THE EFFECT OF DECREASING THE OMEGA 6 / OMEGA 3 RATIO IN FEED ON FATTY ACID CONTENT OF RABBIT MEAT TO MEET HUMAN DIETARY RECOMMENDATIONS

Gigaud V.[1]*, Combes S.[2]

[1]ITAVI – Station de Recherches Avicoles – BP1 – 37380 NOUZILLY
[2]INRA UMR 1289 'TANDEM' INPT-ENSAT, ENVT, Université de Toulouse, 31326 Castanet-Tolosan
*Corresponding author: gigaud@itavi.asso.fr

ABSTRACT

Consumers are concerned about their health and the nutritional value of their diet. In response, the meat industry is concentrating its efforts on improving the nutritional value of meat. Moreover, a publication on recommended daily intakes underlines the importance of a high level of omega 3 fatty acids in our diet and advises a ratio of omega 6/omega 3 fatty acids of 5. The human diet contains varying levels of omega 3 and 6 fatty acids and one way to enhance the beneficial ratio is to include these fatty acids in animal feeds.
The aim of this study was to evaluate the impact of decreasing the omega 6/omega 3 fatty acid ratio in feed on the final fatty-acid content of rabbit meat and to carry out an initial investigation as to when the omega fatty acid feeds should be fed in the rearing period. Four different diets were formulated with decreasing omega 6/omega 3 fatty acid ratios from 12.4 to 1.6. Four batches of 60 rabbits were fed from 35 to 71 days of age with either omega 3^{-}, standard, omega 3^{+}, or omega 3^{++} diets. A fifth batch of 60 animals were fed with the standard diet from 35 to 50 days of age, and then with the omega 3^{++} from day 51 to 71. Lipids, fatty acid content and dry weight were analysed in a homogenous ground sample of all the meat from each rabbit.
A close relationship between omega 3 content in meat and feed was identified. Moreover, omega^{-} and standard diets did not result in the recommended ratio in meat. On the other hand, the other three batches showed a ratio below 5, with 4.8, 2.5 and 1.9 for omega^{+}, the finishing omega^{++} and continuous omega^{++} diets respectively. Thus, the meat from these animals can carry the official label: "source of omega 3". With the omega^{++} (finishing or continuous) diet, rabbit meat can be labelled as being "rich in omega 3" since 30% of the dietary requirement is met. Satisfactory results were obtained when the omega rich diet was fed only in the finishing period and this opens the way to further work to identify precisely the optimum conditions (feed quantity and/or feeding period) to obtain the required dietary results at the lowest cost.

Key words: Rabbit meat, Omega 3 fatty acids, Recommended daily intakes.

INTRODUCTION

Health food is attracting increasing attention from the media and health professionals, and changes in eating habits can be observed. Consumers are concerned about their health and the nutritional value of their diet. In response, the meat industry is concentrating its efforts on improving the nutritional value of meat. Moreover, a publication on recommended daily intakes (ANC, Martin 2001) underlines the importance of a high level of omega 3 fatty acids in our diet and advises a ratio of omega 6/omega 3 of 5. The Human diet contains varying levels of omega 3 and 6 fatty acids and one way to enhance the beneficial ratio is to include them in animal feeds.

The aim of this study was to evaluate the impact of decreasing the omega 6/omega 3 ratio in feed on the fatty acid content of rabbit meat. In addition, the impact of feeding omega 3 rich diet only during

the finishing phase was investigated in order to add value to rabbit meat without significantly increasing cost to the industry.

MATERIALS AND METHODS

Animals and feeding

Three hundred rabbits (Hyplus Grimaud x PS 39) were reared at ITAVI experimental unit for rabbits. They were weaned at 35 days of age and then divided into five batches and kept in cages of 6 animals (40–45 kg/m^2).

Four different diets were formulated with decreasing omega 6/omega 3 ratios (Table 1). Protein, energy and lipid contents were the same in all diets. Feeds were based on the regular standard diet as produced by a main animal feed group (SNIA-SYNCOPA). The omega 3 content was varied by modifying alfalfa content (15 to 30%) and the origin of oil (palm or rapeseed oil) and by adding linseed only to the omega 3^{++} feed.

