an advantageous feeding nature and gastrointestinal tract. By employing feeds derived from biomass (i.e., agro by-products and locally-grown crops), the breeding expenses could also reduced. However, a biofeed plan (a diet derived from biomass ingredients) must be formulated satisfying the rabbits' nutritional needs at minimum cost of production. Space requirement was also another factor that could affect the rabbit's growth. Hence, this study aimed to optimize a biofeed plan and space requirement for rabbits. Treatments were the following: (Factor A) space requirements and (Factor B) CP:CF diet levels organized in a 3 x 4 Factorial RCBD. The thirty-six (36) Californian White x Local (CWxL) rabbits at age of five (5) weeks were divided into three (3) blocks randomly that were breed under three (3) different growing conditions (i.e., air-conditioned room, open rabbitry housing and under the trees' shade). Results of the simplex method optimization revealed that the feeds' prices (€0.27, €0.29 and €0.30 per 1 kg biofeed) were minimized while satisfying the required nutrients. Likewise, the rabbits in medium and small cages fed with commercial feeds were statistically higher from the other treatment combinations in terms of feed conversion efficiency (FCE).

Pascual M., Martin E., Fabre C., Garreau H., Gilbert H., Piles M. Sánchez M. , Sánchez J.P., 2021. Is feed restriction an alternative to the use of antibiotics in non controlled environment farms?. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-13, 4 pp*

The effect of antimicrobials and feed restriction (as an alternative to the use of the formers) on production performance of growing rabbits reared in a non-controlled environment was estimated. A total of 987 young rabbits from a three way cross were randomly distributed into groups of 8 individuals, which were assigned to one of the following feeding strategies from 35 to 63 days of life: ad libitum feeding with medicated feed (antibiotics and a coccidiostatic; AdLibMed), ad libitum feeding with no medicated feed (AdLibNoMed), restricted feeding with medicated feed (RestrMed) and restricted feeding with no medicated feed (RestrNoMed). All groups were fed ad libitum with no medicated feed from 63 to 70 d. Feed offered to restricted animals was calculated weekly as 80% the feed intake of the batch-mates fed ad libitum the week before, increased by 10% to account for the increase in consumption with age. Feed restriction finally applied was on average 84.2%. Ad libitum feeding with no medicated feed led to lower average daily gain and relevantly higher but not significantly different mortality with respect to AdLibMed (-1.0 g/d, p-value<0.01; +3.0%, Pvalue=0.28). Feed restriction did not improve performance, as average daily gain was lower than when animals were fed ad libitum, and mortality rate did not improved (-3.8 g/d, p-value<0.01; -0.52%, Pvalue=0.93; RestrNoMed vs. AdLibNoMed). These results are probably due to the range of variation of actual feed restriction along the trial (72 to 100% of ad libitum feed intake) and the low mortality rate in the overall trial (7.62% for *ad libitum*, and 6.12% for restriction). None of the treatments had effect on feed efficiency. Therefore, feed restriction might not be the best alternative to the production without antibiotics when feed intake is highly conditioned by environmental changes and mortality is low, and the use of other alternatives to avoid a decrease in daily gain is required.

Paul A., Johnson J., Lallo C., 2021. The effects of stocking rate on growth performance and welfare of the fattening rabbits when produced under humid tropical condition in Trinidad. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-14, 4 pp.*

One hundred crossbred growing rabbits (New Zealand White x California White) ages 28-32 days, mean weight of 700 ± 100 grams were used. Rabbits were housed in wire cages (76 x 50 x 40cm) for 56 days and were randomly allocated to one of five stocking rates originally; 7.9, 10.5, 13.16, 15.79 and 18.42 rabbits /m². Environmental measurements were collected. Temperature-humidity index (THI) was calculated using the equation modified by Maria et al. (2001). Feed intake and feed conversion ratio was calculated. Five animals per treatment were randomly selected and the rectal temperature, respiration rate, and ear skin temperature were taken daily for the duration of the study. Deaths were recorded and post mortems were performed. Parameters were statistically analysed using One way Analysis of Variance procedure (Minitab 19 for Windows). The environmental conditions were adverse and exceeded the recommended range (THI >28) between 7:30 AM and 7:30 PM. Under these conditions cage density significantly affected total weight gain (P=0.012) and average daily gain (P=0.012) but had no significant effect (P>0.05) on feed intake, FCR, respiratory rate, rectal temperature and skin temperature. Despite no significant differences, all welfare parameters exceeded normal reference ranges at all treatment levels. As stocking rates increased, mortality rate also increased with higher incidence of deaths occurring subsequent to feeding time between 3-7 weeks of experiment. Findings suggest that despite varying stocking rates animals at all treatments were experiencing environmental stress and were using all mechanism possible for thermoregulation. These were consistent with necropsy reports which indicated that all dead animals had a rupture of either sides of the ventricular wall of the heart, blood-tinged serosanguinous in the lumen of the trachea and their stomach was engorged with pelleted rabbit feed which is all consistent signs of heat stress. It is concluded that farmers should not exceed a stocking rate of 13 rabbits/ m² when producing rabbits under the adverse tropical environmental conditions of the Caribbean, and it is strongly recommended that farmers pay special attention to feeding times thus avoiding feeding at high THI periods.

Rebours G., Raffin J., Vastel P., Reys S., 2021. Descriptive study of speed of fattening rabbit's daily feed intake in constant and progressive hourly feeding with two nutritional levels of feed. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-15, 4 pp.*

This study describes the speed of daily feed intake of 168 fattening Hyplus rabbits assigned to 3 groups of 56 rabbits : the first group had a standard feed during 10h per day (10h STD), the second group had the same standard feed with a progressive hourly feeding, according to 6h per day at the beginning of fattening period and an increase of one hour per week (6h+1 STD) and the third group had the same feeding plan than the second group but with a concentrated feed (6h+1 C+). Speed of daily feed intake (SDFI) was determinate for 3 periods: P1 (37-39 days old), P2 (52-54 days old) and P3 (67-68 days old). For each period, feed intake was measured 1 h, 2h, 3h, 6h and 10h after the feed distribution. Between P1 and P2, the average SDFI of the 3 groups increased by 51%, from 12.7 to 19.2 g/h in average. However, between P2 and P3, it tended to be stable around 19g/h in average (-6% to +4% according to groups). This evolution was due to age, but also to weight because when it is expressed in g/h.kg of live weight (LW), the SDFI of the 3 groups slightly decreased between P1 and P2 (-0.4 g/h.kg LW) then decrease much more between P2 and P3 (-2.7 g/h.kg LW). During fattening, throughout the day, rabbits hourly restricted consumed feed about 2.5 times quicker the first hour after distribution (in average 36.8g/h versus 14.8 g/h for the following hours). More the hourly restriction level increased and more the average SDFI was enhanced: in P1, 6h+1 STD group consumed additional 1.5 g/h in comparison with 10h STD group. The SDFI was higher the

first hour after feed distribution because the 6h+1 STD group consumed 5.5 g more than 10h STD group. The feed concentration slightly decreased the SDFI by regulating feed consumption, knowing that this moderation appear throughout the day and it decrease throughout the fattening : respectively -0.3, -0.5 and -1.2 g/h for P1, P2 and P3 comparing 6h+1 C+ to 6h+1 STD groups.

Rebours G., Raffin J., Vastel P., Reys S., 2021. Effect of a progressive hourly feeding and nutritional level of feed on performance and feed cost of fattening rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-16, 4 pp.*

The aim of this study was to evaluate the effect of a progressive hourly feeding according to two nutritional levels of feed on performance and sanitary status of fattening rabbits and feed cost, in comparison with a constant hourly feeding. 378 Hyplus rabbits were assigned to 3 groups: the first group had a standard feed during 10h per day (10h STD), the second group had the same standard feed with a progressive hourly feeding, with 6h per day at the beginning of fattening period with an increase of one hour per week (6h+1 STD), and the third group had the same feeding plan than the second group but with a concentrated feed (6h+1 C+). The three groups had different average daily weight gain (ADWG) ($p=0.02$), average daily feed intakes (AFDI), feed conversion ratio (FCR) ($p<0.001$) and carcass yield ($p=0.05$). The final live weight of the 6h+1 STD group was similar to the 10h STD group weight (-37g). This group had also a lower ADFI during the first period of fattening (-15.2g/d), which significantly decreased the global FCR (-0.26 point), thus leading to a lower feed cost (2.36€ versus 2.60€/rabbit). The 6h+1 C+ group had similar growth performances than the 6h+1 STD group, and during the second period its ADFI decreased (-5.8g/d), revealing a regulation of rabbits hourly restricted according to the nutritional level of the feed. The 3% concentrate feed allowed to reduce not significantly by 2.7% the global FCR compare to 6h+1 STD and significantly by -10.6% in comparison with 10h STD allowing to reduce the feed cost (2.30 €/rabbit in comparison with 2.36 € and 2.60 €/rabbit for respectively the 2 other groups.

Saiz del Barrio A., Perea-Goya L., Martín-Chaves E., Alfonso-Carrillo C., Marco M., Fernández B., Terreros E., García-Ruiz A.I., 2021. Evolution of growth performance and weight uniformity of growing rabbits under feed restriction. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-17, 4 pp.*

The aim of this study was to test the evolution of performance and weight uniformity of growing rabbits fed following a feed restriction program. The experiment was carried out with a total of 665 crossbreeds (New Zealand x Californian) growing rabbits assigned to five treatments, with 19 replicates per treatment. At weaning, animals were individually weighed and three weight ranges were established as follows: small: 519-680 g; mid: 681-749 g; big: 750-911 g. Treatments varied in the range of weight at weaning; Treatment 1: 7 animals from the mid weigh range; Treatment 2: 1 small + 2 mid+4 big animals; Treatment 3: 3 small + 1 mid+3 big animals; Treatment 4: 4 small + 2 mid+1 big animals; and Treatment 5: 7 animals from the small weigh range. All animals were fed with the same commercial feed following a feed restriction program with a feed intake of 75 and 80 % of the ad libitum feed intake in the first two weeks. Animal performance and body weight uniformity was measured during the growing period. The weight differences established at weaning were maintained throughout the whole study. Treatment 5, where smaller animals were allocated shown a higher feed conversion ratio ($P=0.014$) than the other treatments. Groups with more homogeneous animals maintained the homogeneity established at the beginning of the study. Treatment 2, were heavier animals were allocated, an improvement in body uniformity with age, while a decrease of weight uniformity of these parameters was observed in treatment 5 which started with an homogenous but lighter flock. From these results it can be concluded that the homogeneity of the flock at weaning is important in animals under feed restriction programs.

Schwarz J., Schädler J., Albin S., Peter-Egli J., Schüpbach G., Wiederkehr D., 2021. Promoting rabbit health and welfare by collection and establishment of reliable health and performance data in the two major Swiss meat rabbit integrations. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-18, 4 pp.*

The legislation about rabbit housing conditions in Switzerland differs from that in other countries. Housing on wire mesh floor is prohibited and group housing in fattening units is mandatory. Despite these high-level housing conditions regarding animal welfare, animal losses remain a significant problem, exact numbers are lacking. The main aim of this ongoing study is to improve rabbit health by the collection of health and performance data. The collaboration with the two major meat rabbit production groups (Kani-Swiss GmbH, Integration Kyburz), which cover about 90% of the commercial production in Switzerland, enables the analysis of 52 farms and their performance data. On a primary investigation visit, the varying structures of the farms as well as their husbandry, hygiene and health management systems were recorded. Simultaneously, a prospective data collection done by the farmers is ongoing. For one year, data on every fattening group and litter is recorded with special interest in animal losses and medication, notably antimicrobials. Additional investigation visits during a period with an increased mortality rate allow the performance of necropsies and laboratory tests as well as the detection of changes in management to identify the

triggering factors. General risk factors are identified by comparing farms with low and high mortality rates. As a result, specific prevention and intervention strategies are determined. Partial results of this ongoing study are yet available: during the first three months the mortality rate in fattening rabbits ranged from 3.7% to 41.6% with an average of 19.0%. The mortality in sucklings was 15.7% on average and varied from 4.3% to 34.1%. Besides coccidiostats, 17 of the 52 farms apply no additional medication, unlike 15 farms where antimicrobials are used on a regular basis for every fattening group.

Silva K.G., Sotomaior C.S., 2021. Housing conditions of growing rabbits in Brazil. *12th World Rabbit Congress - November 3-5 2021 - Nantes, Franc, Communication F-20, 4 pp.*

Information about rabbit production systems in Brazil is scarce. The objective of this study was to describe the facilities and housing characteristics of Brazilian growing rabbit farms. Data about farm purpose, animals (breed and age), cages, feeders, and drinkers were collected from 11 farms (3 pet farms, 4 meat farms, and 4 universities). A total of 290 cages holding 843 rabbits were evaluated. Rabbits in meat farms had a higher average age than those in pet farms and universities. The breed number within each farm varied from 1 to 18, with pet farms showing the largest number of breeds. The cage system most implemented by the farmers was flat-deck. Wire cages were observed in 90.9% of the farms. The number of rabbits per cage varied from 1 to 10 rabbits, with an average of 3.1 ± 1.8 rabbits/cage. The average area and height of the cages was 0.43 ± 0.1 m² and 44.2 ± 6.5 cm, with an average of 7.2 ± 3.4 rabbits/m². All cages were clean in 45.4% of the farms. No completely dirty cages were observed. Three farms had unsafe cages; of these, one had 60.9% of the cages with some safety problem. Metal and clay feeders were common, with 45.5% of feeders being inside-cage feeders. The average rabbit/feeder ratio was 2.2 ± 1.2 , with 9.1% of the farms with more than 4 rabbits/feeder. All feeders were clean. The main system and type of drinker used was the automatic nipple drinker (72.7%). Regarding the cleanliness of the drinkers, 27.3% of the farms had dirty drinkers and two farms (18.2%) had malfunctioning drinkers. A variation of facilities and equipment was observed among Brazilian rabbit farms. No housing standardization was observed, and the housing conditions depended on the purpose of the farm, accessibility to equipment, and costs.

Silva S.R., Guedes C.M., Almeida, M., Pinheiro V., 2021. Use of infrared thermography images to predict live weight of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-21, 4 pp.*

The objective of this study was to evaluate the possibility of using infrared thermography (IRT) images to predict the live weight (LW) of growing rabbits. A total of 144 growing rabbits with 1.739 ± 0.448 kg were used to capture images with infrared thermography technique. Rabbits were weighed in the morning (8 to 9 hours). The IRT images were taken using an infrared Flir F4 camera. Images were analyzed and the body measures (area, perimeter, major and minor from the primary and secondary axis of the best fitting ellipse, Feret's diameter and minimum caliper diameter) and shape descriptors (aspect ratio, roundness, solidity, circularity) were recorded. The data were analyzed following multiple linear regression to predict live weight (dependent variable) with body measurements and shape descriptors (independent variables). Results showed that the body measurements obtained after IRT image analysis presented more variation than shape descriptors (CV between 12 and 20% vs 1.4 and 10%, respectively). The best prediction model used four independent variables (area, major and minor axis of ellipses and Ferret's) calculated from IRT (k -fold-R² = 0.945; RMSE = 106.9 g). We concluded that the IRT imaging technique was able to accurately predict the LW of rabbits. Future work will be focused on the increase of accuracy and precision in order to make the process of image acquisition and analysis faster, so that it can be applied as a practical tool for determining rabbit LW.

Zhang M. Y., Wu L. P., 2021. Consumer demand for rabbit meat in urban China: 2011-2018. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-22, 4 pp*

This study assess and report on Chinese consumer perceptions, knowledge and behaviors related to rabbit meat, using a dataset from a series of surveys during 2011-2018. The survey results show that the rabbit meat consumption in urban China is increasing gradually in terms of the quantities and willingness consumed, but the overall consumption is still on the low side. Additionally, more than half of consumers surveyed have no consumption habits on the rabbit meat due to lack of knowledge on the nutrition and health attributes of rabbit meat. Consequently, it is necessary to strengthen media propaganda on nutritional characteristics of rabbit meat and use rabbit meat as functional foods for changing behavior patterns towards the long-term development of the rabbit meat market.

Zhang Shunli, Zhu J.F., 2021. Cost and benefit analysis of meat rabbit breeding based on 2018 national survey data of 13 provinces [of China]. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication F-19, 4 pp.*

This paper analyzed the costs and benefits of meat rabbit breeding by province and scale respectively based on the farmer survey data of rabbit production income in 2018. The results show that: in terms of the cost-benefit analysis of meat rabbit breeding in different provinces, the average production cost and output value of different provinces vary greatly. Henan and Sichuan are at a loss , and all other provinces are profitable. In terms of analysis on different scales, the scale effect of meat rabbit breeding is obvious, and the whole meat rabbit breeding industry is in a profit state.

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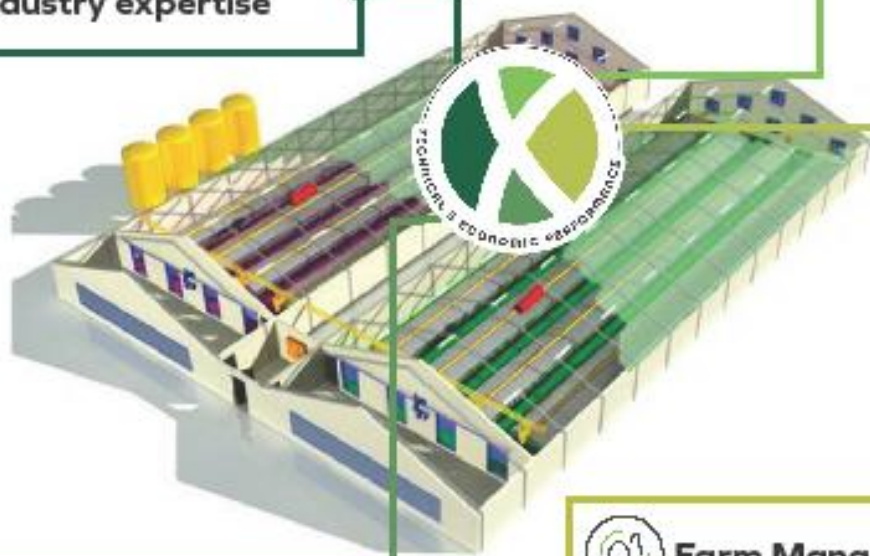
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Invited paper

Martínez-Paredes E., Nicodemus N., Pascual J.J., García J., 2021. Challenges in rabbit does feeding, including the young doe (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-00, 24 pp.*

In this review is summarized the last knowledge on rabbit doe nutrition, to complement the current nutritional requirements and strategies for the young and adult rabbit does, considering the production, and health issues. The rabbit doe must reach an adequate maturity level (body condition) at first artificial insemination (AI) to face its productive life with minimal guarantees (around 7.0 mm of perirenal fat thickness, 2.8 ng/mL of plasma leptin concentration and around 18% and 15-20% of body protein and fat, respectively). This goal can be achieved by restricting feed intake from 12 weeks of age until first AI or feeding ad libitum with a fibrous diet (<10.5 MJ digestible energy/kg) from 60 d of age to first parturition. Once the doe is reproducing, the increase of the n-3 fatty acids (or reduction of the n-6/n-3 ratio), soluble fibre (under epizootic enteropathy) and the Arg/Lys and Gln/Lys ratios may help to improve the reproductive traits of rabbit does, although their optimal level of inclusion remain to be identified. It is recommended to limit an excessive negative energy balance before parturition, and the supplementation of glucose precursors to reduce the ketosis incidence could be useful. The formulation of different diets for the doe and the litter to fit better their requirements and assuring their health would be an option to consider when it would be applicable in the farm. The influence of the mother on the litter microbiota and immune status and its potential modulation through the diet open a new research area that will deserve more studies in the next future.

Short communications

Alves R., Ribeiro D.M., Martins C., Pinho M., Freire J.P.B., Falcão-e-Cunha L, 2021. Alternative feeds for the growing rabbit: carrot roots. Effect on performance and digestion . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-03, 4 pp.*

The objective of this study was to evaluate the effect of including carrot roots in rabbit diets with normal and below-recommended neutral detergent fibre (NDF) values. Four isoproteic diets were formulated according to a 2x2 factorial arrangement: two NDF levels (37% and 30% on a DM basis) and two levels of dry carrot roots (0 or 15%). Diets were fed ad libitum to 4 x 12 weaned rabbits (22 days old) for 6 weeks. Growth performance, feed digestibility (during the 5th week), fermentative activity at day 35 on caecotrophes and small intestinal morphology were determined. Carrot inclusion did not influence daily feed intake or daily weight gain, neither immediately post-weaning nor between 35-63 days. However, it worsened feed conversion ratio (10%). Reducing fibre content led to reduced feed intake (17 and 19%, 1st and 2nd period) and better conversion ratios (9 and 16%, in 1st and 2nd period). Dry matter, organic matter (OM), energy and crude protein (CP) digestibility were not affected by carrot inclusion. Contrarily, ADF and cellulose digestibility of diets with carrots was about 45% and 65% higher than those without carrots. At 35 days, volatile fatty acids (VFA) from caecotrophes of rabbits fed with carrots had significantly higher values for C2 and lower for C4 (P<0.05). Fibre had significant (P<0.05) effects on villus height, crypt depth and villus height/crypt depth.

Atkári T., Jós D., Gerencsér Zs., Nagy I, 2021. Using a mixture of red clover and bird's-foot trefoil in diets for growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-04, 4 pp.*

The aim of the study was to evaluate the different inclusion ratios of a mixture of clover and bird's foot trefoil to replace pure alfalfa in diets of growing rabbits. Four diets containing 0, 15, 20 and 25.6% of the legume mixture (C, Mix15, Mix20, Mix25, respectively) were formulated to replace alfalfa. The chemical composition of diets was similar (DE: 10.1, CP: 17.3-17.8%, CF: 16.4-16.9%). Rabbits were weaned at 37 d and at the end of experiment they were 79 d of age. Significant differences were found in initial weight between C group and the rabbits consumed mixed diets, however no significant differences were found between Mix15, Mix20 and Mix25 groups, which indicates that rabbit does fed the Mix feed had an advantage. Body weight gain and feed conversion ratio of the four groups were similar. The mortality of Mix25 group was the highest (10.7% vs. C: 9.2%, Mix15: 8.8% and Mix20: 5.8%). It can be concluded that the mixture of red clover and bird's foot trefoil alfalfa mix can be included to up to 20% in ratio to replace pure alfalfa in diets of growing rabbits, but it must be careful to mix greater ratio in the diet.

Boudour Khedidja, Daoudi-Zerrouki Nacira, Lankri Elhassen, Aichouni Ahmed, 2021. Effect of incorporation of *Malva sylvestris* powder in rabbit diets on zootechnical and blood parameters. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-06, 4 pp.*

Malva sylvestris (Malvaceae) is an annual plant widely used as a medicinal plant in Algeria. In order to contribute to the search for better zootechnical performance of adult rabbits (*Oryctolagus cuniculus*), the effect of the incorporation of *Malva sylvestris* leaf and stem powder on some zootechnical (feed intake, body weight, scrotal perimeter, antioxidant capacity) and blood parameters (NSF, triglyceride content, cholesterol content) of male rabbits (six-seven months old) was studied in this work. Lot L2 (n=18) received the standard food of the control lot (L1, n=18), supplemented with 3% *Malva sylvestris* powder. Duration of two-month supplementation with *Malva sylvestris* powder had a positive impact on the parameters studied. The high levels of phenolic compounds (polyphenols and total flavonoids) and tannins found in the rabbits must have improved the antioxidant power, body weight and scrotal perimeter of the treated rabbits. No significant differences were revealed in hematological parameters.

Chen J., Wang J., Li F., 2021. Effects of dietary iron levels on growth performance and iron metabolism-related genes expression in growing Rex rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-07, 4 pp.*

This study was conducted to evaluate the effects of dietary iron levels on growth performance and the expression levels of iron metabolism-related genes in growth Rex rabbits. Two hundred healthy rabbits were randomly assigned to five dietary treatment (n=40) according to initial body weight and sex, and fed with a basal diet supplemented with 0, 20, 40, 80, or 160 mg/kg iron in the form of FeSO₄·H₂O, respectively. After a 35-d trial, 8 rabbits per treatment were randomly selected to collect liver and duodenum samples. The results showed that the ADG of rabbits in 40 mg/kg iron group and the ADFI of rabbits in 20, 40 and 80 mg/kg iron groups were higher than those in 0 and 160 mg/kg iron groups. Furthermore, 40 mg/kg iron supplementation upregulated the mRNA expression levels of DMT1 in duodenum as well as the mRNA expression levels of Tf and HAMP in liver. These results suggested that dietary appropriate level of iron supplementation could improve the growth performance of growth Rex rabbit and the optimal addition level of iron was 40 mg/kg in this study.

Colin M., Prigent A.Y., Van Lissum M., 2021. Effects of a fermented product of *Saccharomyces cerevisiae* on growth, health and mortality of rabbits at two different slaughtering ages. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-08, 4 pp.*

During 2 successive repetitions, 1,684 "46 days old" Hycole rabbits were split between 2 treatments, a Control and one with 1 kg/ton of *Diamond V Original XPC*, a source of *Saccharomyces cerevisiae*, to evaluate its effects on the mortality, the growth, the feed intake and the feed conversion ratio (FCR) between 46 and 89 days. Every day, the mortality was registered and the feed intake estimated. The rabbits were weighted at 46, 56, 70 and 89 days. An index evaluates the daily refuse of feed, the "feed intake dropping index". In the first repetition, the *Diamond V Original XPC* decreased of 44.7% the 46-70 days mortality (P = 0.011) and increased of 3.1% the 70 days weight (P = 0.005) but no significant effects were observed in the second one with higher performances than the first repetition. The mortality 46 - 89 days decreased significantly of 38.5% and 31.6% in the both repetitions but the weight at 89 days was not affected. The "feed intake dropping index" decreased between 62 and 76% for the 2 periods 46-70 days and 46-89 days (P<0.001). In conclusion, the *Diamond V Original XPC* is an interesting solution to improve the growth and to decrease the mortality of rabbits, particularly in a context of deteriorated performances or for improving viability in the production of "heavy rabbits".

Craveiro J.M.S., Madeira A.S., Nicolau J.T.S., Souza J.H.A., Ribeiro L.B., Castilha L.D., 2021. Performance and blood parameters of rabbits fed diets containing decreasing levels of alfalfa hay. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-23, 4 pp.*

Alfalfa hay is a fibrous food widely used in rabbit breeding, but its high cost and seasonal availability lead to the need for studies to evaluate its reduction in diet, without reducing nutrient availability and animal performance. This study aimed to evaluate the effect of decreasing alfalfa hay levels in rabbit diets on performance and blood parameters. For this purpose, an experiment was carried out using fifty New Zealand White rabbits of 31 days of age (25 males and 25 females) distributed, in a completely randomized design, in five treatments, with ten replicates per treatment (5 males and 5 females). Treatments were based on five decreasing levels of alfalfa hay in diet (26.72; 20.04; 13.36, 6.68 and 0.00%), with alfalfa hay reduction being offset by soybean meal and wheat bran. The first level of alfalfa inclusion (26.72%) was determined according to the amount generally used in commercial feeds. Animals were individually housed in metabolism cages with automatic drinking nipples. Throughout the experimental period (from 31 to 70 days of age), feed and water were provided ad libitum. The diets provided, the leftovers and the animals were weighed at the beginning of the experiment (31 days), at 50 days, and at the end of the experiment (70 days) to determine the performance

variables. At the end of the experimental period, blood biochemical parameters were determined (glucose, total proteins, urea, triglycerides, total cholesterol, HDL and LDL). From 31 to 50 days of age, rabbits fed diets containing decreasing levels of alfalfa hay presented a linear reduction in final weight ($P < 0.001$). For the phase of 31 to 70 days of age, there was a quadratic effect ($P = 0.013$) of alfalfa hay level on final weight, with the highest value being reached at 25.37%. There was also a quadratic effect ($P = 0.048$) of alfalfa hay level on weight gain, with the best response estimated at 25.64%. There was no variation ($P < 0.05$) in blood biochemical parameters of rabbits fed diets containing decreasing alfalfa hay levels. While decreasing alfalfa hay inclusion in the diet from 26.72 to 0.00% had no effect on blood biochemical parameters of growing rabbits, the highest weight gain from 31 to 70 days was obtained with 25.64% of alfalfa hay.

De Oliveira F., Rani Z.T, Stuart J., Gous R.M., 2021. Effect of non-conventional and pelleted feed on Californian rabbit growth performance in South Africa. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-10, 4 pp.*

Poverty in South Africa is increasing with the increase in unemployment, and households are failing to meet their daily nutritional needs. An alternative source of meat protein produce at low cost can decrease poverty. Feeding costs is the major cost in livestock production, making choice of feed a key in reducing feed costs. Poultry rely on grains for optimum growth whereas rabbits can utilize fibrous diets. The use of non-conventional feed sources to reduce feeding cost and increase profitability without affecting growth performance has been conducted in this study. Two groups of twenty (20) Californian rabbits were used in a feeding trial on a rabbit farm in Howick. Group one was fed commercial diet used for fattening fryers and group two was given a mixture of common grasses which served as nonconventional feed sources (experimental diet). The experimental diet had higher fiber (%) and protein (%) than commercial diet, dietary energy (ME) was unknown for both diets. After 6 weeks feeding trial, results concluded that rabbits that were fed commercial diets performed better than those fed with experimental diet. Carcass traits showed that yield and abdominal fat covering for experimental diet was less than commercial diet. Algometry correlations showed a positive relationship between live weight gain and body length and chest width development. The findings have shown that rabbits can be reared on low feeding costs without affecting its performance by more than 20%. Therefore, poor households can benefit by either marketing the meat or use it for own consumption. Farmers can increase their profits by considering non-conventional feed sources. Thus, proving the potential of rabbit farming in South Africa.

Dorbane Z., Kadi S.A., Boudouma D., Bannelier C., Berchiche M., Gidenne T., 2021. Nutritive value of holm oak (*Quercus ilex*) acorn for growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-11, 4 pp.*

The aim of our work was to assess nutritive value of acorn of the holm oak (*Quercus ilex*: "QI"). The acorn was incorporated at increasing rates in three diets (0, 10 and 20%) as a substitute for a basal diet. Three groups of 7 rabbits, individually caged, received ad libitum one of the three diets. The faecal digestibility of the feed was measured between 46 and 49 days of age. The holm oak acorn (QI) has high starch content: 31% DM but a low protein concentration: 5.6% DM. The digestible energy (DE) concentration of the holm oak acorn estimated by regression was 17.9 ± 1.6 MJ DE/kg DM, corresponding to an energy digestibility of 89.4%. The digestible protein content was 52.4 ± 6.4 g/kg DM corresponding to a crude protein digestibility of 93.9%. The holm oak acorn can be considered as a good source of energy for growing rabbits

Farias-Kovac C., Simbaña F., Reyes M., Ávila A.B., Carabaño R., Nicodemus N., García J., 2021. Effect of cellobiose supplementation in drinking water and feed restriction on apparent faecal digestibility and growth performance in rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-12, 4 pp*

The objective of this work was to evaluate the effect of cellobiose supplementation in water (CEL) and its potential synergy with feed restriction on fecal digestibility and growth performance. Four treatments in a factorial arrangement were used: 2 levels of CEL (0.0 and 7.5 g/L) \times 2 feeding plans (ad libitum and restricted, from 32 to 47 d of age). A total of 236 32-d old rabbits weighing 700 ± 116 g were blocked by litter randomly assigned to the four treatments and caged individually until 60 d of age. The restricted group was fed with 50% the feed eaten by the ad libitum group at weaning and the daily feed supply increased linearly until 100% of intake of the ad libitum group at 47 d of age. Fecal digestibility was determined between 39 and 43 d (D1) and between 53 and 56 d of age (D2) (10/treatment). Cellobiose supplementation had no effect on faecal digestibility but tended to increase starch digestibility in D1 ($P = 0.074$). Feed restriction improved energy, protein (both by 5%), starch (+0.3%) and total dietary fibre digestibility by 11% ($P \leq 0.026$) in D1, with no effect in D2. Feed efficiency improved in the whole experimental period with cellobiose supplementation (+3%. $P = 0.003$), due to the trend to increase the growth rate ($P = 0.11$), with no effect on feed intake and mortality. During the restriction period feed intake of restricted rabbits was a 72% of that of the ad libitum group, while in the whole experimental period accounted for a 90% of the ad

libitum group. As expected, it decreased growth rate (-3.5%; $P = 0.015$) and improved feed efficiency (+7%. $P < 0.001$) in the whole period, resulting in a lower final liveweight (2287 vs. 2231d g; $P = 0.015$). Feed restriction, tended to reduce mortality rate (18.6 vs. 10.1%; $P = 0.067$), and curiously no differences in mortality were observed during the restriction period, and this tendency was explained by reduction of the mortality during the refeeding period ($P = 0.041$). There was no relevant interaction between CEL and feed restriction. In conclusion, CEL supplementation improved growth traits but had no influence on mortality, while gradual feed restriction, tended to decrease mortality with a minor reduction of growth traits.

Farias-Kovac C., Simbaña F., Reyes M., Avila A.B., Nicodemus N., Carabaño R., García J., 2021. Effect of cellobiose supplementation in drinking water and feed restriction on energy and nitrogen retention efficiency in growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-13, 4 pp.*

The objective of this work was to evaluate the effect of cellobiose supplementation in water (CEL) and its potential synergy with feed restriction on nitrogen and energy retention efficiency. Four treatments in a factorial arrangement were used: 2 levels of CEL (0.0 and 7.5 g/L) × 2 feeding plans (ad libitum and restricted, from 32 to 47 d of age). A total of 102 32-d old rabbits weighing 683 ± 124 g were blocked by litter, randomly assigned to the four treatments and caged individually. The restricted group was fed with 50% of the feed eaten by the ad libitum group at weaning, and the daily feed supply increased linearly until 100% of intake of the libitum group at 47 d of age, and the experimental period finished at 60 d of age. Energy and body composition were determined at 32, 47 and 60 d of age using bioelectrical impedance technique. In the whole experimental period CEL did not affect digestible nitrogen and energy intake but tended to increase the nitrogen retained in the body ($P = 0.072$), resulting in an improvement of the body retention efficiency of digestible nitrogen (+5%. $P = 0.010$) and energy ($P = 0.11$). It was associated to a reduction of the urinary nitrogen losses (-6%. $P = 0.037$), and energy losses in urine and heat production ($P = 0.11$). Nevertheless, CEL had no influence on the nitrogen retention efficiency in the carcass, due to the trend to increase nitrogen losses in the skin and viscera ($P = 0.065$). In the whole fattening period, feed restriction had no effect on the body and carcass nitrogen and energy retention but improved the nitrogen and energy retention efficiency in the body and in the carcass (+7%. $P \leq 0.046$). There was no interaction between CEL and feed restriction.

Farias-Kovac C., Simbaña F., Reyes M., Carabaño R., Nicodemus N., García J., 2021. Effect of xylooligosaccharides supplementation in drinking water and feed restriction on faecal digestibility, growth traits and energy and nitrogen retention efficiency in growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-14, 4 pp.*

The objective of this work was to evaluate the effect of xylooligosaccharides supplementation in water (XOS) and its potential synergy with feed restriction on fecal apparent digestibility, nitrogen and energy retention efficiency. Four treatments in a factorial arrangement were used: 2 levels of XOS (0.0 and 7.5 g/L) × 2 feeding plans (ad libitum and restricted, from 32 to 51 d of age). A total of 106 32-d old rabbits weighing 687 ± 126 g were blocked by litter randomly assigned to the four treatments and caged individually. The restricted group was fed with 50% the feed eaten by the ad libitum group at weaning and the daily feed supply increased linearly until 100% of intake of the libitum group at 51 d of age. Fecal digestibility was determined between 39 and 43 d (D1) and between 59 and 62 d of age (D2) (9 rabbits/treatment), and energy and body composition at 32, 51 and 59 d of age using bioelectrical impedance technique. XOS supplementation improved energy and protein digestibility in D1 (by 4 and 5%; $P \leq 0.032$) but had no effect in D2. XOS supplementation had no influence on feed intake and mortality but tended to impair growth rate along the whole experimental period ($P = 0.076$), and nitrogen retention in the body and in the carcass from 32 to 51 d of age ($P \leq 0.079$) mainly due to the trend for a higher urinary nitrogen excretion ($P = 0.082$). It led to a reduction of nitrogen and energy retention efficiency in this period ($P \leq 0.046$). Feed restriction improved energy and protein digestibility in D1 (by 5 and 8%; $P \leq 0.011$), with no effect in D2. In the whole experimental period feed restriction resulted in a 82% of the ad libitum feed intake. It reduced mortality (20.0 vs. 0%; $P < 0.001$), improved the efficiency of nitrogen retention in the carcass (by 7%; $P < 0.001$) and tended to increase that of energy ($P = 0.090$), but impaired growth rate (by 8%; $P < 0.001$), nitrogen and energy retention in the carcass (by 5 and 9%; $P \leq 0.003$). In conclusion, XOS supplementation did not improve growth performance, and even impaired some traits, while gradual feed restriction helped to control mortality with a slight impairment of some growth traits.

Gayraud C., Bretaudeau A., Gombault P., Hoste H., Gidenne T., 2021. Effects of dehydrated sainfoin in rabbit diet on the performance of does and growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-15, 4 pp*

Sainfoin is a candidate worth to be explored for rabbit feeding because of its nutritional properties. In this study, growing performances of rabbits and reproductive performances of does were compared, over 3 reproductive cycles, when fed

isonutritive feeds containing either 0, 13 or 26% dehydrated sainfoin (DS: Perly cultivar). Doe performances (intake, live weight, fertility) were not affected by dietary DS incorporation, while the stillborn rate was improved for cycles 1 and 3 (20.5 vs. 13.3 vs. 8.8% respectively for DS0, DS13, DS26, $P < 0.001$). DS incorporation rate had no impact on kits growth before weaning, but after weaning it slightly reduced the growth rate (44.2 vs. 43.2 g/d respectively for DS0 and DS26, $P < 0.05$) and slightly impaired the feed conversion ratio (2.91 vs. 2.98 respectively for DS0 and DS26, $P < 0.05$).

Gohier C., Menini F.X., Bourdillon A., 2021. Effect of a feed supplemented with Cunidigest® on fattening rabbit performances. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-16, 4 pp.*

Six consecutive trials were conducted in order to assess the effect of Cunidigest® , a nutritional complementary based on organic acids and essentials oils, on fattening rabbits. Each experiment was designed with two dietary treatments: one Control group (Control) received a commercial fattening feed and one experimental group (Cunidigest®) received the same feed supplemented with 0.5% of Cunidigest® . A mortality reduction was observed in five trials (-0.4 percentage units in trial 1, NS; -9 percentage units in trial 2, $P < 0.001$; -4.5 percentage units in trial 3, $P < 0.10$; -5 percentage units in trial 4, $P < 0.01$; and -6.9 percentage units in trial 5, $P < 0.01$). In the last trial, significant morbidity and Sanitary Risk Index (SRI) reductions were observed ($P < 0.05$). Growing performance, feed intake and feed conversion ratio were not affected. According to these results, it may be concluded that the addition of Cunidigest® at 0.5% in diet improves rabbit viability without affecting growing performance

Goncalves C., Della Badia A., Martínez-Paredes E., Ródenas L., Blas E., Pascual J.J., 2021. Fitting digestible protein to digestible energy ratio in growing rabbits selected by growth rate . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-17, 4 pp.*

Growth rate of rabbits has been improved throughout the years as consequence of genetic selection programmes. However, there is not enough knowledge about the consequences of this progress on the protein requirements of animals. To explore this subject, two experimental diets, differing in digestible protein (DP) to digestible energy (DE) ratio, were evaluated in growing rabbits from a paternal line selected by average daily gain during the growing period. Diet L (low DP/DE ratio) was formulated to obtain the current dietary recommendations of PD/DE ratio for fattening rabbits (10.7 g/MJ), while diet H (high DP/DE ratio) had a higher ratio (12.2 g/MJ). A total of 180 weaned rabbits (28 d of age) were divided into two experimental groups and housed in individual cages until the end of the trial (63 d of age). Animals fed with diet H showed higher feed intake (+12.5 g dry matter/d; $P < 0.001$) and average daily gain (+4.3 g/d; $P < 0.001$) during the experimental period than animals fed with diet L. No significant differences in mortality and morbidity were observed between diets. However, the results related to the feed conversion ratio were not consistent along the growing period. Animals fed with diet H showed better feed conversion rate during the first week of growth (-0.10; $P < 0.05$), whereas those fed with diet L showed better results during the last two weeks of the trial (-0.17; $P < 0.05$). These results probably suggest that the proper PD/DE ratio for growing rabbits changes with age. In conclusion, the use of a higher DP/DE ratio during the first weeks after weaning could contribute to improve the performance of the current growing rabbits, characterised by a high growth rate, without compromising their digestive health status.

Guené-Grand E., Davoust C., Poisson A., Launay C., 2021. Impact of the access time to the feeder before weaning on the growth performance of rabbits raised in litters of 11 kits by multiparous rabbit does. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-18, 4 pp.*

The breeding of 11 rabbits per litter is possible on farms where the technicality and the quality of young rabbits at birth is good. The 1st objective is to raise 11 young rabbits per rabbit does to study the growth of these young rabbits, and the 2nd is to study the effects of feed restriction applied 8 hours a day during the 10 days before the weaning. Forty rabbits does and their 11 young rabbits were divided into 2 groups; the 1st one were fed ad libitum while the other one had access to the feeder only from 4pm to 8am each day from 25 d of age to weaning (35 d). From weaning to 70 d of age, all rabbits received the same feed and had access to the feeder 12 h per day. The sanitary condition of this trial was very good in maternity as well as in fattening. There was no effect of feed restriction during the maternity period on the weight of young rabbits (935 vs. 929 g for ad libitum and restricted groups, $P > 0.05$) or the feed intake recorded (712 vs. 706 g/d/cage; $P > 0.05$). At 42, 49 and 56 days of age, rabbits from ad libitum group were heavier than rabbits with restricted access to the feeder (between + 3% and + 2.5%, $P < 0.01$). At 63 and 70 days of age, the weights between the 2 groups were similar ($P > 0.05$). The growth rate over the period 35-49 days of age was higher for rabbit with the ad libitum access compared to the rabbits that had a restricted access to the feeder. (5% variation, $P < 0.001$). It was not different in the other periods studied. In conclusion, the reduction of access time to the feeder

had no impact on the growth performances and health status of the rabbits. Under the conditions of this trial, breeding 11 rabbits per rabbit does allows good zootechnical results, consistent with the standard Hyplus-Grimaud Group.

Guermah H., Maertens L., 2021. Nutritive value of dehydrated chicory pulp for fattening rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-19, 4 pp*

The aim of the study was to determine the nutritive value of chicory pulp for fattening rabbits. Sixteen individually caged 8-week-old rabbits were used to determine the digestibility and preliminary effects on feed intake and weight gain. Dehydrated chicory pulp was incorporated at 30% inclusion level in a basal diet at the expense of all basal ingredients. Basal and experimental diet were fed ad libitum to 8 rabbits during the four days balance trial. A moderate protein digestibility 59.2% was determined corresponding to a digestible protein concentration of 5.3% DM. A quite high energy digestibility of 73% and a DE content of 12.1 MJ/kg DM was found while all fibre fractions had a remarkable high digestibility: CF, NDF and ADF: 65.5; 56.0 and 83.1%, respectively. It may be concluded that chicory pulp can be effectively considered as an energy-rich feedstuff and a good source of fermentable fibre.

Harouz-Cherifi Z., Kadi S.A., Mouhous A., Bannelier C., Berchiche M., Gidenne T., 2021. Effect of increasing level of brewer's grain in diet of rabbits on growth and carcass traits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-20, 4 pp.*

The effect on growth and carcass quality of increasing level of brewer's grain (0, 20 and 30%) in growing rabbit diet was studied. A total of 180 rabbits (5 weeks old, average live body weight of 860 ± 147g) were divided into three experimental groups of 60 rabbits and housed in collective cages (4 rabbits per cage) until slaughter (77 days). Each group was fed ad libitum, either the control diet (B0) or the experimental diet containing 20% (B20) or 30% (B30) of dried brewers grains (DBG). Health status was not affected by the treatment. Also, growth and ingestion performances did not differ significantly between the 3 groups (individual weight gain=29.2 – 30.5g /d and feed intake per cage = 379 - 390 g /d). Feed conversion was higher (P<0.01) in B20 group compared to the 2 other groups (3.92 vs. 3.65). The incorporation of DBG did not alter the carcass characteristics of the groups. Increasing level of brewer's grain until 30%, in partial substitution to soybean meal and decreasing alfalfa and barley grain rates can be used in rabbit diets without effect on health, growth performance or carcass traits.

Hernández M., Nouel-Borges G., Sánchez-Blanco R., 2021. Inclusion of *Prosopis juliflora* pods preserved in sugar cane molasses and *leucaena* leaves in rabbits diets. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-21, 4pp*

The aim of this work was to study the inclusion of a mixture of *Prosopis juliflora* pods preserved in sugar cane molasses (PPM) and *Leucaena leucocephala* leaves flour (LFF) combined with a commercial rabbit feed (CRF) (representing 73.88 and 25% of the diet, respectively) on the feeding of rabbits during 63 days, from the weaning (48 d) to the slaughter (111 d). A total of 30 rabbits were assigned at random to five experimental treatments (three replicates per diet with two animals per replicate): T1: 52.5% PPM, 21.4% LFF and 25% CRF; T2: 43.1% PPM, 30.7% LFF and 25% CRF; T3: 33.7% PPM, 40.1% LFF and 25% CRF; T4: 24.4% PPM, 49.5% LFF and 25% CRF; T5: 100% CRF. The variables measured during the study were feed intake (dry matter, organic matter, ash, crude protein, ADF and NDF), initial and final body weight, live weight gain, carcass weight, feed conversion, and feed cost per kg of live weight gain. Significant differences were found on all analysed variables (P<0.005). The best treatments (P=0.015) on cost of rations (opportunity cost of foods) were T5 and T1 (2.0 and 2.44 USD/kg of live weight gain) and the worst was T4 (4.69 USD/kg of live weight gain), with intermediate values obtained for T2 and T3 (2.92 and 2.49 USD/kg of live weight gain, respectively).