Table 1: Chemical composition and nutritive value of diets (g/100 g)

	Omega$^-$	Standard	Omega$^+$	Omega^{++}
Dry matter	87,2	87,2	87,7	87,5
Proteins	15,3	15,2	14,6	14,7
Lipids	4,3	4	3,9	4,2
Ash	6,1	6,7	7,0	7,3
NDF	34	32,8	32,6	31,7
ADF	19,5	19,5	20,4	20,1
ADL	6,0	6,0	6,1	6,8
DE (kcal/kg)*	2380	2370	2365	2365
Fatty Acids (mg/100 g)				
C16:0 palmitic acid	960	790	450	420
C18:0 stearic acid	130	110	80	100
Saturated fatty Acids	1200	980	620	610
C18:1n-9 oleic acid	940	780	1020	770
Mono-unsaturated fatty acids (MUFA)	960	800	1060	810
C18:2n-6 linoleic acid	1360	1240	1200	1200
C18:3n-3 linolenic acid	110	160	300	760
Poly-unsaturated fatty acids (PUFA)	1470	1400	1500	1960
Ratio omega6/omega3 **	12,4	7,7	4,0	1,6

*: provided by the formula; **ratio C18:2n-6/ C18:3n-3

Vitamin E was added at 170 mg/kg to each diet to limit the poly-unsaturated fatty acid (PUFA) oxidation in meat. Each batch was fed from 35 to 71 days of age with either omega 3$^-$, standard, omega 3$^+$, or omega 3^{++} diets. For the fifth batch, animals were fed with the standard diet from 35 to 50 days of age, and then with the omega3^{++} from day 51 to 71. Feed consumption, growth performance and mortality were recorded at d 35, d 50, d 67 and d 71. Everyday, a health check was carried out.

Slaughtering and analysis

In this study, fifteen rabbits per batch were slaughtered after electro-narcosis at 71 days of age with no prior fasting. The carcasses were weighed to measure carcass yield. They were then cut up and boned. All the meat from each rabbit was vacuum packed and sent to LAREAL laboratory (COFRAC approved). Lipids, fatty acid content and dry weight were analysed in a homogenous ground sample of meat from each rabbit.

All data were analysed using SAS software (SAS Institute, 1999). The effect of diet on meat fatty acid content was tested using a one-way variance analysis with the Generalized Linear Model (GLM) procedure. The Newmann-Keuls test was then used for a comparison of means.

RESULTS AND DISCUSSION

First, as already shown by Dal Bosco *et al.* (2004) and Verdelhan *et al.* (2005) increasing the omega 3 content in diet did not induce significant effects on growth performance, mortality or yield (Table 2).

Table 2: Growth performance

Batches	omega^{-}	Standard	omega^{+}	omega^{++} finishing	omega^{++}	MSE	
Live weight 35 d (g)	895	920	893	909	899	57	NS
Live weight 50 d (g)	1953	1991	1911	1894	1985	115	NS
Live weight 71 d (g)	2928	2900	2859	2832	2922	180	NS
Weigh gain 35-67 d (g/d)	45	45	46	45	51	11	NS
Feed conversion	2,74	2,83	2,66	2,85	2,53	0,53	NS
carcass weight (g)	1668	1653	1611	1580	1644	107	NS
Carcass yield (%)	57,0	57,0	56,3	55,8	56,4	1,8	NS

NS: non significant; MSE: Mean square error

As expected, meat fatty acid content followed dietary content. Thus, when PUFA were increased and saturated fatty acids decreased in feed, a corresponding trend was observed in the rabbit meat (Table 3).