Kouadio Kouakou Serge, Yapi Yapo Magloire, Kimse Moussa, Alla Konan Jean Bédél, Sangare Sidiki, Gidenne Thierry, Wandan Eboua Narcisse, 2021. Effects of sun-dried stylo hay (*Stylosanthes guianensis* cv ciat 184) on rabbits growth and slaughter performances. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-22, 4 pp.*

The effect of sun-dried Stylo hay (*Stylosanthes guianensis* cv CIAT 184) level in complete pellet diet was studied on growth and slaughter performances of local hybrid rabbits in Côte d'Ivoire. Four diets containing 0% (control: Sg0), 10% (Sg10), 20% (Sg20) and 30% (Sg30) of Stylo respectively were produced and distributed ad libitum to 4 batches of 12 rabbits from weaning (35 d, mean weight: 613 ± 29 g) to 91 days old. Rabbits receiving the Sg30 diet had the best daily weight gain of 30.4 g / d (+ 16%, P <0.001) and the highest feed intake (+ 7%, P <0.001) compared to the control Sg0. Feed conversion rate was better with the Sg20 and Sg30 diets (-0.45, P <0.001) compared to the control diet. Animals' health was not affected by Stylo incorporation rate in the diet. In

addition, the cold carcass weight was better with the Sg20 and Sg30 diets compared to the control (+12%, $P < 0.001$). It was concluded that sun-dried Stylo hay could be incorporated in rabbits complete pelleted feed up to 30%, as source of fibres.

Lebas F., 2021. Bentonite in rabbit feeding – a short review. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-24, 4 pp.*

Bentonite can be safely used in rabbit diets up to 2% (legal maximum in Europe). Sodium bentonite can efficiently improve pellet quality, even in presence of additional fat, but not higher than 6%. Sodium and calcium bentonite incorporation in the diet are efficient mycotoxins binders, able for example to nearly suppress the negative effect of aflatoxins. As a negative aspect, presence of bentonite in the diet is incompatible with the efficiency of most coccidiostats.

Liu Tingting, Cao Ningkun, Xia Xueru, Cui Jia, Chang Xingfa, Wei Yuchao, Sun Lei, Li Nan, Chen Baojiang, 2021. Effects of different starch sources on endogenous nitrogen and energy losses in meat and wool rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-26, 4 pp*

The effects of different starch sources on endogenous nitrogen and energy losses in meat and wool rabbits were studied comparing the inclusion of corn starch, potato starch and tapioca starch in nitrogen-free diets. Both a total of eighteen 18-months-old healthy meat and wool rabbits weighting 3.00 ± 0.035 kg, on average, were randomly divided into 3 groups, 6 in each group. Diets with different starch sources (potato, corn and tapioca) were fed ad libitum. The trial period was 7 days. The results showed that: 1) The dry matter intake of the potato group was higher than the corn group ($P < 0.05$); there was no difference in dry matter intake between corn group and tapioca group ($P > 0.05$), both meat and wool rabbits. 2) The metabolic fecal nitrogen (MFN) of tapioca group was higher than in potato starch group ($P < 0.05$), and the difference of endogenous urinary nitrogen (EUN) in each group was not significant ($P > 0.05$), both in meat and wool rabbits. 3) There were no differences in metabolic fecal energy (FmE) and endogenous urinary energy (UeE) among the three groups ($P > 0.05$), both meat and wool rabbits. In conclusion, the endogenous nitrogen and energy losses in the potato group was the lowest for meat rabbits and wool rabbits

Malabous A., Robert D., Barotin.L., Prigent A.Y., Van Lissum M., Colin M., 2021. Influence of metabolites derived from the fermentation of 2 strains of *Lactobacilli* distributed only in maternity on the reproductive and the total performances of rabbits (maternity, growing fattening, slaughtering). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-27, 4 pp.*

In 2 consecutive reproduction cycles, 160 and 117 does were split between 2 feeds, a Control one and one containing 1.32 kg/t of *Metalac*, a product of fermentation of *Lactobacillus farciminis* CNCM-I3699 and of *Lactobacillus rhamnosus* CNCM-I-3698. The reproduction performances of these does and the growing – fattening results of their litters were studied, these last ones receiving all a control feed from weaning to 72 days. The prolificacy was higher in the Control group for unknown reasons, but due to the better homogeneity of the “2 days old rabbits”, the number rabbits/litter after screening (elimination of the small and sickly rabbits) and the one of weaned rabbits/litter were lightly but statistically significantly higher with the *Metalac* (Respectively + 0.27 rabbit/litter and + 0.15 rabbit/litter). The mortalities before weaning were not modified. The weights at weaning of the rabbits and of the litters were heavier with the *Metalac* (respectively, + 30 g and + 406 g). The *Metalac* distribution to the does before weaning did not modify the mortality of their litter during the growing-fattening period but their weight at 70 days tends to be higher (+ 19 g) ($P = 0.1$). The feed intake and feed conversion ratio were not modified. The slaughter yields were improved highly significantly of + 0.8 point for the rabbits receiving *Metalac* before weaning. Calculating on the base of these results, the intake of 21.6 g of *Metalac* increases the feed intake of 980 g/parturition and the production of live rabbit and of rabbit meat respectively of 840 and 600 g .

Matics Zs., Szendrő Zs., Kasza R., Radnai I., Ács V., Dalle Zotte A., Cullere M., Singh Y., Gerencsér Zs., 2021. Effect of silkworm (*Bombyx mori*) oil dietary inclusion on live performance and carcass traits of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-29, 4 pp.*

The objective of the study was to examine the effect of a complete dietary substitution of sunflower oil with silkworm (*Bombyx mori* L.) pupae oil (SWO) and evaluate the growth performance and carcass traits of growing rabbits. Weaned rabbits (5wk) were randomly divided into 2 groups (n=32 rabbits/group; pair-caged) which were both fed with a commercial pelleted diet containing 1.3% sunflower oil (Control) until 7 weeks of age. From 7 to 10 weeks of age, half of the rabbits continued to receive the Control diet, whereas the second group received a diet in which the sunflower oil was completely

(1.30%) replaced by SWO. *Ad libitum* feeding was applied throughout the experiment and drinking water was also freely available from nipple drinkers. The individual body weight and on a cage basis feed intake of rabbits were measured weekly. Daily weight gain and feed conversion ratio were then calculated. Morbidity of animals was also monitored weekly, whereas mortality was checked daily. At 10 weeks of age, rabbits were slaughtered and dissected. Globally, the weight gain, feed intake and feed conversion ratio of rabbits were not influenced by the dietary inclusion of SWO. No morbidity and mortality were observed during the growing period in both groups. Carcass traits were also similar in the two experimental groups. In conclusion, SWO can be considered a promising feed ingredient for growing rabbits as it ensured satisfactory growth performance and carcass traits.

Menini F.X., Gohier C., Bourdillon A., Leroy G., 2021. Effect of the monopropylene glycol addition in drinking water at different periods during maternity period on the performance of rabbit does and kits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-30, 4 pp*

Monopropylene glycol (MPG), a complementary feed and precursor of glucose for the treatment and prevention of subclinical acetonemia in cattle, has been tested in a rabbit farm by addition in drinking water at different times during parturition period. Three groups of does received 0,4% of MPG in water either during four days before birth B (B-4 days to B, BB group), or double distribution (B-4 to B) and around the lactation peak (B+14d to B+18d, LP group), or without MPG (C group). Mortalities of does and kits were unaffected by the addition of MPG. However, the addition of MPG only before parturition had a positive effect on growths and weights of rabbits from 21 to 25 days old.

Nursita I.W., Cholis N., 2021. The effect of complete feed substitution with kelor (*Moringa oleifera*) dried leaves on the physiological and production performance of male weaned crossed New Zealand White rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-31, 4 pp.*

The purpose of the research was to study the effect of a dietary substitution with kelor dried leaves on the physiological and production performance of weaned male crossed New Zealand White rabbit. The kelor (*Moringa oleifera*) leaves have a high crude protein content (26-30 %). Sixteen rabbits were used in a randomized trial design with 4 treatments and 4 replicates/treatment. Experimental rabbits were fed a complete diet (control: P0) or a diet with 10% substitution (P1), 20% substitution (P2) and 30% substitution (P3) with dried kelor leaves. The data obtained were analyzed by analysis of variance. The results showed that although the feeding of leaves had significant effects on the frequency of respiration ($P < 0.05$) but physiologically they are still in the normal range (tb: 39.3°C; fr: 74-86 times/min). The feed intake, and the body weight gain of the rabbit fed leaves were lower than in controls (8, 16 and 9%, respectively; $P < 0.05$). It was concluded that substitution of complete feed with dried *Moringa oleifera* leaves is not recommendable to young rabbits although there were not physiological effects on the animals.

Oliveira T.C., Nicolau J.T.S., Souza J.H.A., Leite S.M., Ribeiro L.B., Castilha L.D.1, 2021. Effect of physical form of diet and feeder type on performance of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-33, 4 pp.*

This work aimed to evaluate the influence of different physical forms of diet and types of feeder on the performance and economic viability of growing rabbits. Forty animals (20 males and 20 females) were housed, from 31 to 70 days of age, in individual galvanized wire cages with automatic drinking fountain. A single commercial feed was formulated based on corn, soybean meal, wheat bran, amino acids, vitamins, minerals and additives to meet the nutritional requirements of growing rabbits. A completely randomized study was designed in a factorial scheme 2 vs 2 (two physical forms of diet vs two types of feeder), with ten replicates per treatment. The physical forms of diet were pelletized or bran, while the feeder types were semi-automatic or manual. Throughout the experiment period, feed and water were provided *ad libitum*. The diets provided, the leftovers and the animals were weighed at the beginning of the experiment (31 days), at 50 days, and at the end of the experiment (70 days) in order to determine the performance variables. The cost of production was determined based on the value of feed in relation to the value of the weight gained by the animals. A significant interaction between treatments was detected for feed conversion ($P=0.018$) and production cost ($P=0.023$), from 31 to 70 days of age. In the manual feeder, the best results both for feed conversion and production cost were obtained with the pelletized diet whereas there were no significant differences between feed types when a semi-automatic feeder was used. For the 31 to 50 days phase, the highest values of final weight ($P=0.003$), weight gain ($P=0.011$) and feed intake ($P=0.005$) were obtained with the pelletized diet, but there were no differences ($P>0.05$) between types of feeder. Similarly, for the 31 to 70 days phase, the highest values of final weight ($P<0.001$), weight gain ($P<0.001$) and feed intake ($P<0.001$) were also obtained with the pelletized diet. Regarding the type of feeder, the only difference ($P=0.009$) found was for daily weight gain, with the semi-automatic feeder providing

the best result. In conclusion, the best results for weight gain of growing rabbits were obtained with the pelletized diet and with the semi-automatic feeder. Feed conversion and production cost were increased with bran feed when a manual feeder was used, whereas there were no differences between pelletized and bran feeds when the feeder used was semi-automatic.

Paës C., Gidenne T., Bannelier C., Bébin K., Duperray J., Gohier C., Guené-Grand E., Rebours G., Aymard P., Combes S., 2021. Suckling rabbit digestibility: effect of the age at introduction of a starter feed. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-34, 4 pp*

Early feeding in the nest is a promising biomimetic strategy to improve gut health and prevent digestive diseases. To formulate adequate starter feed, it is essential to determine the nutritional values of the preweaning diets. However, the assessment of suckling rabbits' digestion is challenging since the kits are raised together with their mother along with the fact that gut morphology and functionalities are deeply changing during the transition from milk to solid feed. To study the digestive capacity of the young rabbits, a 15-days digestibility trial was performed from 21 days of age to weaning on rabbits provided with early feeding or not. A mother-litter separate feeding system with controlled suckling was used to monitor intake and faecal excretion of 20 litters. All the litters had access to pellet feeds from 15 days. A starter feed in a form of a gel was provided as early as 3 days of age to half of the litters. Gut development dynamics and milk intake were taken into account to adjust faecal digestibility calculations. Digestibility coefficients of dry matter, crude protein, gross energy, and fibre fractions (NDF, ADF, Hemicelluloses) were high between 21 and 24 days (64%, 72%, 68%, 44%, 37% and 55%, respectively) and were followed by a decrease between 25 and 27 days (-16%, -10%, -16%, -32%, -37%, -7%). Starter feed supplementation did not modify faecal digestibility. Our original data revealed a short period where digestive capacity of the rabbit seemed to be overwhelmed by the sudden influx of dry matter in the gut. This could be implemented in the future for pre-weaning feed formulation.

Parra-Almao J., Nouel-Borges G., Sánchez-Blanco R., 2021. Effects of sugar cane molasses, rice bran and *Leucaena leucocephala* leaves on digestibility and performance of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-35, 4 pp.*

Two experiments were conducted to evaluate the rice bran(RB) and sugar cane molasses (SM) as energy feeds, with dry *Leucaena leucocephala* leaves (LL), in diets for growing rabbits. A total of 24 rabbits (77± 5 d age), weighting 2157 ± 46.1 g, were distributed in individual digestibility cages. A full random experiment design with 6 treatments and 4 rabbits/treatment were used. Treatments were: T1 (0% SM and 50% RB); T2 (12.5% SM and 37.5% RB); T3 (25% SM and 25% RB); T4 (37.5% SM and 12.5% RB); T5 (50% SM and 0% RB) and Tt (100% commercial balanced food). The first 5 treatments also contained 49% dry LL and 1% mineral premix. Experimental period was 14 days (8 days of adaptation of diets and 6 days of recording data). The dry matter intake (DMI) was higher in Tt (135 g/d, P<0.05) respect to T4 (82.4 g/d). Likewise, the apparent digestibility of crude protein was higher T1 (85.9 %, P<0.001) with respect to Tt (56.9 %). From the first experiment, T2, T3 and Tt were selected to evaluate weight daily gain (WDG), DMI, feed conversion rate (FCR) and feeding cost (USD/kg live weight) in 45 rabbits from 40 to 110 days of age (3 rabbits for cage and 5 cages/treatment). Significant differences (P<0.05) were detected in all variables studied, WDG g (T3 20.1 lower than Tt 50.4); DMI g/d (T2 223 lower than Tt 294); FCR g/g (T3 11.5 higher than Tt 5.9). In conclusion, the results obtained this work may be influenced by the low availability of crude protein that could be caused for heat damage on feed processing in evaluated diets.

Prado Y.M., Martínez-Paredes E., López-Luján M.C, Ródenas L., Blas E., 2021. Digestibility in lactating rabbit does and growing rabbit: a comparative study. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-36, 4 pp.*

The present study is proposed to elucidate whether nutrient digestibility differs between lactating rabbit does and growing rabbits, by using a common methodology, performing simultaneous measurements and with all animals housed in the same room. A total of 13 lactating rabbit does and 24 growing rabbits were used. Digestibility trials were conducted during four consecutive days, in two different periods: P1 (in lactating rabbit does: days 14 to 18 of lactation; in growing rabbits: days 42 to 46 of age) and P2 (in lactating rabbit does: days 21 to 25 of lactation; in growing rabbits: days 49 to 53 of age). The DM and OM digestibility of diet (190 g CP, 363 g NDF and 182 g ADF per kg DM) was higher in lactating rabbit does than in growing rabbits (64.6±0.27% vs. 63.5±0.23%, P=0.003, for DM; 64.9±0.25% vs. 63.8±0.22%, P=0.003, for OM). These differences are essentially explained by the increase in NDF digestibility (29.9±0.49% vs. 27.8±0.44%, P=0.003), linked to the increase in ADF digestibility (20.2±0.57% vs. 16.7±0.51%, P<0.001) since the type of animal did not affect digestibility of hemicelluloses, as well as that of CP. Discrepancies with some previous studies could have their origin in methodological

differences. Consequently, it would be of interest to have a standardized reference method to evaluate the digestibility of nutrients in lactating rabbit does, similar to what already occurs in growing rabbits .

Raffin J., Rebours G., Vastel P., Reys S., 2021. Effect of the dietary ratio between digestible and indigestible fibres on the digestive health and performances of fattening rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-37, 4 pp.*

In animal nutrition, it is common to distinguish digestible fibres (DF) from indigestible fibres (ID), which both have benefits on rabbits' performances and health. DF includes a fraction of hemicellulose, pectins and soluble polysaccharides and ID are usually represented by the ADF. The aim of this study is to deepen through a meta-analysis the influence of the ratio between DF and ID (DF/ADF ratio) on the sanitary status and the performance of fattening rabbits. The database contained 28 diets from 8 trials runned in the same experimental center (3856 rabbits from Hyplus genetic), with a ratio DF/ADF ranging from 0.73 to 1.03. Within each trial, feeds were distributed in the same quantity and had a similar nutritional content (excepted for fibre). During the whole fattening period (32 to 71 days old), there was a significant decrease of the digestive sanitary risk (DSR) ($P < 0.01$), the mortality and the morbidity ($P < 0.05$) when the DF/ADF ratio increased. By breaking down the DSR into different types of pathologies, this beneficial effect was observed on the Rabbit Epizootic Enteropathy (REE) and on paresia ($P < 0.05$), but not on diarrhea ($P = 0.27$). The influence of the DF/ADF ratio on the DSR was significant throughout the first part of the fattening period (32 to 50 days old): A 2.7 point reduction of DSR was observed per 0.1 point of DF/ADF. Throughout the second part of the fattening period (51 to 71 days old), this effect was not significant but tended to decrease the DSR by 1.1 point per 0.1 point of DF/ADF ($P = 0.16$). About performance, the Average Daily Gain (ADG) ($P = 0.96$) and the Feed Conversion Ratio (FCR) ($P = 0.98$) were not influenced by this ratio. These results suggest that the individual effect of DF and IF on health status can be optimized when their intake respects a certain balance.

Ribeiro D.M., Martins C., Pinho M., Freire J.P., Falcão-e-Cunha L., 2021. Effect of using carob pulp in growing rabbit diets on performance, digestibility, intestinal morphology and caecal parameters. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-09, 4 pp.*

The objective of this study is to evaluate the effect of including carob pulp in rabbit diets and the consequent growth performance, feed digestibility, intestinal mucosa morphology and caecal fermentative activity. Early weaned (22 days old) rabbits (N=39) were divided among three diets with 0%, 12.5% and 25% carob pulp, all with the similar CP and NDF content. During the 5th week of trial, faeces were collected to determine feed digestibility. At the end, rabbits were slaughtered. Caecal content was harvested and a section from the middle of the small intestine was taken to analyse intestinal morphology. Carob pulp inclusion did not affect growth performance with the exception of feed conversion which deteriorated 12% at 25% of inclusion. The digestibility of all fractions lowered significantly with 25% inclusion of carob pulp with the exception of ether extract which was unaffected. Dry matter digestibility lowered from 67.0% to 62.2%; organic matter and energy digestibility decreased between 7.5 and 8.9%, whereas crude protein digestibility decreased 21.1% (83.3% vs 65.6%). NDF digestibility was around 24% lower at higher level of inclusion. Neither intestinal morphology nor parameters of caecal fermentation, caecal pH and molar proportions of volatile fatty acids were affected by the inclusion of either 12.5% or 25% carob pulp in the diets of fattening rabbits.

Sangare S., Kimsé M., Bléyé M.N., Yapi J.N., 2021. Effect of spirulina (*Spirulina platensis*) on growth performance and rabbit health (*Oryctolagus cuniculus*). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-39, 4 pp.*

Spirulina is a cyanobacterium that is one of the oldest known life forms on Earth. This blue-green filamentous alga has been consumed for centuries by certain populations. Thanks to its complete nutritional qualities, including a high protein value, amino acids and essential fatty acids, vitamins and minerals, combined with high digestibility, spirulina is the subject of much research around the world. With this work we aimed to evaluate the effect of spirulina *Spirulina platensis* on growth performance and health of the rabbit (*Oryctolagus cuniculus*) in order to evaluate its subsequent use in cuniculture. Four batches of 14 rabbits weaned at 35 days weighing 500 ± 70 g were reared in individual cages. Thus, in addition to control (T), which was fed without spirulina, there treatments containing spirulina at different doses in the drinking water were used (10 mg/L of water for D1, 50 mg/L for D2 and 100 mg/L for D3). The study found that the intake of *Spirulina platensis* did not result in significant differences in growth performance: average daily feed intake (ADFI), average body weight (ABW), average daily gain (ADG), and feed conversion rate (FCR). The health risk index (HRI) was particularly high in the first two weeks in all different groups, but no differences were observed among the four treatments.

Santinoni J.T., Miranda V.M.M.C., Angelo S.S., Souza J.H.A., Ribeiro L.B., Castilha L.D., 2021. Performance and organ weights of growing rabbits fed diets with extruded broken bean at various levels. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-40, 4 pp.*

The use of agroindustrial coproducts as alternative feed in animal nutrition has been an alternative to reduce production costs. The objective of the present study was to evaluate different levels of extruded broken bean (EBB) in diets for rabbits and evaluate its effect on the growth performance and organ weights. Fifty New Zealand White rabbits of 31 days of age at the start of the experience were used, with initial mean weight of 921±158g. The experimental design was completely randomized, in which treatments consisted of five levels of EBB in diets (0, 5, 10, 15 and 20%), with ten replicates per treatment and one animal per experimental unit. Throughout the experimental period, feed and water were supplied ad libitum. The diets provided, refusals and animals were weighed at the beginning of the experiment (31 days), at 50 days, and at the end of the experiment (70 days), to determine the growth performance. The weight of organs was determined in relative terms after the slaughter of the animals. The performance variables did not differ among the levels of EBB ($P > 0.05$). Only the production costs were influenced, both in the period from 31 to 50 days ($P = 0.033$) and from 31 to 70 days ($P = 0.001$), with a linear increase in the values due to the increasing levels of EBB in the diets. Inclusion levels up to 20% of EBB in rabbit diets do not change performance and organ weights but increase production costs up to 22.04% .

Singh Y., Cullere M., Gerencsér Zs., Matics Zs., Cappellozza S., Dalle Zotte A., 2021. Effect of dietary replacement of sunflower oil with silkworm (*Bombyx mori* L.) oil on the total tract apparent digestibility and nutritive value in growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-41, 4pp.*

This study aimed to evaluate the effect of the dietary incorporation of silkworm (*Bombyx mori*) oil (SWO) in rabbit diets as a total replacement of sunflower oil, on the total tract apparent digestibility (TTAD) and nutritive value of experimental diets. To this purpose, twenty-four 55-days-old rabbits (Martini group hybrid) were individually housed in digestibility cages and randomly assigned to one of the two experimental groups (12 rabbits/group): the first group received a standard commercial diet containing 1.30% sunflower oil (Control), whereas the second group received a diet in which sunflower oil was replaced entirely with 1.30% silkworm oil (SWO). Rabbits had ad libitum access to water and feed throughout the experimental trial. The digestibility trial consisted of a seven-day adaptation period followed by a four-day collection period. The experimental diets and the collected faeces were analysed to evaluate the TTAD, and the nutritive value of the diets was then calculated. No morbidity and mortality was observed during the trial in both groups. The inclusion of SWO did not influence the TTAD of nutrients. However, SWO diet displayed a higher digestible protein (DP) to digestible energy (DE) ratio than the Control group ($P < 0.001$), which resulted from the highest DP ($P = 0.001$) and the lowest DE ($P = 0.022$). In conclusion, SWO has provided a TTDA comparable to that of sunflower oil and can therefore replace plant-based oil in diets for growing rabbits without any adverse effect on nutrients digestibility and on the nutritive value of the diets.

Xiccato G., Birolo M., Pascual Guzman Á., Bordignon F., Trocino A., 2021. Effect of dietary supplementation with chestnut and grape pomace extracts on growth performance, nutrient digestibility and meat quality of rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication N-42, 4 pp.*

The present study aimed at evaluating the effect of the dietary supplementation with two high-tannin extracts (chestnut vs. grape pomace) at two inclusion levels (0.2% vs. 0.4%) on growth performance, nutrient digestibility, and meat quality in growing rabbits. A total of 270 crossbred rabbits were randomly divided into 5 experimental groups and fed from weaning to slaughter (30 to 66 d of age) with: control diet (B); diets supplemented with 0.2% or 0.4% of chestnut extract (C2 and C4, respectively), diets supplemented with 0.2% or 0.4% of grape pomace extract (G2 and G4, respectively). The mortality rate was very low (0.4% on average) without differences among groups. Growth performance was not affected by the dietary treatments. In the post-weaning period, the digestibility of crude protein was higher in G2 and G4 groups compared to the C4 group (+2.9%; $P < 0.001$). The digestibility of ether extract was lower in rabbits fed diet C4 compared to the others ($P < 0.001$). In the fattening period, the digestibility of dry matter (+3.1%), fibre fractions and gross energy was higher in rabbits fed diet G4 with respect to the control group ($0.05 < P < 0.001$), whereas the digestibility of crude protein was the lowest with diet C4 ($P < 0.001$). Slaughter weight, cold carcass, and dressing percentage averaged 2664 g, 1618 g and 60.8%, respectively, without significant differences among groups. Meat pH, colour indexes, and oxidative status were not modified by the dietary treatments. In conclusion, both chestnut and grape pomace extracts rich in tannins can be used as feed additives in diets for growing rabbits at inclusion levels ranging from 0.2% to 0.4% without negative effects on growth performance, slaughter results, and meat quality traits. However, the chestnut extract reduced nutrient digestibility at the highest supplementation

rate during the postweaning period, whereas grape pomace extract increased nutrient digestibility at both rates in the postweaning and fattening periods.
utilization and growth during post-weaning stress period with high profitability, under Egyptian environmental conditions.

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Short communications

Adeoye A.A., Udoh J.E., 2021. Morphometric traits in American Standard Chinchilla rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-01, 3 pp*

Data on body weight and linear body measurements collected from one hundred (100) American Standard Chinchilla rabbits comprised 61 females and 39 males at 8 weeks were used to predict the live body weight of the rabbits, correlations among the growth traits and to determine the effect of sex on the growth traits. The estimates were statistically ($p < 0.05$) higher in the female compare with male in virtually all the traits considered except in fore arm length. The values for body weight, body length, ear length, tail length, fore arm length, heart girth and abdominal circumference for females were 1.19 kg, 31.97 cm, 10.67 cm, 9.89 cm, 15.61 cm, 21.61 cm and 23.75 cm respectively, while the corresponding values for males were 0.88 kg, 28.00 cm, 10.44 cm, 8.95 cm, 14.74 cm, 19.62 cm and 21.67 cm. The correlations between body weight and the linear body measurements were positive, significant ($p < 0.05$ and $p < 0.001$) and range between 0.301 and 0.951 in males, and between -0.235 and 0.681 in females. Coefficient of determination was highest (0.858) when body length was fitted in the model, followed by abdominal circumference (0.735). The best predictor of live body weight at eight week in American Standard Chinchilla rabbits was body length.

Amroun Thilali, Daoudi-Zerrouki Nacira, Martin Patrice, Miranda Guy, Charlier Madia, 2021. Impact of milk composition on neonatal mortality in two strains of rabbits, the white population and the synthetic strain in Algeria. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-02, 4 pp.*

The aim of our study is to assess mortality of rabbit kits during early life according to the genetic origin of the nursing milk. Therefore, a protocol based on cross-adoptions between litters from the two genetic types of rabbits bred in Algeria, the white population (PB) and the synthetic strain (SS) has been used. Samples of milk were analyzed by liquid chromatography coupled to a mass spectrometer (LC-MS). During three lactations, mortality rates varied according to the genetic origin of the suckled milk. In the control groups, the highest mortality rate was recorded in the litters PB receiving milk PB $18.50 \pm 0.18\%$. This rate drops when these rabbits suckle SS milk ($12.50 \pm 0.01\%$, $P < 0.05$). In the control groups, the SS rabbits receiving SS milk, the mortality rate is $12.50 \pm 0.03\%$. This rate increases when SS rabbits suckle PB milk ($27.00 \pm 0.04\%$, $P < 0.05$). The different chromatographic profiles highlight a polymorphism of the α_{s1} and α_{s2} -caseins, which is particularly marked in PB milk. The lowest mortality rate is recorded in individuals carrying the natural variant (NV) of α_{s2} -casein, which increases together with the new variant (Var B). The deleterious effect of variant B of α_{s1} -casein (NV/B individuals) seems to be more marked than that of α_{s2} -casein (32% vs.15%, $P < 0.05$), probably due to a cumulative effect of the presence of variant B of α_{s2} -casein. This study reveals significant effects of the genetic origin of milk on the viability of young rabbits, in particular the presence of new genetic variants of the α_{s1} and α_{s2} -caseins.

Boucher S., Nicolier A, Tatone F., Sauvaget S., 2021. Regarding a case of blue coloration on meat rabbit carcasses. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-03, 5 pp.*

A slaughterhouse told us about the occurrence of a blue coloration of meat from commercial rabbits. It occurs in the summer time, a few days after slaughter, at retailers. In order to highlight the potential etiological agent, histological and bacteriological examinations were carried out at the same time. Four bacteria emerged: *Enterococcus hirae*, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas libanensis*, which were identified and confirmed using Maldi-tof mass spectrometry technology. The isolated bacteria were then seeded individually at room temperature under a hood on the surface of a healthy rabbit carcass. Coloration occurred after 48 hours only on meat inoculated with *Pseudomonas libanensis*. We conclude that this bacterium is at the origin of the coloration observed in retailers. The literature indicates that a break in the cold chain is necessary for the bacteria to develop at 25 - 30 ° C. A slaughterhouse cleaning procedure and a reminder on the disinfection of the hands of chain operators are in place. Recording thermometers are put in boxes when they leave the slaughterhouse in order to identify where the cold chain has broken.

Boucher S., Carneiro M., Vieillard J., 2021. The Alfort jumper rabbit: review of the scientific works conducted from 1935 to 2019. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-04, 4 pp.*

The "Alfort jumper rabbit" is an original rabbit known since 1935 and easily recognized by its particularly acrobatic locomotion behavior and constant ocular lesions. The specific feature of this rabbit is an irregularity in its way of moving. Sometimes, the hind legs will lift, lose contact with the ground and the animal moves in an upright position, with hind paws and tail above the

head. A lot of studies have been done on this rabbit since 1935. The jumper rabbit shows retinal dysplasia and early-onset congenital cataracts resulting in glaucoma, which are responsible for its blindness. The 'jumper' character is the expression of a major recessive gene (sam) and its hereditary transmission is in accordance with a Mendelian distribution. A genomic study, demonstrated that the mutation is located in the RORB gene and that in "jumper" rabbits the Dmrt3 spinal population of neurons is misplaced. The histological observations of brain have shown a severe hypoplasia and an immature aspect of the cerebellum in young rabbits. Nowadays, more than 270 frozen embryos are stored in the national cryobank. The researchers that are interested in the gene (s^{am}) have to submit their program research to a scientific committee.

González-Redondo P., Finzi A., 2021. Efficiency of the rabbit underground cell keeping system in maintaining good thermal regime under cold weather conditions. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-05, 4pp.*

An alternative open-air rabbit keeping system, called "Underground cell system", has been adopted in Italy since more than 30 years and it is slowly and spontaneously wide-spreading in rabbit keeping commercial units which produce a very appreciated and well-paid high-quality meat at low input costs. The system is based on a cell covered with earth till the rim and connected by a tube to an external cage, simulating natural conditions and offering a sheltering preferred by does even if they could accede to a free-range area. The cell offers micro-environmental conditions that are fresher in the hot season and warmer in cold season. Since the nest is set inside the cell and kits are sensible to cold, the internal cell temperature has been tested in the cold season in comparison with the external temperature. Six concrete and six plastic underground cells, each keeping a single doe, were tested in a farm located in Viterbo (Italy). Minimum outside temperature and minimum temperature inside the cell were measured between mid-December 2013 and early April 2014. The results show that the difference ($P < 0.001$) between the external and the internal temperature increases with the decrease in environmental temperature and the concrete cell was slightly but significantly more efficient than the plastic cell ($P < 0.05$). When outside temperature lowered until $-2/-4$ °C the internal temperature of the cell remained 9-10 °C higher and sufficient for the nesting area, as demonstrated by previous studies showing that the kits' mortality during the cold season is similar to the one of the warm season.

Lukefahr S.D., Oseni S.O., 2021. Vertical rabbit farming integrative systems for cities: models and opportunities – A bibliographic review. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-06, 4 pp.*

A recent development in human history is the fact that most people now live in cities. With many serious issues or challenges that affect current food production levels including the rising demand for food, it has become increasingly evident that urban inhabitants must contribute a significant share of global food production. With recent advancements in technologies applied to the development of vertical farming systems, this challenge is presently being embraced with fortitude in some major cities. Such systems are now beyond the mere blueprint stage and even involve closed-loop or circular ecosystems where solar energy and wind power are harnessed, and rainwater is collected. Such systems much farther limit the carbon footprint compared to traditional rural farms. It is forecasted that soon, some cities will become food self-sufficient. This paper will describe several innovative and applicable vertical farming models (e.g., aeroponics, aquaponics, and hydroponics), which could potentially include a rabbit meat component. Unlike poultry and fish, rabbits are ideal because they can subsist largely on plant wastes. Moreover, their fecal and urine wastes can be recycled and processed as fertilizer to grow vegetables and other crops or even to fertilize ponds used for aquaculture. An opportunity exists for rabbit scientists to engage in research programs that address the need to solve preliminary problems in order to promote rabbit production in futuristic vertical farming systems that are used for urban food production.

Oseni S. O., Lukefahr S. D., 2021. Rabbit data for development (RD4D): concept, processes, outcomes. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-07, 5 pp.*

With the recent global upsurge in the application of data analytics tools in business and enterprise development, it becomes imperative to explore and deploy the same tools as a strategic intervention to promote rabbit enterprises for wealth creation. Actualizing this goal will require a mechanism for capturing and harnessing data analytics for sustainable meat rabbit enterprise and value chain development. The main objective of this presentation is to explore a strategy for the creation of a "Rabbit Data for Development" (RD4D) portal to facilitate the compilation, organization and dissemination of data analytics and insights -on all aspects of rabbit production and value chains - as a key strategy for meat rabbit enterprise development. Methodology describes a generalized architecture for RD4D that embodies databases and repositories with the capability to generate periodic analytics, insights and intelligence for stakeholders in the meat rabbit value chain. Expected outcomes include: (a) a framework for the dissemination of rabbit data analytics and intelligence for viable and sustainable meat rabbit enterprises, (b) a functional RD4D architecture for rabbit data warehousing with multiple databases and repositories, covering all activities in the meat rabbit value chain, and (c) decision support tools and systems to promote efficient meat rabbit production enterprises and value chains.

Oyedele O.J., Odeyinka S.M., Oyebanji B.O., 2021. The haematological and biochemical parameters of rabbits fed with *Moringa oleifera* Lam. based diets. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-08, 4 pp.*

In a 12-week trial, 70 weaner rabbits aged between 4 to 6 weeks of both sexes, (average weight of 388 ± 0.8 g) were randomly allotted to five experimental groups. The animals were fed *Moringa oleifera* (M) and *Centrosema pubescens* (C) based diet in the following ratio, 100%C, 75%C+25%M, 50%C+50%M, 25%C+75%M and 100%M in a completely randomized design. The rabbits comprised of crosses of New Zealand White, Chinchilla, and California breeds. The animals were weighed weekly and at the expiration of the experiment, blood samples were collected for haematological and biochemical parameters analysis and carcass was analyzed. There were no significant differences in red blood cell (RBC) and white blood cell WBC ($p > 0.05$) counts of the animals in all the groups. The packed cell volume (PCV) of animals fed 25C75M (43.7%) was significantly ($P < 0.05$) higher compared with animals in other groups. The serum cholesterol of animals fed 100M diet were significantly ($p > 0.05$) lower than values obtained from other animals. There was no significant difference in the carcass parameters evaluated except the stomach weight of animals fed 100% *C. pubescens* which was significantly ($p < 0.05$) higher than those obtained for other animals. It was concluded that *Moringa oleifera* [leaves] can effectively replace *Centrosema pubescens* in rabbit's diets without any deleterious effect and can therefore be used to develop a novel strategy to produce rabbit's meat with lower cholesterol and saturated fatty acid contents.

Ouagliariello G., Lafalla L., 2021. Importance of the contribution of rabbit meat in the diet of families in vulnerable conditions, in departments of northeastern Mendoza, Argentina.. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-09, 5 pp.*

The feeding of families in poverty, especially in developing countries, is limited in the intake of animal protein, among other deficiencies. The diet can be improved from the raising and consumption of rabbits at the family level. This has been demonstrated by the results of the implementation of projects and programs for this purpose, in different emerging countries of the world, over time. The PROHUERTA Program, financed by the Ministry of Health and Social Development of the Argentine Republic and executed by INTA (National Institute of Agricultural Technology), has been implemented for almost 30 years, with the purpose of improving the diet of the population in a situation of vulnerability through orchards and breeding of domestic species. In this research work, the amounts of protein contributed to the family diet and the times for animal care were quantified, which determine the importance of this type of breeding in rural and peri-urban areas in the east of the Province of Mendoza. The methodology was based on the analysis of the results of 32 surveys of members of these families. In addition, interviews were conducted with qualified referents: Public agents of the Area of Extension and Rural Development of INTA, responsible for the territorial execution of the PROHUERTA Program. As a result, it is possible to observe that the contribution of rabbit meat was sufficiently significant for the families surveyed, who consume it with a weekly frequency in 44% of the cases or monthly in 56%.

Rotimi E. A., 2021. Evaluation of body weight and morphometric traits of New Zealand rabbits breed raised under semi-arid condition in Nigeria. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-10, 4 pp.*

Rabbit production plays important role in increasing animal protein supply in Nigeria. Rabbit production provides a cheap, affordable and healthy source of meat. The growth of animals involves an increase in body weight, which can change the conformation of various parts of the body. Live weight and linear measurements are indicators of growth rate in rabbits and other farm animals. This study, therefore, was conducted to evaluate the morphometric characteristics of New Zealand rabbits breed raised in the semiarid region of Nigeria and also to investigate the morphometric variables that contribute to the body conformation the breed using Principal Component Analysis (PCA). Data were obtained from 80 New Zealand rabbits (40 bucks and 40 does) raised in Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsinma. Data were taken on body weight (BWT), body length (BL), ear length (EL), tail length (TL), heart girth (HG) and abdominal circumference (AC) on individual animals. Data collected were subjected to multivariate statistical analysis using SPSS 20.0 statistical package procedures. The results of the descriptive statistics showed that the mean BWT, BL, EL, TL, HG and AC were 0.91kg, 27.34cm, 10.24cm, 8.35cm, 19.55cm and 21.30cm respectively. Sex showed significant ($P < 0.05$) effect on all the variables examined, with higher values recorded for female rabbits (1.01 kg, 28.53 cm, 10.53 cm, 8.70 cm, 20.30 cm and 22.28 cm for BWT, BL, EL, TL, HG and AC respectively) while males had lower values (0.80 kg, 26.15 cm, 9.96 cm, 7.99 cm, 18.80 cm and 20.33 cm for BWT, BL, EL, TL, HG and AC respectively). This trend reveals the manifestation of sexual dimorphism among the rabbit breeds in favour of female rabbits. The phenotypic correlation coefficient values (r^2) between the morphometric traits were all high and positive, ranging from $r^2 = 0.406$ (between EL and BL) to $r^2 = 0.909$ (between AC and HG). HG being the most correlated with BWT ($r^2 = 0.786$) while the lowest correlation was between BWT and EL ($r^2 = 0.462$). Two principal components (PCs) from the factor analysis of morphometric traits explained about 80.42% of the total variance. PC1 accounted for 64.46% while PC2 accounted for 15.97% of the total variance. Three variables, representing body conformation, loaded highest in PC1. PC1 had the highest contribution (64.46%) to the total variations and it is regarded as body conformation traits.

Sánchez J.P., Perucho O., Pascual M., Rafel O., Piles M., 2021. Electronic feeder to record individual feed intake on rabbits raised in collective cages. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-11, 4 pp.*

Individual recording of feed intake of animals raised in groups is essential to improve feed efficiency in breeding programs and also for research on nutrition, feeding behaviour, health and animal welfare. We have designed and manufactured 30 pieces of devices allowing such recording. In this work, we present the device, showing the type of raw data it produces as well as how this information is edited. Raw visits recorded are merged to meals at a rate of approximately 0.6-0.65 (meals/visits), and approximately 40-45% of the declared meals have associated null feed intake records. Thus, the relatively high proportion of visits with misidentification (25%) actually do not have serious consequences since they involve short meals with actually no intake. In spite of the fact that we are already working with the described device, the software for editing information provided by the feeder is still under development and improvement to increase the quality of the feed intake recorded information.

Sangare S., Kimsé M., Bléyééré M.N., Yapi J.N., 2021. Typology of rabbit farmers in the district of Abidjan and the regions of south Comoé and Mé. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-12, 5 pp.*

After a decade of growth, the rabbit industry in Cote d'Ivoire has experienced a slowdown due to the 2010 and 2011 electoral crises. Nevertheless, we are seeing renewed growth in rabbit workshop facilities in recent years. The aim of this work is to draw up a typology of rabbit breeding actors in the Ivory Coast. This characterisation was based on a three-month pre-survey phase from April to June 2017, followed by a two-year survey phase from July 2017 to June 2019. The study involved a survey of 216 rabbit farmers spread across Abidjan District, the South Comoé region and the Mé region. The results showed that the majority of rabbit farmers are nationals (92.4%). All age groups and both sexes are represented in the rabbit farming activity. Nationals have the highest proportion of married and single people with 88.2% and 89.3%. In all localities, the number of farmers who attended school was higher. The results of the survey show that the largest number of rabbit workshops, 51%, were established after 2013. However, rabbit farming remains a secondary activity for most farmers.

Szendró K., Szabó-Szentgróti E., Szigeti O., 2021. Consumers' motivation for (not) choosing rabbit meat - A global view -. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-13, 4 pp.*

The aim of the study was to examine consumers' attitudes and motivations for (not) choosing rabbit meat through a questionnaire. The global consumer study was conducted online in 2018. The motivation of 420 Hungarian, 229 Spanish, 201 Chinese, 242 Italian, 198 Polish, 69 French, 59 Mexican and 442 other nationality respondents was evaluated. The most frequent rabbit meat consumption was registered in the Mediterranean countries. However, the rabbit meat consumption of younger generation is low. Since they are the consumers of the future, particular emphasis should be placed on increasing their awareness on the benefits of rabbit meat, besides introducing rabbit meat in kindergarten and school catering. The availability of semi-finished products and ready-to-eat meals could also encourage consumption.

Youssef Y. M. K., Emam A.M, Abou Khadiga G., 2021. Rabbit breeding situation in Egypt- a case study. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication O-14, 4 pp.*

The objective of this communication was to point to the current situation of the development of the rabbit industry in Egypt by using specifically selected lines. A brief of the historical background of the local Egyptian rabbit lines and the establishment process of the distinguished new lines was mentioned in the manuscript. Three specialized rabbit lines were established and improved through genetic programs in Egypt during the last two decades. One paternal line (Alexandria), one maternal line (APRI) and one global objective line (Moshtohor) were developed in the framework of an Egyptian-Spanish project to develop specific rabbit lines in Egypt. The performance of these specialized selected rabbit lines in different traits was characterized in many papers. A spot on the development of these lines and their current performance is considered to present in this communication.

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PATHOLOGY & HYGIENE

Invited paper

Capucci Lorenzo, Cavadini Patrizia, Lavazza Antonio, 2021. Viral haemorrhagic disease: RHDV type 2, ten years later (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-00 11 pp.*

Until the early 1980s, it was totally unknown that lagomorphs were the hosts of several caliciviruses, which were included in the genus Lagovirus by ICTV in 2000. In those years, two new diseases appeared, with very similar clinical and pathological profiles and associated high mortality rates: rabbit hemorrhagic disease (RHD) in rabbits and European brown hare syndrome (EBHS) in European brown hares. It took a few years to ascertain that both diseases, actually acute and fatal hepatitis, were caused by two genetically related caliciviruses, but finally classified by ICTV into two distinct viral species on the basis of their molecular characterization and epidemiological data: RHDV in rabbit and EBHSV in brown hare.

RHD has had a devastating effect on rabbit farms, causing great economic damage, especially in China, where RHD was first noticed around 1982, and in Europe. RHD has also severely affected wild rabbit populations, whose drastic decline has caused serious ecological imbalances in territories, such as Spain, where rabbits are a central link in the wildlife food chain. Since the early 1990s, with the increased availability on the market of RHDV vaccines effective in protecting rabbits from RHD, the impact of the disease on rabbit farms has been significantly reduced. In the following years, also considering that RHDV is an endemic virus that cannot be eradicated, farmers learned how to manage the continuous use of RHDV vaccine in relation to the epidemiological situation, the type of breeding farm and the costs of vaccination prophylaxis. Although precarious, the management of the RHD risk for rabbit farmers reached an acceptable equilibrium, which was, however, completely upset starting from 2010, by the emergence of another lagovirus, also causing RHD.

The genome of the newly emerged virus shows limited differences with that of RHDV, but the phenotypic traits of the two viruses are distinctive in at least three main respects. 1) the antigenic profile of the virus (the "face" of the virus recognized by the antibodies) is largely different from that of RHDV; 2) newborn rabbits only a couple of weeks old die of RHD when infected with the new virus, while RHDV infections run asymptomatic until 7-8 weeks of age; 3) the new virus, which started in Europe, has spread over the years to several continents affecting wild and/or domestic rabbit populations. During this worldwide distribution, the new virus infected several species of lagomorphs and was shown to cause RHD in most of them. Considering these marked differences and the fact that the new virus is not a variant of RHDV, we proposed the name of RHDV type 2 (RHDV2). All these main distinctive traits that differentiate RHDV from RHDV2 have in practice the following consequences: 1) the antigenic difference between RHDV and RHDV2 (their 'faces') is so great that we need "new" specific vaccines to control RHDV2 (i.e. RHDV2 is a new serotype); 2) in the case of a RHDV2 infection of suckling rabbits, the presence of maternal antibodies to RHDV2 in its blood is the only way to prevent RHD. In contrast, newborns are naturally resistant to RHD if infected with RHDV and therefore, in terms of protection, the presence of maternal antibodies is useless; 3) when RHD outbreaks occur in territories where rabbits live in sympatry with populations of other lagomorphs, viral contamination in the environment reaches so high levels that facilitate the transmission of RHDV2 to other lagomorphs, including those with a lower susceptibility to infection than the rabbit.

Taken together, these phenotypic traits characteristic of RHDV2 are the reason for its rapid spread across the territory and the concomitant disappearance of RHDV. Probably the most striking example of the epidemiological consequences related to the peculiar features of RHDV2 is its rapid spread in USA and Mexico where is now practically endemic. There, despite repeated isolated outbreaks of RHD caused by RHDV from 2000 onwards in small rabbit farms, RHDV has never been able to become endemic.

Short communications

Arts H.T., Arts B., 2021. *Lawsonia* bacteria, an unknown pathogen, newly discovered as pathogen in rabbit farms. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-02, 4 pp.*

The pathogenicity of *Lawsonia* infection in rabbit farms is never reported. This field case reports *Lawsonia* present in manure samples derived from rabbit farms. Since the ban in 2006 on growth promoters as feed additives in animal feed, rabbit farms in The Netherlands suffer more with problems after weaning, because of Epizootic Rabbit Enteropathy (ERE). This study shows that *Lawsonia* is one of the pathogens causing ERE in meat rabbits. The diagnosis *Lawsonia* gives veterinarians possibilities to treat rabbits short before slaughter with registered antibiotics instead of antibiotics off label use with 28 days withdrawal time.

Arts H.T., Arts B., Rommers J., 2021. Rabbit haemorrhagic disease virus type 2 (RHDV-2) in The Netherlands and Germany: clinical and epidemiological findings. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-03, 4 pp.*

RHDV field case report. Since 1986 rabbits in farms in the Netherlands and Germany have problems suffering from RHD. In 2014 a new type RHDV2 infected 2 farms in the Netherlands. PCR or ELISA to determine RHDV were not available. Incidences occurred till outside weather temperature went down so that flying insects can't survive. In wintertime is less ventilation needed and rain makes outside air free of dust. New outbreaks were seen from spring till November each year. Virus typing was determined by State Laboratory (Friedrich-Loeffler-Institut Greifswald DE). Although does are vaccinated, weaned or suckling rabbits are not protected. Maternal antibody protection only last till 4 weeks of age. Healthy development and young age recovery of organs and body of rabbits beneath 3 weeks of age makes no clinical sign.

Atkinson A., Espinosa-Ayala E., Hernández P.A., Le Roux J.F, Mendoza G.D., Pulido-Huertas S., Velázquez-Cruz A.L., Prigent A.Y., Colin M., 2021. Effect of a polyherbal mixture of *Saccharum officinarum* and of *Acacia concinna* on the oocystal excretion, zootechnical performance and meat quality of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-04, 4pp*

Two experiments, Exp. 1 and Exp. 2, were conducted to evaluate the use of Peptasan, a polyherbal mixture of *Saccharum officinarum* and of *Acacia concinna*, in contributing to the control of *Eimeria* in growing rabbits. Exp. 1 was carried out in Mexico, using 40 rabbits weaned at 30 days of age split into 4 groups, supplemented with 0.00; 0.25; 050 and 0.75 kg / ton of Peptasan. Exp. 2 was carried out in France in a deteriorated sanitary context, where 299 rabbits weaned at 34 days of age were divided into 2 groups, with feed supplemented with either 1 kg/ton of Peptasan or control. Feces collection was carried out at 50 days of age in both experiments and also at 70 days in Exp. 2. Weights and slaughtering yields were recorded in both experiments. In Exp. 1, feed intake, feed conversion ratio (FCR) digestibility, dry mater digestibility, meat pH and color parameters were measured. In Exp. 2, mortality was recorded daily and fat characteristics were analyzed. Peptasan decreased the oocystal excretion in both experiments, from 1520 to 240 oocysts / gram in Exp 1 where the level of contamination was low and in Exp. 2, with a high level of contamination, from 33 500 to 25 000 oocysts / gram. This decrease of total oocyst excretion was essentially due to the significant reduction of pathogenic *Eimeria* (*Eimeria magna* + *Eimeria media*) from 27 300 to 18 600 oocysts / gram. In Exp. 2, Peptasan highly significantly decreased mortality in growing rabbits, particularly between 34 and 55 days. Growth performance and slaughtering yields were not significantly modified in either experiment. Peptasan had no effects on feed intake, FCR and dry mater digestibility. Measurements of meat quality (pH, cholesterol) were not modified by Peptasan except meat luminosity, which was improved, demonstrating that this product had probably no negative effect on iron absorption. Consequently, Peptasan is an interesting solution to contribute to the control of *Eimeria* development in rabbit farming using only natural products.

Baratelli M., Molist-Badiola J., Puigredon-Fontanet A., Pascual M., Boix O., Mora-Igual F.X., Woodward M., Lavazza A., Capucci L, 2021. Characterization of the maternal derived antibody immunity against RHDV-2 after administration in breeding does of an inactivated vaccine. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-05, 4 pp.*

Inactivated strain-specific vaccines have been successfully used to control rabbit haemorrhagic disease (RHD) caused by RHDV-2 in the rabbit industry. It is unknown whether and how vaccination of breeding does contributed to protect the population of young susceptible rabbit kits. The present study investigates whether the immunity against RHDV-2 produced by vaccination of breeding does is transmitted to their progeny and its dynamic once inherited by kits. For this purpose, New Zealand female rabbits of 8-9 weeks of age were allocated into 2 groups of 40 subjects each and bred during 6 reproductive cycles. The first experimental group was vaccinated with a commercially available inactivated vaccine against RHDV-2 whereas the second group was inoculated with PBS. Six months later, 10 vaccinated rabbits were re-allocated into a new group and re-vaccinated with the same vaccine. Moreover, the present study was also meant to identify the mechanisms of transmission of that maternal immunity. For this reason, rabbit Kits of vaccinated and non-vaccinated breeding does were cross fostered before milk uptake. The RHDV-2 antibody response was monitored in the blood serum of breeding does and of their Kits by ELISA techniques. Results showed that RHDV-2 antibodies were inherited by Kits up to one year from vaccination of breeder does and that the revaccination increased but not significantly the antibody response. Once inherited, the maternal derived antibody response against RHDV-2 lasted at least until 28 days of life. Finally, the study also elucidated that the major contribution to the maternal derived immunity against RHDV-2 in Kits was provided during gestation and probably transmitted through transplacental mechanisms. The present study contributed to elucidate the characteristics of the maternal antibody immunity produced by vaccination and its mechanisms of transmission; however, the extents of protection of this response are still not fully clarified.

Belloumi D., Argente M.J., García M.L., Blasco A., Santacreu M.A., 2021. Study of biomarkers of disease sensitivity in a robust and a standard maternal line. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-07, 4 pp.*

Robustness is related to less sensitiveness to stress and diseases. The objective of this paper is to study biomarkers of resilience to disease in two commercial maternal lines, a robust line founded using longevity criteria (line LP) and a standard line (line A) after stimulation by vaccination against rabbit haemorrhagic disease (RHD). No clear difference in white blood cells (WBC) was found between lines before and after vaccination ($P=0.80$). The A line showed lower percentage of lymphocytes (-7.13%, $P=0.99$), lower percentage of monocytes (-2.32%, $P=0.98$) and higher percentage of granulocytes (+9.26%, $P=1.00$) than the LP line. These differences were maintained after vaccination. Lower percentage of lymphocytes in line A suggests a higher disease sensitivity of this line, it is known that lymphocytes are involved in the adaptive immune system. A higher basal C-reactive protein (CRP) concentration was observed in the line A (+41.40 $\mu\text{g/ml}$, $P=1.00$). After vaccination, the A line still shows higher CRP concentration (+23.81 $\mu\text{g/ml}$, $P=0.97$), but it should be noticed that the LP line showed a higher response to stimulation by vaccination than the A line (+14.6 $\mu\text{g/ml}$, $P=0.93$) and this is related to a good functionality of the inflammatory system (McDade et al., 2005). There is not enough evidence of having differences between lines in bilirubin before vaccination ($P=0.83$) but line A showed lower bilirubin than the LP line after vaccination (-0.14 $\mu\text{mol/l}$, $P=0.93$). This weak response to stimulation in line A could be explained by a high susceptibility to diseases of this line. Both lines showed similar concentrations of triglycerides and cholesterol before and after vaccination, but the response to vaccination was higher in the LP line than in the A line for triglycerides (+0.05 $\mu\text{mol/l}$, $P=0.90$), which is related to a good functionality of the liver metabolism in combating infections and reducing inflammations. Rabbit females from line LP showed better disease biomarkers results than line A, which could be related to a higher resistance to diseases.

Ben Chehida Faten, Ben Salem Ameni, Daboussi Imen, Sghaier Soufien, Kalthoum Sana, Attia-El Hili Hédia, 2021. Characterization of rabbit farms in Tunisia and retrospective epidemiological studies on RHDV-2. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-08, 4 pp*

The Tunisian rabbit breeding structure has changed this last decade passing from a traditional breeding to a more modern structure allowing the industrialization of rabbit farming to thrive. However, rabbit industry faces several health problems leading to an important morbidity and mortality. Among these, Rabbit Haemorrhagic Disease (RHD) is one of the pathogen causing the highest damage in the Tunisian rabbit farms. In this context, we carried out an epidemiological study consisting in a retrospective survey involving 60 industrial farms located in 16 governorates and 166 traditional farms. The objectives were to characterize the Tunisian rabbit farms and to estimate the prevalence of RHD by molecular analyses in suspected farms in order to detect possible risk factors of the appearance and the spread of the disease.

Bokreta S., Khaldoun H., Makhlof C., Daoudi-Zerrouki N., 2021. The possible alleviating effect of *Thymus vulgaris* essential oil against Voliam Targo® induced cardiotoxicity in rabbits of a local population (*Oryctolagus cuniculus*). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-09, 4 pp.*

The aim of the present study is to evaluate the potential cardiotoxicity of Voliam Targo® (VT) and to investigate the protective effect of a co-administration of the *Thymus vulgaris* essential oil against heart histopathological alterations in male rabbits. Twenty adult rabbits were divided into four equal groups and treated for 21 consecutive days: control, voliam targo® (VT), thyme essential oil (TEO) and voliam targo® plus thyme essential oil (VT+TEO) groups. Subacute exposure to VT caused a significant decrease in mean body weight compared to control. Absolute and relative heart weights were significantly altered in VT group. This study revealed no changes in coronary risk index (TC/HDLc) level, while, atherogenic index of plasma and LDL-C/HDL-C ratio were found significantly reduced in VT-treated group compared to the other groups. The treatment with voliam targo® caused histopathological alterations in the myocardium such as congested blood capillaries, inflammatory cell infiltration, increased masses of collagen fibers around the congested blood vessels. While the co-administration of *Thymus vulgaris* essential oil showed significant improvement in morphological changes of the heart. In conclusion, exposure to VT induces toxic effect on heart tissue and the essential oil of *T. vulgaris* alleviates this deleterious effect and may have healing and protective effects.

Cavadini P., Campisi G., Vismara A., Lavazza A., Capucci L., 2021. Study of genetic evolution of RHDV-2 in Italy from 2011 to 2019. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-11, 4 pp.*

Rabbit Haemorrhagic Disease Virus (RHDV) is a very virulent virus of the genus Lagovirus causing a severe and fatal hepatitis in the European rabbit (*Oryctolagus cuniculus*), with 100% morbidity and 80-95% mortality. It firstly emerged in 1984 in China and then it rapidly diffused worldwide in those countries where the European rabbit is present. On 2010 a new RHDV-related virus, called RHDV2, showing a specific antigenic profile different from RHDV, emerged in Europe. It again rapidly spread worldwide becoming prevalent in the field and causing extended epidemics in wild and domestic rabbits and also in some hare species. Indeed, since the first identification, RHDV2 virulence increased and it frequently underwent to recombination events. To understand the virus evolution in Italy, we sequenced the capsid gene plus an 800bp upstream of the start codon, of 87 RHDV2 strains identified from 2011 to 2019. The phylogenetic analysis showed that the different Italian isolates fall in the same cluster of other RHDV2 strains identified in Europe. In particular, they appear to be divided into subgroups more related to the identification year than to geographical origin, with the exception of three strains identified respectively in 2013-14 in Cuneo and Perugia province and in Sardinia in 2016, located in the subgroup of the viruses firstly identified in France and Italy in 2010-2011. In addition, we detected 10 recombinant strains that show the break point located in a region close to the VP60 initiation codon and include the RHDV2 structural proteins with RHDV-G1 non-structural proteins. Considering that the RHDV genotype G1 circulated in the Iberian Peninsula until the appearance of RHDV2 and it is now completely disappeared, while in Italy the G6 and G3 RHDV genogroups are still circulating, we could presume that such recombinant strains more likely originated in Portugal/Spain and they were then "introduced" in Italy, an hypothesis supported by the phylogeography analysis.

Circella E., Camarda A., Schiavone A., Romito D., Schiavitto M., Casalino G., Belloli C., 2021. Minimal inhibitory and mutant prevention concentrations of enrofloxacin for *Pasteurella multocida* from rabbits affected by pasteurellosis. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-13, 4pp.*

Pasteurella multocida is the agent of one of the most significant diseases in rabbits and it is associated with a heterogeneous clinical picture. Drugs belonging to the fluoroquinolones class are useful to control pasteurellosis. Among them, enrofloxacin is one of the most used molecules in rabbit industry and it is the only one fluoroquinolone registered for this species in Italy. Enrofloxacin adopted dosages are currently based on Minimum Inhibitory Concentration (MIC). Nevertheless, MIC is not effective against possible pathogen sub-populations with lower susceptibility that may be selectively amplified, leading to possible problems of antibiotic resistance. Mutant Prevention Concentration (MPC) could represent an approach to minimize the risk of resistance selection in pathogens. The aim of this work was to test the sensitivity to enrofloxacin of *P. multocida* strains isolated from rabbits affected by pasteurellosis to evaluate if MPC-based dosages can represent a valid option. The study was performed on ten strains of *P. multocida* isolated from rabbits from two industrial farms of Puglia, South Italy. The sensitivity to enrofloxacin has been evaluated by MIC tests by microdilution method and MPC tests performed according to Marcusson et al. (2005) with minor modifications. The results of MIC and MPC tests have revealed that MPC dosages are on average 8,4 times higher than MIC dosages. This data highlight that, although MPC-based dosages are useful to prevent the selection of potential mutant, they could be higher than MIC-based ones, leading to possible issues related to their application in field, for example the potential risk of possible toxicity for animals and residues in meat.

Cornaggia M., Palazzolo L., Di Castri A., Vascellari M., Tonon E., Viel L., Bano L., 2021. Histological and immunohistochemical features of dysautonomia in commercial rabbits affected by intestinal disorders. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-14, 4 pp.*

Dysautonomia is a severe fatal gastro-intestinal disorder characterized by caecal impaction, anorexia, and depression. The disease has been reported in a wide range of animals such as horse, cat, dog, hare and rabbit. Histopathological findings are identified by degenerative damages of the autonomous nervous system, that can be evidenced by means of targeted immunohistochemical (IHC) techniques. Rabbits affected by dysautonomia showed a severe large intestinal paralysis that could be associated with the presence of *C. botulinum* in the gut, as already demonstrated in cats. The aim of our work was to evaluate the presence of BoNT producing Clostridia in rabbit with gastrointestinal disorders and to assess the neurological damages occurred in the gut by IHC techniques targeted on a neurodegenerative marker (synaptophysin). To this purpose, 66 live commercial rabbits with an intestinal disorder history were euthanized and necropsied. Gross lesions were categorized in two forms: cecal constipation (CC) and fluid entero-typhilitis (ET). BoNT producing Clostridia were not detected in the caecal contents. Degenerative lesions of the autonomous nervous system were detected in the 39.4% of the analyzed subjects. The highest IHC positivity occurred in rabbits with CC suggesting that constipation could be mediated by a neurological damage of the myenteric plexa. Further studies with healthy control rabbits with no gastro-enteric disorders are required to better understand the pathogenesis of dysautonomia and to investigate other etiological causes.

Dakouri S.A., Kimsé M., Koné M.W., Touré A., Komoin O.C., 2021. Seasonal evolution of coccidial infection in domestic rabbits in Abidjan district, Cote d'Ivoire. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-15, 4 pp.*

A detailed study on rabbit Eimerioidosis in a humid tropical region of Côte d'Ivoire relating to prevalence, intensity of infection, species involved and risk factors associated to climate data, was undertaken from January 2017 to July 2019 in Abidjan District. A total of 146 rabbit's farms were visited. Coccidiosis was present in all the farms in this survey (100%). Oocyst per gram of faeces (OPG) were counted using the McMaster method. *Eimeria* species were identified by microscope using morphological criteria. The older rabbits showed mild infections (94.52%) while 76,03% of younger ones were affected by moderate coccidial load. Eleven species were of *Eimeria* were identified. The infection with oocyst of *Eimeria media* species display the highest prevalence rate (100%) followed by the *E. perforans*, *E. magna*, *E. exigua*, *E. coecicola*, *E. irresidua*, *E. piriformis*, *Eimeria stiedae*, *E. flavescens*, *E. intestinalis*, and *E. vej dovskyi* with an prevalence rate of (90.41, 84.25, 78.08, 76.03, 58.90, 45.21, 36.99, 21.92, 14.38%, and 8.9%) respectively. Mixed infections with two to eight *Eimeria* spp especially those concerning 3 species were common. Rainy seasons and the month of July were the most susceptible for coccidial infection. The results highlight the major impact of age group in the level of coccidial load.

Dakouri S.A., Kimsé M., Koné M.W., Komoin O.C., Touré Alassane, 2021. Effects of *Ficus exasperata*, *Azadirachta indica* and *Mangifera indica* leaves on oocystal coccidia excretion and on rabbit growth. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-16, 4 pp.*

Synthetic anticoccidial curative action was decreased significantly. The aim of this study was to find an alternative cure to synthetic anticoccidials for the growing rabbits. We used 54 growing rabbits (6 groups and 9 rabbits per group). Three experimental groups (A, B and C) were used to test the effect of tropical leaves on coccidian. In addition, other 3 groups (T1, T2 and T3) were used to test the effect of sulfadimethoxine. Groups A, B and C diet was supplemented with *Ficus exasperata*, *Azadirachta indica* and *Mangifera indica* fresh leaves respectively. All animal of 3 groups were artificially infected with a coccidial inoculum at 25 days age. Group T1 was infected such as leaves groups and untreated; group T2 was not infected but it was treated with sulfadimethoxine and group T3 neither was infected nor received sulfadimethoxine. The mortality was low in group A (0 rabbits) compared to groups B, T3 (3 rabbits), C (5 rabbits) and T1 (9 rabbits) (P<0.1). It was similar to group T2 (2 rabbits). The secreted oocyst decreased in group A, C and T2 to 57%, 31% and 44% respectively from 35 to 65 days of age (P <0.01). However, oocyst rate was not reduced in group B, T1 and T3. It was increased (36%) in group T1 (P <0.01). *F. exasperata* leaves could be used as alternative to synthetic anticoccidians treatment in traditional rabbit breeding.

Dakouri S.A., Kimsé M., Koné M.W., Touré Alassane, Yapi Y.M., Komoin O. C., 2021. Rabbits gastro-intestinal and external parasites in Ivorian improved system. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-17, 4 pp.*

The aim of this study is to characterise rabbit endo and ecto parasites found in Côte d'Ivoire rabbit farms. The farms are regularly infected by various parasites. Treatments are provided without the microorganisms that are responsible being known. this work will make it possible to determine the most frequent parasites in farms and improve the health care of rabbits. 33 breeding and 660 growing rabbits were used. Test was conducted from January to July 2019. Samples and observations were taken monthly. 66 samples were collected, 33 from growing rabbits and 33 from breeding stock. The flotation technique with NaCl was used for parasites observation. For endoparasites, 1 cestode, 2 species of trematodes, 8 nematodes and 11 species of *Eimeria* were observed. *Eimeria* oocysts were present in all samples (100%). The most common helminths were *Graphidium strigosum* and *Trichostrongylus retortaeformis* (36.36%). For ectoparasites, 6 species of ectoparasites were observed. These are 3 mites, 2 parasitic insects and fungus (*Trichophyton mentagrophytes*). The most commonly encountered ectoparasite was *Sarcoptes scabiei* (13.63%). Multiple outbreaks involving from 2 to 5 endo-associated with 1 or 2 ectoparasites were met.

Di Castri A., Cornaggia M., Palazzolo L., Rizzardi A., Bottin S., Viel L., Foiani G., Vascellari M., Bano L., 2021. Occurrence of tympanic bullae empyema in commercial rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-18, 4 pp.*

Respiratory infections sustained by *Pasteurella multocida* are one of the most important cause of mortality and economic losses in rabbit industry. Middle ear can be reached from upper respiratory tract site of infection and it acts as a safe niche for *P. multocida*. In order to study the infection of this particular anatomic district, the tympanic bullae of 445 commercial New Zealand White rabbits sent to the laboratory for the routine diagnostic investigations, were inspected. Tympanic bullae empyema was the most common lesion observed (48.3%; 215/445), and *P. multocida* was the bacterial agent more

frequently isolated (76.1%). Other lesions typical of pasteurellosis such as rhinitis, conjunctivitis, pneumonia, thorax empyema, splenomegaly and cutaneous abscesses, were simultaneously present. Surprisingly, in 5.6 % of animals the middle ear empyema was the only anatomic-pathological lesion observed. Rabbits affected by pulmonary pasteurellosis are commonly treated with antimicrobials that usually result widely susceptible when tested *in vitro*. Unfortunately, few pharmacokinetic studies demonstrated the capability of those drugs to reach the middle ear at effective concentrations. For this reason, the *in vitro* most effective antimicrobial might fail to treat a poor vascularized site, such as the tympanic bulla, leading to asymptomatic chronic infection difficult to detect and to control in commercial rabbitries.

Garreau H., Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Robert R., Gunia M., 2021. 2021. *Pasteurella multocida* experimental infection 3): relationship between resistance to diseases and production traits in rabbits raised in commercial farms. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-19, 4 pp.*

Pasteurellosis is the first cause of female mortality in rabbit farms. The RELAPA project aims at studying the genetic determinism of resistance to pasteurellosis. 955 rabbits produced by 65 sires from 6 commercial lines were inoculated at 6 weeks of age with a pyogenic strain of *Pasteurella multocida* (Pm) and were monitored during 14 days. These rabbits were scored for resistance to pasteurellosis from 0 to 4 by taking into account *post-mortem* examinations. Fifty five sires having at least 10 inoculated offspring produced also 9943 rabbits tested for health and growth and 1468 females with 6676 litters tested for reproduction in commercial farm conditions. Weaning and final growing weights were significantly higher in offspring of resistant sires than in offspring of susceptible sires (+7 g, P=0.04 and +14 g, P=0.02 respectively). On the contrary, total number born and number born alive were significantly lower in daughters of resistant sires than in daughters of susceptible sires (- 0.27, P=0.02 and -0.41 P=0.003). Prevalence of digestive diseases and infectious diseases were significantly lower in the resistant growing rabbits than in the susceptible ones (-1.9 point, P=0.006 and - 3.2 points, P < 0.001 respectively). This result suggest that resistance to pasteurellosis assessed by an experimental infection using a single strain of *Pasteurella multocida* is favorably correlated to resistance to other infectious diseases.

Guichard P., Bordas A., Moreac T., Chevance A., Blot J., Travel A., Hemonic A., Le Normand B., Liber M., Leorat J., Verdon J., Hurtaud-Pessel D., Orand J.P., Amar H., Maris P., Baduel L., Mompelat S., 2021. Impact of disinfectant water treatment for pigs, poultry and rabbits on the stability of antibiotics. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-20, 4 pp.*

In farms, drinking water is frequently treated with a disinfectant to improve its bacteriological quality. This water can also be used to administer collective treatments for animals. However, the verification of compatibility between biocides and medicines is not required in the Marketing Authorization dossiers. This study aims to evaluate the impact of biocides on the stability of antibiotics. Ten veterinary medicinal products (VMPs) containing doxycycline, amoxicillin, sulphonamidestrimethoprim, tiamulin and colistin were tested with two biocides (hydrogen peroxide-H₂O₂ at 50 ppm and sodium hypochlorite at 0.5 ppm of active chlorine) in two standardized waters, a soft one (6 ° f, pH = 6) and a hard one (35 ° f, pH = 8). Then, VMPs containing amoxicillin, tiamulin and doxycycline were diluted with H₂O₂ in water from a well rich in iron and manganese. Antibiotics were dosed by UV-Liquid Chromatography at different defined times in a stock solution and in a 1:20 diluted solution to simulate an administration by a dosing pump or a tank. For each analysis, the stability of a substance was considered insufficient if its average concentration was more than 10% lower than that of the control sample without biocide and if the difference was significant (T-test, p <0.05). Hydrogen peroxide impacted the stability of both amoxicillin VMPs in the hard water, only one amoxicillin VMP in the soft water and one doxycycline VMP in the well water. Chlorine degraded colistin in soft water and all VMPs in hard water except sulphonamides. This study confirms the impact of disinfectants on the stability of some antibiotics in the water and demonstrates the multifactorial and complex nature of this stability.

Gunia M., Lantier F., Bed'hom B., Guitton E., Helies V., Helloin E., Herbert C., Maupin M., Riou M., Robert R., Garreau H., 2021. *Pasteurella multocida* experimental infection 1): resistance and hematological response. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-21, 4 pp.*

Pasteurellosis is the first cause of female mortality in rabbit farms. During the RELAPA project (Genomics for the Genetic Resistance of Rabbits to Pasteurellosis), 953 rabbits were inoculated at 6 weeks of age with a pyogenic strain of *Pasteurella multocida* (Pm) and were monitored during 14 days. Disease response was very variable among animals, with 7% of resistant animals and 11% of highly susceptible rabbits. Blood cell counts were performed at day 14 after inoculation on 574 inoculated and 28 control rabbits. Significant differences in white blood cell, red blood cell, and platelet counts were observed

according to the disease resistance score. Susceptible rabbits have a lower red blood cell count, probably due to the hemolytic and hemorrhagic activity of *Pm*. They also have a higher percentage of monocytes, neutrophils and eosinophils (mainly involved in the innate immune system and inflammatory responses) and, conversely, a lower percentage of lymphocytes (mainly involved in the adaptive immune response) compared to highly resistant and control rabbits. They do not seem able to mount an effective immune response to control the infection.

Hu Bo, Fan Zhiyu, Wei Houjun, Chen Mengmeng, Qiu Rulong, Song Yanhua, Zhu Weifeng, Xu Weizhong, Xue Jiabin, Wang Fang, 2021. Emergence of rabbit hemorrhagic disease virus *RHDV-2* in China. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-22, 3 pp.*

Rabbit hemorrhagic disease (RHD) is an acute fatal disease caused by the Lagovirus rabbit hemorrhagic disease virus (RHDV), which was first reported in 1984 in China. Strains of two different genotypes (GI.1a and GI.1c) have been detected in China to date. In 2010, a new RHDV variant with a unique genetic and antigenic profile was identified in France, designated RHDV-2, which rapidly spread throughout continental Europe and nearby islands. Here, we report the first outbreak of RHD induced by RHDV-2 (GI.2) in rabbit farms in the Sichuan province of China. We conducted phylogenetic analysis of the new RHDV isolate SC2020/04, which was identified as a non-recombinant strain belonging to the RHDV-2 (GI.2) genogroup. The current GI.1 licensed vaccine used in China could not provide effective protection against the new isolate. Considering the serious risk of RHDV-2 to the Chinese rabbit industry, the circulation of RHDV-2 in the population should be carefully monitored in China.

Huneau-Salaün A., Guillou-Cloarec C., Thomas R., Le Maître E., Lopez S., Nouvel L., Le Gall-Reculé G., Le Bouquin S., 2021. Evaluation of cleaning and disinfection procedures in rabbit farms affected by rabbit haemorrhagic disease, in France. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-23, 4 pp.*

Rabbit Haemorrhagic Disease (RHD) affects many commercial rabbit farms in France. Some farms experience several successive outbreaks, which raises the question of the efficacy of cleaning and disinfection (C&D) measures implemented after the outbreaks. This study aimed to evaluate the efficacy against RHD virus of C&D protocols applied on four infected farms in 2019. We sampled the husbandry rooms and their surroundings by swabbing to detect the RHDV2 genome by RT-PCR. Samples were taken before C&D, after C&D and three months later. A total of 35 samples out of 75 taken before C&D were positive for RHDV2 (47%). The most frequently contaminated surfaces were the rendering container (3/4), the floor of the husbandry room (3/4) and the surroundings (4/6). Virus genome was thus detected on equipment in contact with rabbits but also on surfaces soiled by faeces, blood and dust. After C&D, the RHDV genome was detected in 14 samples out of 74 (19%). The rendering containers were positive on three farms: they had not been treated during C&D operations. Three months later, RHDV genome was still recovered from rendering containers on two farms. Residual contamination may be observed after decontamination in insufficiently treated areas. This underlines the importance for the farmer and the technical advisors to establish a complete decontamination protocol adapted to the farm.

Legendre H., Goby J.P., Le Stum J., Hoste H., Cabaret J., Gidenne T., 2021. Organic rabbit farming: should we be afraid of gastro-intestinal parasites?. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-24, 4 pp.*

Our trial aimed to study the gastro-intestinal parasitism in pasture raised rabbits, during three seasons: winter 2014/2015, summer 2015 and spring 2016. For every season, at weaning two groups of five movable cages (three rabbits per cage) were disposed either in a sainfoin or a grass pasture. Nematodes eggs and *Eimeria* oocysts were counted on a weekly basis in faeces, oocysts were identified at species level every two weeks. At slaughter (100-day old), the liver was examined and the digestive tract was sampled to count the number of nematodes. The type of pasture had no significant effect on egg excretion or on nematode prevalence and intensity, or oocyst excretion of all species combined. Spring 2016 was characterized by a high prevalence of *Trichostrongylus* sp. (93% of rabbits) and a 50% increase in the total excretion of oocysts, particularly in sainfoin pasture (6.5 M.OPG) where the rotation times was shorter. No diarrhoea was observed during the trial, neither were intestinal macro-lesions in the slaughtered rabbits. However, 64% of the livers presented white nodules due to *Eimeria stiedai*. A negative correlation between the intensity of infection by *Trichostrongylus* sp. and daily gain was observed. The mean excretion of *E. flavescens* may explain a part of the lower daily weight gain (-5 g/d) observed, whatever the pasture type, at spring 2016 compared to the two other seasons. Our first results suggested increasing the pasture rotation time over the two months requested by current organic rabbit farming regulation in France to reduce worm infections.

Liu Y., Wei Q., Xiao C.W., Ji Q.A., Huang Y.E., Bao G L., 2021. Immune efficacy of inactivated *Bordetella bronchiseptica* vaccine in rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-25, 4 pp.*

Vaccination is considered to be an effective way to prevent and control *Bordetella bronchiseptica* (*B. bronchiseptica*) disease. However, licensed vaccines are not available for rabbits in China at present time. In order to determine the efficacy of whole-bacterium inactivated vaccine in rabbits, immunization trials were conducted by using New Zealand White rabbits. The results showed that a single dose of subcutaneous immunization with 1.6×10^{10} CFU inactivated whole cells (CZJ-1 strain) resulted in high levels of specific IgG antibody, and high protection rate against *B. bronchiseptica* challenge in rabbits (2.0×10^{10} CFU) during 21 to 120 days post immunization (protection rate $\geq 87\%$). In this study, we reported a success in preparation of a potent and efficacious inactivated *B. bronchiseptica* vaccine which is a promising approach for controlling *B. bronchiseptica* disease in rabbits.

Makhlouf C., Khaldoun-Oularbi H., Zerrouk N.H., Bokreta S., Oularbi Y., Tili T., Aroun R., Daoudi-Zerrouki N., 2021. Beneficial effects of ascorbic acid against nephrotoxicity induced by ivermectin repeated highdose therapy in rabbits (*Oryctolagus cuniculus*). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-26, 4 pp.*

Ivermectin (IVM) is a lipophilic anthelmintic drugs widely used for the control of internal and external parasites in both human and veterinary medicine. The present experiment pertains to the protective role of ascorbic acid (AA) against biochemical and histopathological nephrotoxicity induced by IVM repeated high dose therapy in male young rabbits (*Oryctolagus cuniculus*). Twenty rabbits were divided into four groups of five: Control, IVM, IVM + AA by gavage, IVM + AA supplemented in food groups. The creatinine, uric acid and urea levels were measured from the plasma while the kidneys tissues samples were used for histopathological investigations. IVM alone induced a significant ($P < 0.05$) decrease in the body weight and body weight gain and a significant increase in both left and right kidney weights. This study showed a disruption of renal biochemical parameters with a statistically significant increase in creatinine levels in IVM group compared to control group. However, coadministration of AA moderately improved this biochemical parameter. Light microscopic observations revealed variable signs of renal toxicity in the IVM group where the renal cortex exhibits serious pathological changes, including vascular changes, hemorrhages, mononuclear infiltrating cells and degeneration of tubular cells. In the other hand, the AA treatment showed significant improvement when co-administered orally with IVM. These results suggest that AA has beneficial influences in neutralizing the toxic effects of IVM for the biochemical and histological parameters of the kidney of rabbits.

Montbrau C., Gascon S., Ruiz M.C., 2021. Efficacy of ERAVAC® against a heterologous challenge with a virulent RHDV-2 strain in the presence and/or absence of maternal derived antibodies. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-27, 4 pp.*

Vaccination against the variant of rabbit haemorrhagic disease (RHDV-2) is the principal measure available for the protection of young animals against this lethal virus. However, limited scientific information is available about the impact of maternally-derived antibodies (MDA) on vaccination. The aim of the present study was to evaluate the efficacy of ERAVAC® (Hipra, Spain) under the influence of MDA against an experimental challenge using a heterologous RHDV-2 strain, in 1-month old rabbits. Two groups of 20 rabbits were vaccinated subcutaneously. One of these groups consisted of animals without MDA and the other one consisted of animals having MDA. The MDA titres found in the latter were representative of the titres found in animals under field conditions. Additionally, another group of 20 rabbits with MDA was kept as a (non-vaccinated) control and was followed weekly for decay of MDA. When MDA had disappeared in this control group, all the animals were challenged with a heterologous virulent strain of RHDV-2 by the intramuscular route. After challenge, mortality rates were followed up to support the efficacy of ERAVAC® in the presence of MDA. The results showed that vaccination with ERAVAC provides full protection against mortality after experimental challenge in the presence of MDA as well as in the absence of MDA in RHDV-2-infected young rabbits, whereas the control animals suffered significantly greater mortality. This study helped to demonstrate that MDA have no effect on ERAVAC® vaccination, which is the main alternative for RHDV-2 control on farms.

Moreno-Grúa Elena, Pérez-Fuentes Sara, Muñoz-Silvestre Asunción, Viana David, Selva Laura, Pascual Juan J., Arnau-Bonachera Alberto, Corpa Juan M., 2021. Effect of selection for growth rate on macroscopic lesions after intradermal skin infections with *Staphylococcus aureus*. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-28, 4 pp.*

Rabbits from paternal lines present some undesired characteristics such as poor reproductive performance or low stability on farms. Last fact suggests that selection could be getting worse the way selected animals respond to infectious challenges. To test this hypothesis, we performed an experiment that involved 73 2-month-old rabbits from a paternal line selected by average daily gain during the growing period at two levels of selection (VR18, generation 18; VR36, generation 36). These young rabbits were intradermally inoculated in their backs with *S. aureus* of two rabbit strains of different virulence (Jwt, high virulence; and Jrot+, low virulence). Severity of lesions were evaluated by the presence and area of the erythema and nodules for 7 days. The presence of erythema and nodule was lower when inoculations were performed in animals from VR36 than when they were performed in animals from VR18 (-8.4 and -6.5 percentage points, respectively; $P < 0.05$). Nodules increased their size over time independently of the generation used for the infection. However, compared to VR18, animals from VR36 presented smaller nodules from day 3 after inoculation onwards ($P < 0.05$). Consequently, it seems that lesions caused by *S. aureus* in animals from VR36 were less severe than those caused in animals from VR18. These results are compatible with the fact that selection is not getting worse the way rabbits from paternal lines respond to infectious challenges.

Patinha S., Pinheiro V., Soares A.S., Dias S., Fraga M.F., Matos M., Venâncio C.A., Coelho A.C., 2021. Occurrence of dermatophytes in captive wild rabbits without clinical signs. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-29, 3 pp.*

Dermatophyte or ringworm infection is a superficial skin infection, with veterinary and public health importance. An epidemiological dermatophytosis survey was carried out in captive wild rabbits without clinical signs in Northern of Portugal. Between August and December 2019, 71 hair samples were collected with the Mackenzie toothbrush technique. In this study, dermatophytes were identified from samples of 5 wild rabbits. The overall occurrence of dermatophyte species was 7.0% (95% confidence interval, CI: 2.3% to 15.6%). *Trichophyton mentagrophytes* Complex was the only genus isolated. Considering the paucity of epidemiological reports in this country, these results could make a useful contribution towards the diagnosis and prevention of wild rabbit dermatophytosis. Following the work, it will be important to increase the number of samples and expand the study area.

Pellicciotti S., Accurso D., Lavazza A., Mula P., Bravaccini P., Dorigo F. 2021. Evaluation of the persistence of antibiotics residues in drinking water distribution system after static and dynamic washing. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-30, 5 pp.*

Some critical problems in modern rabbit intensive farming could be related to the use of antimicrobials administered through drinking water. The industrial breeding of rabbits is a short production cycle and this method of therapeutic administration has an increasing importance in quantitative terms. In this study the presence of different classes of antimicrobials simultaneously in the same sample was analysed, and the persistence of active antimicrobial ingredients at different points of the water distribution system was verified. In particular, after having carried out either "static or dynamic washing" of the lines and before introducing another cycle of animals, in the production logic "all in, all out". Multiresidue analysis for analytes belonging to ten different group of antimicrobials was done by LC-HRMS and a comparison of the results obtained by using the two different washing system was done. At the end of the cycle, many molecules were present at different concentration, some resulting from the last cycle treatments, others from previous cycles. At the same time, the comparison between different cleaning systems used at the end of the cycle highlighted evident differences. This study highlighted significant elements on the use of antimicrobials and gave indications on how to reduce the potential risk of multiple contamination.

Rosell J.M., de la Fuente L.F. Badiola, J.I., Fernández de Luco, D., Casal, J., 2021. Rhinitis in does: prevalence and seasonal effect. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-32, 4 pp.*

In this cross-sectional study, prevalence of clinical rhinitis (CR) of rabbit females and yearly-seasonal risk factors were determined on 539 doe rabbit farms in Spain and Portugal, from January 2001 through December 2018. The information was obtained by carrying out 2622 visits and doing physical examinations of 159,093 lactating does, sorted in 3003 cohorts. Overall mean prevalence of CR was 18.03% (CI95% [17.07-18.99]), (minimum to maximum: 0–95% prevalence of CR). This result may be considered a baseline on commercial rabbitries in Spain and Portugal. In addition, our study suggests that season is an enabling risk factor for rhinitis ($P < 0.001$); farmed domestic rabbit does have more snuffles during summer.

Sánchez-Matamoros A., Woodward M., Navas E., Boix O., Valls L., 2021. Effect of vaccination on protection against RHDV-2 and viral load. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-34, 4 pp.*

Vaccination against Rabbit haemorrhagic disease (RHD) is the principal measure available for protection against this lethal virus, although limited scientific information is available about the impact of vaccination on disease replication and spread. The aim of this study was to assess the clinical course, viral load, survival rate and humoral immune response of animals vaccinated with ERAVAC after experimental RHDV-2 infection at 6 months post-vaccination. These analyses may lead to a better understanding of the effect of vaccination on RHDV-2 transmission in the long term. To this end, 38 New Zealand rabbits of 1 month of age were randomly distributed between two groups of equal size; the first group was vaccinated with ERAVAC (V group) and the second group received PBS (C group - control). After 6 months, control and vaccinated rabbits were challenged with a heterologous virulent RHDV-2 strain and clinically monitored for 7 days. All the animals were necropsied and blood, organs and faeces were sampled for detection of the viral load. The results showed that vaccination with ERAVAC provides full protection against mortality after experimental challenge and prevents the spread of RHDV in faeces, as well as the persistence of the virus in major target organs, in RHDV-2 infected adult rabbits at 6 months post-vaccination. This study contributed to describing the effect of the vaccine on RHDV-2 transmission, being the main alternative for RHDV-2 control on farms.

Vastel P., Rebours G., Le Normand B., Chatellier S., Capucci L., 2021. Concentration of antibodies and immunoglobulins in does and their offspring vaccinated against RHDV-2. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-36, 4 pp.*

Rabbit haemorrhagic disease virus 2 (RHDV-2) is a highly infectious disease and causes significant mortality in rabbit farms, especially during fattening. Despite vaccination of all reproductive does, new cases of fattening RHDV-2 are reported in French rabbit farms, which raise the question of humoral immunity transmission from females to their kits. Serological monitoring was carried out in a farm on 30 primiparous does vaccinated at 10 weeks of age against RHDV-2, and on 2 of their kits. Four months after the first vaccination, 3 out of 30 does didn't have RHDV-2 Antibodies (Ab). After a booster vaccination of does (D25), geometric mean titration (GMT) was increased with a wider range of cELISA RHDV-2 Ab titers (from 80 to 1280 at D25 and from 80 to 20480 at D36). At weaning (D36), the kits with the highest GMT of cELISA RHDV-2 Ab (GMT = 1712) came from does with high titers (GMT = 465) at D25, but those rabbits didn't have Ab at D59, 14 days after they have been vaccinated. Conversely, kits with low cELISA RHDV-2 titers (GMT = 160) at D36 were from does with very low titers at D25, and they had the highest titers (GMT = 160) at D59. These results indicate that there is a large individual variation in the humoral immune response of does to vaccination, that there is an effective transfer of maternal Ab to kits, and that vaccination of reproductive does seems to inhibit the early development of young rabbit humoral immunity.

Vereecken Monita, Willems Jan, de Vries Selinde, De Gussem Koen, 2021. Field study on the control of coccidiosis in rabbits housed in park systems. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-37, 3 pp*

This study describes a close monitoring of a commercial rabbit farm when 2 different anticoccidial drugs were applied in the feed. Fattening rabbits were housed in groups in a park system with plastic slatted floors. Two houses with two compartments, housing in total 8.424 commercial fattening rabbits were monitored for mortality, oocyst excretion and general health when receiving robenidine (authorised for use in rabbits in EU) or salinomycin (currently not authorised for use in rabbits in EU) in the feed from weaning until one week before slaughter. Based upon mortality, clinical signs and oocyst excretion it was shown that coccidiosis was not well controlled by robenidine. Inclusion of salinomycin instead of robenidine in the feed could significantly improve mortality rates, diarrhoea and oocyst excretion. The trial reveals problems observed in the field with coccidiosis control in rabbits when housed in parks and with limited authorised anticoccidial drugs available, stresses the need for more authorised drugs for rabbits to control coccidiosis.

Wei Qiang, Xiao Chen-Wen, Huang Ye-e, Li Ke, Ji Quan-An, Liu Yan, Bao Guo-Lian, 2021. Establishment of infection model of pathogenic *Escherichia coli* in rabbits by oral administration. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-38, 3 pp.*

In order to evaluate the efficacy of antibiotic substitutes for pathogenic *E.coli* in rabbits, it is necessary to establish an oral *E.coli* infection model. After pathogenic *E.coli* and concentrated bacterial solution were prepared, four different challenge ways were adopted, including intramuscular, intraperitoneal, intravenous injection and oral administration. The dose range from 7.3×10^8 CFU/ml to 175.2×10^8 CFU/ml according to the design requirements. The results showed that all of the four

routes could cause diarrhea and death in the experimental rabbits, but the oral route with a dose of 175.2×10^8 CFU had the best effect, the most typical symptoms and pathological changes, Thus, it is the most suitable way for the actual needs in evaluation of antibiotic substitutes. Therefore, the model of diarrhea caused by oral administration of pathogenic *E.coli* was successful in this study, which laid a foundation for the evaluation of antibiotic substitutes of pathogenic *E.coli*.

[Wei Qiang](#), Qian Wei, Xiao Chenwen, Liu Yan, Ji Quan'an, Huang Ye'e, Li Ke, Bao Guolian, 2021. Establishment of pathogenesis model of *Bordetella bronchiseptica* in rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-39, 4 pp.*

In order to establish the pathogenetic model of *Bordetella bronchiseptica* (B.b.) in rabbits, rabbits were challenged with a virulent strain FX-1 which has been screened out by the way of rabbit intravenous, intrapleural, intraperitoneal, nose drop and subcutaneous injection. And the most suitable way has been screened out. The half lethal dose of FX-1 strain to rabbit is 6.61×10^9 CFU. The pathogenetic model of B.b. in rabbits has been established. The model was used to test the immune effect of the inactivated vaccine of B.b., and the ideal result was obtained. It proved that the established model was accurate and reliable.

[Wocewicz M.](#), Hrynkiewicz R., Niedźwiedzka-Rystwej P., 2021. Preliminary studies on defensins expression in liver of rabbits experimentally infected with *Lagovirus europeus* [RHDV] GI.1 and GI.1a. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication P-40, 4 pp.*

Among innate immunity elements, defensins play a pivotal role in viral, bacterial and fungal infections and mechanisms of innate immunity are crucial in the pathogenesis of rabbit haemorrhagic disease caused in rabbits by *Lagovirus europeus*. Taking the above into the account, the main purpose of the study was to check the presence of defensin NP-4 in livers of rabbits infected experimentally with RHDV (*Lagovirus europeus* GI.1) and RHDVa (*Lagovirus europeus* GI.1a), as the first step in further analysis of involvement of those proteins in the course of this viral disease. The method used in the study is real time PCR. The presence of defensins has been confirmed in all tested samples infected with different virus strains with high accuracy. This is the first study on defensins in livers of rabbits infected with *Lagovirus europeus* and further experiments are needed.

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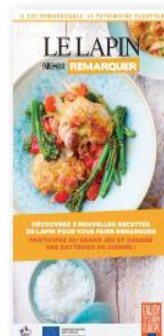
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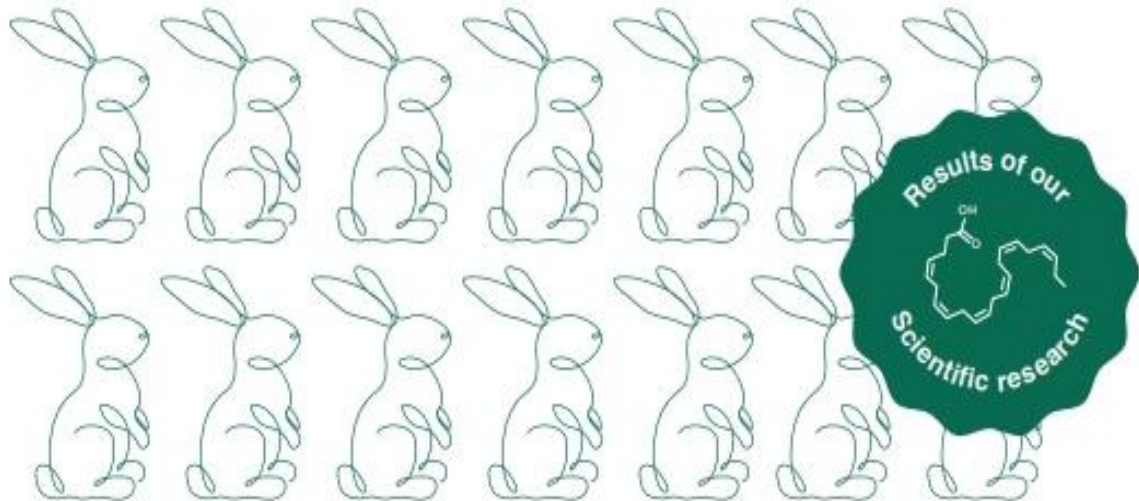


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Invited paper

Leroy F., Petracci M., 2021. Rabbit meat: a valuable source of nutrition or too-cute-to-eat? (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-00 8pp.*

Rabbit meat is a component of traditional diets, often incorporated into iconic dishes of regional cuisine. Its consumption is tracing back to the ancient civilizations of the Mediterranean and beyond, well into the Paleolithic era. Even though it has been representing considerable nutritional and cultural value since millennia, a decline in consumption is now noticeable. Specific categorial dynamics are at play, which are related to the various superimposed roles of rabbits as livestock, game, pests, laboratory animals, and pets. Their perceived cuteness in particular can lead to emotional responses that are hard to reconcile with the sensitivities of the post-domestic paradigm. Such effects compromise the acceptability of rabbit meat in contemporary Western societies that are typified by problematic human-animal interactions and a disconnect from the food chain. Especially the young and urban populations now seem to have difficulties facing the notion that the production of food requires the killing of animals. As a result, a traditional food source risks becoming irrelevant despite its high nutritional value and potential for sustainable meat production, due to reasons that are emotive rather than rational.

Short communications

Almeida M., Silva S., Garcia-Santos S., Guedes C.M., Ferreira L.M., Dominguez R., Trindade H., Lorenzo J.M., Pinheiro V., 2021. Effect of total replacement of soybean meal by lupine seeds (*L. albus* and *L. luteus*) on carcass characteristics and meat fatty acids composition of growing rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-04, 4 pp.*

The present study aimed to evaluate the effect of total replacement of soybean meal (SBM) by two species of lupine seeds (*L. albus*, cv. Nacional and *L. luteus*, cv. Mister) on carcass characteristics and fatty acids composition of growing hybrid of rabbits both sexes (New Zealand x Californian) at slaughter. Three diets were formulated to be nearly isonitrogenous and isoenergetic; the control diet (CTD), containing 15% of SBM as the main protein source, and the other two diets with complete replacement of SBM by seeds of LA (LAD) and LL (LLD). At weaning (35 days), rabbits were housed in groups of 2 and randomly assigned into 3 groups according to diet (ten replicates per treatment) and controlled for 5 weeks. At the end of the trial (69 days age), thirty rabbits (ten of each treatment) were slaughtered, and the head, liver, hind leg and dissectible fat were weighed to estimate each percentage in relation to the whole carcass. Colour and pH were measured after 24h chilled carcass. Fatty acid composition and cholesterol content were also determined. Total replacement of soybean meal by lupine seeds had no significant effect ($p>0.05$) on the contribution of the dressing out percentage, carcass part yield, dissectible fat, pH and colour parameters. Rabbits fed with LLD presented a similar ($p<0.05$) final weigh to those fed with CTD; however, LAD had a negative effect on weight at slaughter. Diets containing lupine seeds seem to have had a negative effect on the amount of SFA content compared to the control diet ($p<0.01$). Both, LAD and LLD diets presented higher PUFA values (27.44 and 28.98 vs 24.12 for control, $p<0.01$) The results of PUFA n-6/ PUFA n-3 ratio were higher in rabbits fed with LLD and the lowest in samples from the LAD group. Incorporation of lupine seeds in the diets did not affect carcass characteristics but improved the fatty acid profile.

Bouzaida M.D.E., Resconi V.C., Romero J.V., Gimeno D., Olleta J.L., Miranda-de la Lama G.C., Asenjo B., María G.A., 2021. Can the inclusion of pomegranate pomace in rabbits diets improve the fatty acid profile of their meat?. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-06, 4 pp.*

The present research studied the effect of the inclusion of pomegranate pomace in fattening rabbit diets on the fatty acid profile of the intramuscular fat. Thirty-six New Zealand white rabbits were weaned at 35 d old, allotted in two groups and fattened in cages with 6 animals each. Both groups were fed ad libitum, either the medicated control diet (CON) or the experimental diet: a non-medicated control supplemented with 20% of pomegranate pomace (POM). At 65 days of age, rabbits were slaughtered and after 24h samples of Longissimus dorsi were obtained. Meat from rabbits from POM group reached the same intramuscular fat but a distinctive fatty acid profile compared to CON. The bioactive compound punicic acid was only present in the meat from animals fed the by-product tested, achieving 5.40% of the total fatty acids. The

inclusion of pomegranate pomace in the fattening rabbit diets increased the intramuscular percentage of polyunsaturated, saturated, total n-3 fatty acids, thrombogenic and peroxidability indices, and decreased the monounsaturated and the n-6/n-3 ratio

Colin M., Lebas F., Delarue J., Caillaud L., Van Lissum M., Prigent A.Y., 2021. Meat from rabbits fed vegetable DHA can be an important part of a DHA-oriented human diet. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-08, 4 pp.*

The average individual intake of docosahexaenoic acid (C22:6 ω 3 fatty acid, generally named DHA) by human populations is significantly lower than the recommendation of 250 mg/day, established to maintain the health situation of the population. In France for example the average intake is 137 mg/day. Because of the long half life of DHA in the organism, it is more accurate to consider the consumption per week than per day. With this way of expression, the recommendation and the average intake are respectively 1750 and 960 mg of DHA / week, meaning a deficit in this fatty acid of 790 mg / week. The target of this study, on the basis of the eating habits of the French population, is to propose a short list of modifications of the human diet in order to provide the 790 mg of DHA necessary to reach the weekly recommendation. A list of the DHA content of the main animal products included in the normal diet of French people is provided. The target of +790 mg additional DHA /week can be obtained through the products of rabbits, laying hens and broiler chickens fed diets supplemented with microalgae very rich in DHA. With products obtained from these animals, one rabbit meal per week (150 g) replacing a pork or a beef meal, provide 37% of the necessary additional DHA. Replacement of all eggs directly purchased by consumers (2.67 eggs/w) and all chicken meat consumed (365 g/w), with "DHA" products, provides respectively 24% and 23% of the necessary additional DHA. Consequently, rabbit meat, eggs and chicken meat issued from animal receiving feed with microalgae rich in DHA can supply 84 % of the missing DHA in the French diet for example. The last 16% can be provided by the addition to the normal diet of 50 g of rabbit pâté or 25 g rabbit liver per week. Besides this approach corresponding to the current alimentary habits in many countries, it is emphasized that coming back to the high rabbit meat consumptions (300 g/week) observed 30 or 50 years ago for some categories of the population, it is easier to solve the chronic DHA deficit of populations without using "DHA" chicken meat. Anyway, the inclusion in the weekly diet of meat produced by rabbits receiving vegetable DHA in their feed, can be an important way to decrease and compensate the chronic deficit in DHA of the population.

Cullere M., Szendrő Zs., Kasza R., Gerencsér, Zs., Dalle Zotte A., 2021. Impact of heat stress on the meat quality of rabbits divergently selected for total body fat content. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-09, 4 pp*

The present research studied the impact of heat stress condition during farming on the meat quality traits of rabbits divergently selected for total body fat content. A total of 60 10-week old rabbits belonging to the 5th generation of divergent selection were used: they consisted of the 25% of the population with the lowest body fat content (Lean) and the 25% with the highest body fat content (Fat). Lean and Fat rabbits were housed at two different environmental temperatures: 20 °C (Control), and 28 °C (Heat). Therefore, four groups of 15 rabbits each were considered: Control Lean, Control Fat, Heat Lean and Heat Fat. From each carcass, meat was dedicated to the following analytical determinations: proximate composition, heme-iron content, oxidative status and fatty acid (FA) profile. Data were analysed by a two-way ANOVA with environmental temperature (Control, Heat) and divergent selection (Lean, Fat) as fixed effects. Overall, farming temperature and divergent selection, but not their interaction, affected most of the meat quality traits evaluated in the present study. High ambient temperature increased meat heme-iron ($P<0.001$) and water ($P<0.001$) contents, the latter to the detriment of the lipids ($P<0.001$). Heat stressed rabbit exhibited the greatest PUFA ($P<0.001$) and the lowest MUFA ($P<0.001$) fractions. Fat rabbits were characterized by a higher fat ($P<0.001$), ash ($P=0.008$) and heme-iron ($P<0.001$) content compared to Lean rabbits, whereas meat oxidative status displayed the opposite situation ($P=0.037$). Fat rabbits had a FA profile poorer in PUFA ($P<0.001$) and richer in MUFA ($P<0.001$) compared to Lean rabbits, as a result of a significant reduction in the n-6 fraction ($P<0.001$). The latter led to a decrease of the n-6/n-3 ratio ($P<0.001$) in Fat group. Overall, heat stress condition did not impair rabbit meat quality, including its oxidative status. Different body fat contents did not result in specific meat qualitative changes in response to different environmental temperatures.

Dalle Zotte A., Szendrő Zs., Kasza R., Matics Zs., Cullere M., 2021. Rabbit divergent selection for total body fat content: effect on proximate composition and fatty acid profile of meat. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-10, 4 pp*

The purpose of the present study was to investigate the effect of a divergent selection for total body fat content (Lean vs Fat Lines) of 10-week-old rabbits, measured by computer tomography, on their meat quality. The first 4 generations of selection

were considered. Offspring of the selected rabbits were slaughtered at the age of 11 weeks. Proximate composition of hind leg (HL) meat of 120 rabbits (15 samples x Line x Generation) was analysed, whereas fatty acid (FA) profile was determined on the HL meat of generation IV rabbits. At generation IV of selection, the lipids content of the meat was significantly higher (5.58 vs 4.73 g/100 g; $P < 0.001$) and the water content significantly lower (75.0 vs 76.2 g/100 g; $P < 0.05$) in the Fat Line. The FA profile of the HL meat was also significantly modified by the divergent selection, resulting in differences for monounsaturated FA (26.4 vs 30.8% total FA; $P < 0.001$) and polyunsaturated FA (32.3 vs 28.5% FA methyl esters; $P < 0.001$) for Lean and Fat lines, respectively, with a more favourable n-6/n-3 ratio for Fat Line (16.1 vs 13.0, for Lean and Fat lines, respectively; $P < 0.001$). It can be concluded that the divergent selection for total body fat content was effective in modifying the meat fatness and the FA profile of its lipids, while maintaining the protein content unchanged.

María Gustavo A., Resconi Virginia, Bouzaida Mohamed, Fernández-Bautista Michel, Olleta José L., Asenjo Begoña, Vieira Romero Jakeline, Miranda-de la Lama Genaro, 2021. Use of non-medicated feed with the addition of pomegranate by-products in commercial rabbit fattening . *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-11, 4 pp.*

Rabbit meat has excellent nutritional properties for the human diet. The commercial rabbit-farming sector is experiencing a severe crisis. In this study we tested whether fattening commercial rabbits with nonmedicated feed, with 20% addition of 3 different pomegranate by-products (pomace, shell or seed extract), affected production traits and meat quality compared to a conventional strategy. 72 weaned rabbits were used, reared indoors in cages with 6 rabbits each (571 cm²/head). Ad libitum fattening lasted 30 days and the animals were divided into 12 groups of 6 rabbits each. The treatments include 3 replicates (6 rabbits each, n=18). The control group received medicated concentrate until day 21 of fattening and nonmedicated withdrawal feed until slaughter. The other three received 20% pomegranate by-product integrated in non-medicated withdrawal feed: pomace (n=18), shell (n=18) and seed extract (n=18). Productive traits were recorded and a brief economic study was carried out. Rabbits were slaughtered in a commercial abattoir and carcasses were transported refrigerated to the lab. The ultimate meat pH was measured and meat colour was assessed by CIELAB coordinates. The L. dorsi was removed for the analysis of meat texture by Warner–Bratzler (WB). The data were analyzed using GLM procedure including the fixed effects of feeding strategy. Production and quality variables were within the range of commercial acceptability for consumers. Only slight differences between treatments were observed. In general, the meat in the pomace group was 71% tenderer than the industrial group ($p \leq 0.05$). The meat in the seed group was less luminous than the others and data would suggest that the treatment strategy affording the greatest net income is pomace. Our findings show that 20% of expensive industrial concentrate could be replaced by cheap pomegranate by products, avoiding the use of medicated concentrate and obtaining similar or slightly better results than those obtained in conventional strategies.

Laghouaouta H., Zubiri-Gaitán A., Sosa-Madrid B.S., Blasco A. , Hernández P., 2021. Changes in fatty acid composition due to selection for intramuscular fat. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-13, 4 pp.*

Two rabbit lines divergently selected for intramuscular fat (IMF) in the longissimus thoracis et lumborum muscle (LM) were studied to evaluate the relationship between IMF content and the fatty acid composition. Data from the ninth generation were analysed using Bayesian methodology. Response to selection was estimated as the phenotypic difference between high-IMF and low-IMF lines. The direct response to selection for IMF was 0.51g/100 g of muscle, representing 3.3 phenotypic standard deviation. Moreover, selection for IMF content affected clearly the fatty acid composition. The correlated response to selection was positive for saturated (SFA) and monounsaturated (MUFA) fatty acids percentages, 1.71% and 3.24 %, respectively, with greater values in the high-IMF line. In contrast, it was negative for polyunsaturated fatty acids (PUFA) percentage (-4.96%), with greater values for low-IMF line. The divergent lines were clearly separated by the projection on latent structures discriminant analysis ($R^2 = 84\%$). High-IMF line was mainly influenced by linolenic acid and SFA percentages, whereas low-IMF line was influenced by stearic acid and PUFA percentages. Thus, selection for IMF changes the meat fatty acid composition and affects its quality.

Lebas F. , Colin M., Delarue J., Caillaud L., Van Lissum M., Prigent A.Y., 2021. Rabbit is particularly interesting to deposit DHA in its meat, without effects on meat's organoleptic quality – a review. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-14, 4 pp.*

Docosahexanoic acid (C22:6 ω 3) generally known as DHA, is the predominant structural fatty acid of cell membrane phospholipids. The recent recommendation for humans is 250 mg DHA/day, about twice the present daily DHA intake in modern populations. Increasing the human DHA intake up to recommendations improves clearly the health status. Because

fish as source of DHA cannot be increased, because level in other animal products is insufficient and because higher plants are not able to synthesize this fatty acid, DHA production with microalgae (MA) like *Schizochytrium* spp has been developed. DHA content of most MA cultures used in experiments was 18% but it can be increased up to 28% of dry matter. This product is well accepted by animals and is able to largely increase the DHA content of animal products. But excessive incorporation in animals diet may induce problems of palatability of the products. For rabbit the inclusion level must remain below 1.5% MA. Maximum limits vary widely between species e.g. 0.8% MA for pigs and 3.7% MA for broiler chickens. With respect of the maximum incorporation level, fixation rate of the dietary DHA obtained from MA in edible parts of the rabbit is close to 40%. It is 31% for eggs production, 18% in chicken meat, 15% in pork meat, 10% for dairy milk and only 6% for beef meat or trout fillet. Simultaneous inclusion in diets of C18:3 ω 3 sources with MA reduces the rate of fixation of DHA for all studied species, but in any case rabbit remains the most efficient species for fixation of DHA in its edible parts.

Luis-Chincoya H., Herrera-Haro J. G., Pr3-Mart3nez A., Santacruz-Varela A., Jerez-Salas M. P., 2021. The effect of dietary supplementation zinc source and level on growing performance, mineral deposition and meat quality. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-15; 4 pp.*

Zinc is involved in the normal and adequate growing of animals. Therefore, it is assumed that zinc supplementation improves the characteristics of canal and meat of New Zealand White rabbits (NZW). The objective was to compare the effect of two zinc sources on growing, meat quality, and muscle deposition in NZW rabbits during the fattening stage. 100 35-day-old NZW rabbits were considered. Treatments consisted of: T1= A basal diet (BD) zinc-free, T2= BD+ 25 ppm Zn (ZnSO₄), T3= BD+ 75 ppm Zn (ZnSO₄), T4= BD+ 25 ppm Zn (Zn-Methionine) y T5= BD+ 75 ppm Zn (Zn-Methionine). A completely Random Design was used in accordance with factorial treatments 2x2+1 (2 sources x 2 level of zinc + control). Test period was 30 days. Variables considered were growth and meat quality; Zinc content was determined in serum, liver, loin and leg in each test unit. Results showed no differences in growth characteristics; in loin, L*, B* and collagen content in the organic source were affected. No significant differences were found (P>0.05) regarding the source of zinc, but there were differences between zinc levels (P=0.02), favoring the level of supplementation 25 ppm. No differences (P>0.05) were found in leg between sources and zinc levels. The importance of determining a zinc level that improves its deposition in rabbit meat can help meet Zn's daily requirements in adults.

Mancini S., Mattioli S., Dal Bosco A., Paci G., 2021. Effects of garlic powder and salt as ingredients in rabbit meat burgers. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-16, 4 pp.*

The effects of garlic powder and salt were assessed on physical-chemical traits of rabbit burgers. Four type of burgers were formulated (only meat - control; 0.25% of garlic powder; 1% of salt; 0.25% of garlic powder and 1% of salt). Burgers (a total of 180 samples) were analysed both as raw and cooked products for the determination of pH, colour indexes, water holding capacity, lipid and protein oxidation, antioxidant capacity, tocopherols and tocotrienols content and fatty acids profile. Garlic powder partially modified the chemical characteristics of the burgers (mostly colours indexes and in particular b* index of raw samples, P<0.05) and partially increased the antioxidant capacity of the samples. Addition of salt increased the lipid and protein oxidations showing a doubling of TBARS values of raw samples (control 0.08 mg MDA/100 g to 0.25 mg MDA/100 g of burgers with 1% of salt, P<0.001) and a six-fold increase of carbonyls (from 5.71 to 29.47 nmol of carbonyl/mg of protein, respectively for the control and the formulation with 1% of salt, P<0.001). The burgers with both garlic powder and salt showed mixed results. Mixing garlic powder and salt could be a potential practical application although garlic powder partially increased the antioxidant capacity of the burgers and did not counteract completely the prooxidant properties of the salt.

Matics Zs., Szendr3 Zs., Dalle Zotte A., Cullere M., Radnai I., Kasza R., Gerencs3r Zs., 2021. Production performance and carcass traits of three rabbit breeds reared at different temperatures. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-17, 4 pp.*

The aim of the study was to investigate the effect of breed and ambient temperature on the production performance and carcass traits of growing rabbits. The experiment was conducted at the Kaposv3r University and it considered the Pannon Ka (PKa), Pannon White (PW) and Pannon Large (PL) rabbits. Rabbits were housed in two identical rooms where the temperature was controlled using air conditioning. In the control room, the average ambient temperature was 20°C and in the other room it was 28°C. From 5 to 11 weeks of age, weaned rabbits (n= 60 rabbits/genotype/room) were housed in wire-mesh cages (3 rabbits/cage). Commercial pellets and water were available ad libitum. Individual body weights and feed intake per cage were recorded fortnightly and weight gain and feed conversion ratio were subsequently calculated. At the end of the experiment the rabbits were slaughtered and the carcass traits were evaluated. Overall, ambient temperature significantly influenced the production performance and carcass traits of growing rabbits. At high temperatures feed intake, weight gain and body weight decreased but feed conversion ratio improved. Concerning the productive performance, a clear tendency could be observed under control temperatures; the PL rabbits had the

best and PKa breed the worst performances, while PW rabbits showed intermediate results (weight gain: 39.6 g/day, 45.9 g/day and 54.4 g/day; feed conversion ratio: 3.50, 3.11 and 2.91 in groups PKa, PW and PL respectively, $P < 0.05$). At high temperatures PW rabbits had similar performances to the PKa rabbits. PL rabbits consumed more feed at both temperatures and their feed conversion ratio was better than the other two breeds (feed conversion ratio: 3.19, 3.01 and 2.65 in groups PKa, PW and PL respectively, $P < 0.05$). At high temperatures the dressing percentage of the three breeds was higher than that recorded at normal temperature, and it was higher in PW rabbits than in other the two breeds (at 20°C: 60.4%, 61.2% and 60.6% and at 28°C: 61.1%, 62.4% and 61.2% in groups PKa, PW and PL respectively, $P < 0.05$). The effects of breed and temperature on the three carcass parts were significant. At both temperatures, PKa rabbits had more perirenal and scapular fat than PL and PW rabbits (perirenal fat: at 20°C: 1.81%, 1.07% and 1.29% and at 28°C: 1.25%, 0.74% and 0.95% in groups PKa, PW and PL respectively, $P < 0.05$). Significant breed x temperature interactions were also found and influenced the weight gain, feed conversion ratio, slaughter weight and chilled carcass weight. The results indicated that the three examined genotypes differ in adaptability regarding high ambient temperatures, which might be connected to the amount of fat deposits.

Ribeiro J., Andrade E., Monteiro D., Pinheiro V., 2021. Effect of a feed restriction and gender on the performance and characteristics of the rabbit carcass in the fattening period. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-18, 4 pp.*

The aim of the present study is to evaluate the effect of gender and a moderate feed restriction on carcass characteristics and development of the viscera in rabbits of both genders, during the fattening period. The study was conducted in the rabbit sector of the University of Trás-os-Montes e Alto Douro, Vila Real, Portugal. In the experiment 24 rabbits (12 male and 12 female) of the New Zealand X Californian breed were used, which were controlled between 62 and 86 days of age. The rabbits were individually housed and randomly distributed between the two treatments, one with feeding at will (ad libitum group) and the other feeding with 20% restriction (restricted group). During the trial, commercial pelletized feed was provided to the animals. At the end of the experiment, ten animals of each treatment were slaughtered to evaluate the development of the digestive tract and carcass characteristics. The feed restriction significantly increased ($P < 0.05$) the percentage weight of the liver (+ 14 %) and the dry matter content of the caecum (+17%) and decreased the proportion of total fat in the carcass (reduction from 29%, from 1.87 to 1.33 g/kg LW). The gender of the animal also significantly influenced some parameters ($P < 0.05$). In males, there was an increase in the slaughter weight (+ 167g) and the muscle weight of the hind leg (+13.2 g; + 7%) and a decrease of the fore part of the carcass (22.7 vs. 24.6%) and the colon length (-12 cm). According to the results obtained, we can point out that under the conditions in which the test was performed, the dietary restriction increases the liver weight and decreases the content of fat in the carcass.

Soglia F., Baldi G., Petracci M., 2021. Relationship between protein and lipid oxidation in rabbit hind leg meat. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication Q-19, 4 pp.*

The present study aimed at evaluating the effect of the exposure to oxidative conditions as well as of the incubation with different malondialdehyde concentration (MDA) on protein oxidation assessed by measuring carbonyls and free thiol groups on rabbit hind leg meat. For this purpose, five rabbits (10 weeks-old, average live weight of 2.7 kg) were collected from a commercial processing plant and, after deboning the hind legs, the resulting meat was minced and divided into twelve aliquots/each: six exposed to strong oxidant conditions and six considered as fresh. Both fresh and oxidized samples were treated with the addition of different final concentrations of MDA (i.e. 0, 0.25, 0.5, 1.0, 2.5 and 5 mM) and subsequently used to assess carbonyls and free thiol groups content. The same experiment was repeated on turkey (100 days-old, average live weight of 9.7 kg) thigh meat. Data concerning rabbit and turkey meat were separately analyzed according to a 2×6 factorial design (ANOVA) to investigate the main effects of the exposure to oxidative conditions and MDA addition. The exposure to oxidative conditions resulted in a 3-fold increase (2.27 vs. 6.68 nmol/mg of proteins; $P < 0.001$) in carbonyl content together with a significant reduction (-52%) in free thiol groups (197.5 vs. 94.9 nmol/mg of proteins; $P < 0.001$) in rabbit hind leg meat. On the other hand, the incubation with different MDA concentration did not exert any relevant effect on protein oxidation. These results are in overall agreement with those obtained on turkeys' thigh meat subjected to the same experimental design, even if rabbit meat proteins appear to be less prone to a lipid-induced oxidation. Overall, the findings of the present study show that rabbit meat is pretty resistant to main oxidative occurring to proteins. However, the occurrence of oxidative reaction affecting the polypeptide chains might change according cut-up characteristics, thus development of processing strategies aiming at reducing the extent of protein oxidation in rabbit meat and processed products needs to carefully consider its quality traits and attitude for further processing but also the processing steps as well as the storage conditions to which these meats will be subjected.

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Invited paper

Mattioli S., Maranesi M., Castellini C., Dal Bosco A., Arias-Alvarez M., Lorenzo P.L., Rebollar P.G., Garcia-Garcia R.M., 2021. Physiology and modulation factors of ovulation in rabbit reproduction management (Invited paper). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-00, 10 pp.*

Rabbit is an induced ovulatory species, so ovulation takes place after mating. Traditionally, exogenous and synthetic hormonal factors (administrated by intramuscular and intravaginal via) such as GnRH and analogues, or different physical procedures (i.e. stimulation by intravaginal cannula) have been used to induce ovulation in females when artificial insemination is applied in rabbit farms. Restriction and public rejection in the use of hormones is leading to the study of the seminal plasma components with potential action on ovulation induction. The objective of the present review is to collect and summarize the strategies used, during the last years, to trigger ovulation and improve rabbit fertility management with respect to more animal-friendly manipulation methods. Furthermore, special attention has been paid to the use of a semen component (as endogen molecule) such as beta nerve growth factor (β -NGF) in male and female rabbit reproductive physiology. This neurotrophin and their receptors (TrKA and p75NTR) are abundantly distributed in both male and female rabbit reproductive tract, and it seems to have an important physiological role in sperm maturation and behaviour (velocity, apoptosis and capacitation), as well as a modulatory factor of ovulation. Endogen β -NGF is diluted in the seminal doses with the extenders; hence it could be considered an innovative and alternative strategy to avoid the current hormonal exogenous (by intramuscular route) and stressful treatments used in ovulation induction. Their addition in seminal dose could be more physiological and improve animal welfare in rabbit farms.

Short communications

Anoh K. U., 2021. The influence of organic and synthetic antioxidant on the reproductive performance of heat stressed rabbit under tropical condition of Nigeria. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-02, 4 pp.*

The aim of this study was to evaluate the influence of organic and synthetic antioxidant on the reproductive performance of heat stressed rabbit under tropical conditions of Nigeria. A total of forty (40) matured rabbits were used. The rabbits were allotted into the treatment groups with ten (10) rabbits per treatment in a completely randomized design. Rabbits in the first group (T1) were the control, animals in the treatment 2 (T2) were fed with diets as in the controls and given sodium bicarbonate (NaHCO₃) buffer water. Rabbits in treatment three (T3) were fed diet containing synthetic vitamin C and the fourth group (T4) was fed diet containing Baobab Fruit Pulp Meal as an organic antioxidant. Rabbits were given access to feed and water *ad libitum*. Blood samples (5 ml) were collected from the ear vein at 10.00 h from five animals chosen randomly from each group of rabbits respectively before, during and after gestation and thyroxine hormone concentrations were evaluated. Reproductive performance of the female rabbits was also evaluated. Vitamin C and BFPM significantly ($P < 0.05$) increased thyroxine secretion and improved reproductive performance of the does. It was concluded that baobab can be used as an antioxidant for alleviating heat stress and was recommended to be included in rabbit diets during the hot period.

Cherfaoui-Yami D., Berchiche M., Lebas F., 2021. Influence of male on reproductive performance of Algerian local population rabbit. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-07, 4 pp.*

The aim of this work was to study the influence of male on reproductive performance of Algerian local population rabbits. Over 1 or 2 years according to the farm, a total of 274 females and 75 males carried out 1734 mating in three farms in the Tizi-ouzou area (Algeria). Reproductive performances (mating acceptance rate, fertility rate, litter size and litter weight at birth and at weaning) were analyzed according to the male's age and average weight at mating time. Results showed that the buck's average weight had generally no significant effect on reproductive performance. Mating acceptance and fertility were affected by male's age at mating: younger ones whose age was less than 190 days provided the best results (acceptance rate = 85.3 %; fertility rate = 83.1 % vs 73.7% and 73.1% for males older than 330 days at mating). These observations, particularly the effect of male's age on mating results, suggest that the elimination of old males (older than one year) may improve the average production of a rabbitry. Nevertheless this conclusion must be confirmed with other rabbit populations and conditions.

Eiben Cs., Sándor M., Sándor F., Mohaupt M., Kustos K., 2021. Effect of short fast-refeeding and light program on rabbit doe reproduction. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-08, 4 pp.*

The reproduction of 1-14 day controlled nursing rabbits subjected to light stimulation (L) or fastrefeeding plus light stimulation (FL) before AI (on day 11) was compared in two reproduction cycles in winter in Galgamácsa rabbit farm. On day 8 before AI the daily 9 h and 50 lux LED lighting was increased to 16 h and 100 lux that was gradually set back until day 5 after AI. The L rabbits were fed ad libitum. As nutritive stimulus, the FL rabbits received the same diet but they had a 24 h water-only fast and 48–50 h ad libitum re-feeding before AI. Fast-refeeding plus light stimulation did not further improve doe reproduction. Sexual receptivity, pregnancy and kindling rates of the FL and L does did not differ significantly in the first cycle (FL: 44, 91 and 86%; L: 42, 90 and 85%) nor in the second reproduction cycle (FL: 44, 92 and 89%; L: 51, 91 and 86%). With refeeding plus light stimulation the number of live born kits per litter hardly changed in the first cycle (FL: 9.07 and L: 9.28) but seemed to decrease ($P=0.056$) in the second cycle (FL: 9.69 and L: 10.2). Compared to the L rabbits (789) the productivity (number of live born kits per 100 AI) of the FL rabbits was similar in the first cycle (784) but 2.0% lower (881 vs 863) in the second cycle. In conclusion, the productivity of light-stimulated rabbits cannot be further increased with fast-refeeding combined with light stimulation.

García M.L., Peiró R., Agea I., Argente M.J., 2021. Study of body condition, energy mobilization and leptin profile in reproductive females. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-09, 4 pp.*

This study examined the effect of reproductive and lactating status, and gestation order on body condition, non-esterified fatty acids (NEFA) and leptin concentration in rabbit females. A total of 26 rabbit females from a synthetic line were used in the experiment. Body weight, perirenal fat thickness, NEFA and leptin concentration were measured at mating and at 12 days of gestation. The model used included the effects of reproductive status (mating or 12 days of gestation), lactation status at mating (lactating or not lactating), gestation order (second and third), and female effect. All statistical analysis were performed by Bayesian methodology. Body weight and perirenal fat thickness were -5 % and -12 % lower at mating than at 12 days of gestation ($P=1.00$), but NEFA were similar at both status ($P=0.81$). Leptin concentration was +18 % higher at mating than at 12 days of gestation. Lactating females showed higher body weight (+3 %; $P=0.92$) and perirenal fat thickness (+8 %; $P=0.96$) than non-lactating females. NEFA were -50 % lower in lactating females than non-lactating females and leptin concentration was similar ($P=0.70$). All traits were lower in the second gestation than in the third gestation. In conclusion, reproductive status, lactation-gestation overlap and gestation order affect body condition, energy mobilization and leptin concentration.

Gerencsér Zs., Kasza R., Radnai I., Matics Zs., Dalle Zotte A., Cullere M., Szendrő Zs., 2021. Effect of drinking water cooling on the reproductive performance of rabbit does housed under high ambient temperature. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-10, 4 pp.*

The aim of the study was to examine the effect of cooled water at high ambient temperature on the reproductive performance of rabbit does. The experiment was conducted at Kaposvár University with Pannon Ka multiparous rabbit does which were housed in two air-conditioned rooms where the average ambient temperature were 20 °C and 28 °C. Specifically, three groups ($n=30$ does/group) were formed: in the positive control group (PC) the ambient temperature was 20 °C and the drinking water was not cooled, in the negative control group (NC) the ambient temperature was 28 °C and the drinking water was not cooled and in case of TP group the ambient temperature was on 28 °C and the drinking water was cooled. Rabbits were housed in wire-mesh cages and fed ad libitum with commercial diet. For the experiment, two reproduction cycles were examined with the same rabbit does. During the first cycle, the cooled water's temperature was 17-18 °C and in the second cycle it was 12 °C. In both cycles, the PC group displayed better feed intake, litter size, litter weight were and lower suckling mortality compared to both the NC and TP groups. No differences were observed between NC and TP groups. It was concluded that cooling the drinking water was not a good strategy to improve the reproductive performance of rabbit does kept under high ambient temperature.

Guillevic M., Minetto A., Prigent A. Y., Colin M., 2021. Effects of the increase of the feed alpha-linolenic acid level on the performances of reproduction of the rabbit does. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-11, 4 pp.*

Three experimentations carried out in 3 different places and involving 777 does have compared a control feed with low omega 3 level (0.09 to 0.16 % of alpha-linolenic acid) to one containing extruded flax Tradiilin® (Flax) in order to increase its

alpha-linolenic acid level between 0.61 and 0.68 %. The fertility at birth, the number of "4 days old" rabbits / litter, the number of weaned rabbits / litter, the mortality before weaning and the weight at weaning (individually and for the litters) were measured on 1 221 cycles of reproduction. No differences were observed on the fertility. The "4 days old rabbits" / litter number was very highly significantly increased from 10.07 to 10.96 in average when the flax is incorporated in the feed, in agreement with the results observed for the piglet. This improvement can be explained by the high content in alpha-linolenic acid and in lignans of the flax seed. The number of rabbits at weaning / litter had the same evolution and went up very highly significantly from 8.69 to 9.67. The mortality before weaning dropped highly significantly from 11.2 to 9.7 % with the incorporation of flax in the feed as for the piglet, probably as a consequence of the increase of the omega 3 level in the colostrum and in the milk, improving the immunity of the rabbits and their inflammatory status. The individual weights and the litter ones increased very highly significantly respectively from 811 to 912 grams and from 7 044 to 8 026 grams, on the same way than from the piglet. Consequently, the extruded flax Tradilin® appears as an important source of omega 3, enabling an improvement of the performances of reproduction of the rabbit, particularly in a context of reducing the alfalfa content of the rabbit feeds, creating a decrease of the level of this fatty acid in the feed if not compensated. It brings too the lignans which probably explain partly the increase of the number of rabbits at birth.

Kasza R., Szendrő Zs., Donkó T., Nagy I., Gerencsér Zs Radnai I, Dalle Zotte A., Cullere M., Matics Zs., 2021. Effects of different environmental temperatures on the reproductive performance of rabbit does divergently selected for total body fat content. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-12, 4 pp.*

The experiment was conducted at Kaposvár University with Pannon Ka (maternal line) rabbits which were divergently selected for low (Lean) or high (Fat) total body fat content. Rabbit does in the fifth generation were housed in two identical rooms (30 Lean and 30 Fat does/room) which were only different in temperature (normal: 20°C or warm: 30°C). The performance of does was examined during two consecutive reproductive cycles. Kindling rate was significantly higher in the Fat line only in the first cycle (P<0.05). The 21-day litter size was higher for the Fat group in both cycles (P<0.05). Litter weight at 21 day was higher at the normal temperature (P<0.001). The feed intake of the does was higher in normal temperature (P<0.001). The milk yield of does was measured during the first cycle, and it was lower in the warm room (P<0.001), but difference between lines was not observed. Ultimately, high temperatures are less detrimental to the production of rabbit does with more fat reserves than lean rabbits.

Khaldoun Oularbi H., Makhlof C., Bokreta S, Settar A., Tarzali D., Zitouni G., Hamadou D., Kais S., Daoudi-Zerrouki N., 2021. Ampligo® insecticide induces injuries on the testes of rabbit *Oryctolagus cuniculus*: alleviating effects of vitamins C and E (ascorbate/α-tocopherol). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-13, 5 pp.*

This study was conducted to evaluate the potential reproductive toxicity induced by "Ampligo® 150 ZC" (AP) (Chlorantraniliprole 9.3% + Lambda cyhalothrin 4.6% ZC) in male rabbits and to examine the protective effect of vitamins C and E (CE) against AP hormonal and histological toxicity. Twenty male rabbits "*Oryctolagus cuniculus*" were divided into four groups: Control, vitamins C and E (CE), ampligo (AP) and AP plus CE (AP+CE) groups. Testosterone, follicle-stimulating hormone (FSH), and luteinizing hormone (LH) were measured from the serum, while the testes tissue samples were used for histopathological examinations. Ampligo exposition induced decreased body weight gain and reproductive organs testes and epididymis weights. This study revealed no changes in serum hormonal LH and FSH concentrations, while, testosterone concentration were found significantly reduced in AP treated group than the other groups. Our observations also showed that treatment with AP significantly decreased the morphometrical parameters of seminiferous tubules. Histomorphometrical examination revealed a decrease in germinal layer thickness, disorganization of seminiferous tubules, degeneration of the epithelium and congestion. Vitamins C and E supplementation with AP significantly reversed the above mentioned damages. The present results indicate that vitamins C and E combination exerts curative effects against Ampligo®-induced male reproductive toxicity.

Machado L.C., Faria C.G.S., Zeferino C.P., Castilha L.D., Silveira J.M.M., Silva V.G.P., Pereira D.L., 2021. Productive, reproductive, behavioral and sanitary aspects of rabbit does from different genotypes. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-14, 4 pp.*

In order to compare the productive and reproductive performance, also behavioral and sanitary aspects, 27 rabbits does were used for this study, totalizing nine from the New Zealand White breed, nine from Botucatu genetic group and nine crossbreds. In general, the results showed that rabbit does from New Zealand White breed required fewer number of inseminations to achieve a positive pregnancy, but presented lighter kits during lactation (P<0.05). Botucatu genetic group showed high weight of their kits during lactation. However, there was high elimination rate of these rabbit does and it needs to be further evaluated. Crossbred does

provided more kindlings and weaned kits, as well as, higher feed intake. The use of crossbreds from the New Zealand White and Botucatu is indicated in Brazilian rabbit farms. New studies evaluating the longevity of rabbit does under Brazilian conditions need to be performed .

Nabi Ibrahim, Fatmi Sofiane, Iguer-Ouada Mokrane, 2021. Interests to supplement tris-base extender with cholesterol / α -tocopherol preloaded in cyclodextrins and vitamin-C to chill rabbit semen at 4°C. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-15, 4 pp.*

Semen refrigeration deteriorates the motile quality of rabbit semen and limits its usefulness over 48h of storage. The oxidant stress associated with the diminution of temperature leads to the high production of Reactive Oxygen species (ROS) and harmful alterations of the cell membrane. In this context, The objective of the present study was to supplement the extender with Vitamine C (VitC) and Cholesterol (CLC) or α -tocopherol (TLC) both Loaded in Cyclodextrins, to explore the quality of rabbit semen preserved at 4°C for 48h. Rabbit semen was collected, pooled and then treated by CLC (2.5mg), TLC (0.625) and VitC (0.125mg) for 80-100 million spz/ml; and by different duals (CLC+TLC), (CLC+VitC), (TLC+VitC) and (CLC+TLC+VitC). We analyzed motility kinematic parameters by a Computer-assisted semen analysis (CASA SPA®); and the oxidative status by measuring the amount of lipid peroxidation (TBARS). The results showed a diminution of motility during the time of preservation. However when compared to the control, CLC and TLC treatment improved significantly ($p < 0.05$) the kinematic parameters after 24h of 4°C conservation. Velocity Curvilinear (VCL) and Velocity of Average Path (VAP) in TLC treatment (56.0 ± 23.9 and 32.2 ± 15.3 $\mu\text{m/s}$, respectively) and CLC-TLC (VCL 57.9 ± 22.5 , VAP 36.4 ± 15.3 $\mu\text{m/s}$) were significantly higher compared to the control (VCL: 46.9 ± 24.0 , VAP: 24.8 ± 14.7 $\mu\text{m/s}$). After 48h, VAP (34.9 ± 17.0 $\mu\text{m/s}$) was significantly ($P < 0.05$) higher in TLC-TLC-VitC treatment than in control (22.9 ± 11 $\mu\text{m/s}$). With concern to the oxidative status of refrigerated semen, we noticed a similar level of TBARS at 0h in all treatments. However, we did not notice a significant elevation of TBARS levels in all treatment after 24h or 48h compared to the control. The benefit of CLC and TLC was highly attributed to the higher solubility of cholesterol and α -tocopherol through cyclodextrins.

Rouillon C., Camugli S., Carion O., Echegaray A., Delhomme G., Schmitt E., 2021. Development of a new antibiotic composition for a rabbit semen dilution medium (Galap®). *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-16, 4 pp.*

Given the alarming increasing of bacterial resistance, it was necessary to remove fluoroquinolone of semen dilution media, particularly GALAP® for rabbit semen. The purpose of this study was to search for new enrofloxacin-substitutable antibiotics and to study the effect of a new antibiotic composition of GALAP® based on semen motility and fecundity. Several bacterial strains were isolated from poorquality ejaculates, and were tested for antibiotic resistance. Out of 15 antibiotics tested, gentamycin was the one that caught our attention by targeting 82.8 % of the colonies identified. In vivo tests were then carried out to analyze the effects of this antibiotic change on sperm parameters. Pools of good quality semen were diluted in original or gentamycin added GALAP®. Ejaculates were analyzed on the day of collection and up to 6 days storage. After 24h of storage, the motility in the new medium was reduced by 7.7 % compared to the original medium and this decrease was not amplified with storage time. At 6 days storage, no difference between the two media was detected. Females were then inseminated with semen pools diluted 1:10 in original or GALAP® with gentamycin. No difference in female fecundity was detected, between the 2 media. The decrease in motility does not impact the female reproductive performance when following the routine protocol of semen processing centers. To conclude, dilution of semen with the new antibiotic formulation of GALAP® is recommended for the insemination of rabbits.

Savietto D., Debrusse A.M., Bonnemère J.M., Labatut D., Aymard P., Combes S., Fortun-Lamothe L., Gunia M., 2021. Reproductive performance of a maternal rabbit cross: Fauve-de-Bourgogne \times INRA-1777. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-18, 4 pp.*

Here we compared the reproductive performance of the French rabbit breed Fauve-de-Bourgogne (Fauve), the maternal rabbit line INRA-1777 (INRA), and their cross (Crossed). We followed the life of female rabbits of the three genotypes from 70 days of life until the weaning of litters produced from the third artificial insemination (AI) attempt. They had the same age, were house in the same room, were manage under a reproductive rhythm of 42 days and received antibiotic free diets. Crossed females were heavier at first AI than Fauve females (4.2 vs 3.9 kg; $P < 0.05$), INRA females being between both genotypes (4.1 kg). Between the first AI attempt and the birth of the first litters, we observed the presence of *Pasteurella* spp. This pathogen impaired the prolificacy of all genotypes and caused mortality of females around parturitions from the second AI attempts. Most losses were from the INRA genotype (four diagnosed deaths for INRA, one for Crossed and none for Fauve females). In brief, the overall losses of Fauve, INRA and Crossed females were two, fourteen and four females, respectively. The high female survival (91%), together with an acceptable reproductive performance (7.5 newborn kits, kit survival during lactation of 80% and weaning weight of kits of 871 g) of Crossed females, indicates that this maternal cross combine the alleged rusticity of the Fauve-de-Bourgogne breed kits with the reproductive potential of INRA maternal line.

Vasallo G.E., Sarduy Lucia., Herrera Magaly, 2021. Effect of reproductive condition and season on productive performance of female rabbits. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-19, 4 pp.*

The aim of the current study was to evaluate the effect of reproductive condition and season on productive performance of female rabbits, in Cuba. A Kruskal-Wallis test was used to analyze the effects of time of mating (10 to 13, 17 to 20, 24 to 27 and 31 to 42 post-partum days), season (low rainy and rainy periods-RP-) and their interaction on non-parametric variables (receptivity, fertility and mortality rates), while an analysis of variance was used to study the effect on litter size. The results showed a significant association between the four times of mating and the two seasons ($P < 0.0001$), in the low rainy period, whose ambient temperature is lower receptivity, fertility and mortality rates and, litter size were higher than rainy period (RP). The worst result of receptivity was obtained to mating time 17 to 20 days and RP (76.7%). Mating time of 24 to 27 days and 31 to 42 days improve the size of the litter at birth and weaning and paradoxically does mated 10 to 13 days postpartum gave better litter size at birth and weaning than other mating times in the rainy period. Our findings suggest that the time of mating postpartum of 10 to 13 days is profitable but the use of other time of mating attending the season are recommended to obtain the best reproductive performance .

Villamayor P.R., Gullón J., Vilá M., Yáñez U., Aramburu O., Sánchez M., Sánchez-Quintero P., Martínez P., Quintela L., 2021. Preliminary report of potential biostimulation methods based on chemical communication in rabbit doe reproduction. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-20, 4 pp.*

Biostimulation is an animal management practice that helps improving reproductive parameters by modulating animal sensory systems. Chemical signals, mostly known as pheromones, have a great potential on this regard. This study was conducted to determine the influence of short-term female rabbit exposure to different conditions, potentially pheromone-mediated, on reproductive parameters of inseminated does. Groups of 60 females/each were exposed to 1) female-female interaction, 2) female urine, 3) male urine and 4) seminal plasma, just before artificial insemination. Controls of isolated females and Ringer Lactate exposure were, respectively, performed. The following reproductive parameters were analyzed for each group: receptivity (vulva color), fertility (transabdominal palpation), and prolificity and number of born alive and dead kits/litter. Despite some differences could be noticed in receptivity rate, especially in the 'female-female interaction' group, the results showed no fertility and prolificity significant differences among groups suggesting that all the stimulation methods employed had similar effects. Moreover, similarity between the 'female-female interaction' group –usually performed in rabbit farms– and its control –no animal handling– should be reconsidered to avoid unnecessary animal management and time cost. On the other hand, fertility ranges were lower for animals with white vulva color whereas no differences were noticed among the other three (pink, red, purple), thus suggesting that these three could be grouped together. Overall, despite all groups showed similar effects, it remains to be elucidated how chemical signals released by both urine and seminal plasma can affect reproduction.

Wang Fupeng, Wu Yingjie, Qin Yinghe, 2021. Cryopreservation of rabbit sperm using dimethyl sulfoxide in combination with trehalose and hyaluronic acid. *12th World Rabbit Congress - November 3-5 2021 - Nantes, France, Communication R-21, 4 pp.*

Rabbit sperm cryopreservation is a great challenge, and there are not a reliable cryoprotectant for the commercial application yet. The present study evaluated the effects of disaccharides (sucrose and trehalose) and hyaluronic acid on rabbit sperm cryopreservation, when were added to a dimethyl sulfoxide (DMSO) containing extender. The result showed that the supplement of 0.05 mol/L trehalose increased the motility ($P < 0.05$), progressive motility ($P < 0.05$), and acrosomal integrity ($P < 0.05$) of frozen sperm after thawing, and 800 $\mu\text{g/mL}$ hyaluronic acid significantly raised the acrosomal integrity ($P < 0.05$). Finally, artificial inseminations were conducted and the fertility rate was 53.9%.

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