Table 3: Fatty acid (FA) content in rabbit meat

	Omega $^{-}$	Standard	Omega $^{+}$	Omega $^{++}$ Finition	Omega^{++}	MSE	P
C 10:0	0.31b	0.40ab	0.46a	0.38ab	0.35b	0.11	***
C 12:0	0.28b	0.36ab	0.41a	0.34ab	0.34ab	0.09	***
C 14:0	2.64	2.62a	2.37b	2.47ab	2.33b	0.21	***
C 15:0	0.51	0.53	0.59	0.55	0.55	0.08	NS
C 16:0 iso	0.19b	0.18b	0.22a	0.19b	0.20ab	0.03	**
C 16:0	29.64a	29.02a	24.62c	26.33b	24.05c	1.23	***
C 17:0	0.55b	0.55b	0.63a	0.61a	0.61a	0.06	***
C 18:0	7.35a	7.09ab	6.79bc	6.65bc	6.55c	0.57	***
Saturated FA	41.94	41.20	36.68	38.08	35.57	2.30	***
C 14:1	0.21	0.21	0.18	0.17	0.20	0.11	NS
C 16:1	3.73	3.81	3.11	3.22	3.42	1.08	NS
C 17:1	0.24b	0.27a	0.29a	0.29a	0.29a	0.04	***
C 18:1	29.52b	28.85b	31.23a	26.62c	26.47c	1.16	***
C 20:1	0.39b	0.37b	0.48a	0.37b	0.37b	0.06	***
MUFA	34.28	33.70	35.54	30.88	31.00	2.46	NS
C 18:2 n-6	20.85	21.11	21.67	20.96	20.66	1.67	NS
C 18:3 n-3	1.53e	2.57d	4.51c	8.45b	10.89a	0.53	***
C 20:2 n-6	0.23	0.23	0.23	0.21	0.21	0.04	NS
C 20:4 n-6	0.47	0.51	0.55	0.48	0.51	0.10	NS
C 22:4 n-6	0.19	0.19	0.20	0.14	0.14	0.01	NS
C 22:5 n-3	0.10d	0.11d	0.18c	0.20b	0.29a	0.05	***
PUFA	24.01e	25.41d	28.09c	31.34b	33.70a	2.31	***

Means with different letters on the same line/row differ significantly; NS: non significant, ** <0.01; ***<0.001; MSE: Mean square error

Regarding PUFA content in meat, linoleic acid content did not change between batches, whereas that of linolenic acid was multiplied by 3.2 and 4.2 in the omega 3^{+} and omega 3^{++} batches respectively. The close relationship between omega 3 content in meat and feed was strongly correlated (R^2=0.89 P<0.001) as can be clearly seen in Figure 1.

Western diets, characterize by higher intakes of processed and red meats, refined grains, sweets, and desserts and relatively low vegetables and fruits contents, contain a relatively low level of omega 3 but are rich in saturated fatty acids. However, ANC in France advise limiting the intake of the latter and recommend an omega 6/ omega 3 ratio of 5 or under. This enhances biosynthesis of long-chain PUFA.

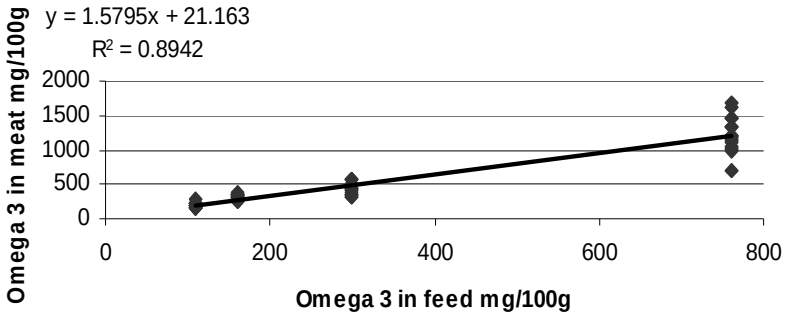

Figure 1: Omega 3 content in meat according to the omega 3 content in feed (n=15 rabbits/batch)

In the present study, omega $^{-}$ and standard diets did not result in the recommended ratio in meat. On the other hand, the other three batches showed a ratio below 5, with 4.8, 2.5 and 1.9 for omega^{+}, the finishing omega^{++} and continuous omega^{++} diets respectively.

In addition, the dietary requirements for men and women are met up to 15 and 17% respectively when eating 100 g of meat from a rabbit fed a standard diet (Table 4).

Table 4: Omega 6, Omega 3 content (mg/100 g), omega 6/omega 3 meat ration (Mean) according to different diets and ANC omega 3 requirements for 100 g rabbit meat

	omega^{-}	Standard	omega^{+}	omega^{++} finishing	omega^{++}	MSE	
lipid content	13.0a	12.5 ab	10.5 b	12.2 ab	11.8b	2.1	**
humidity	66.6	67.2	68.4	67.2	67.7	2.0	NS
C18:2n-6 linoleic	2481	2579	2042	2429	2359	315.6	NS
C18:3n-3 linolenic	198^{e}	319^{d}	431^{b}	959^{c}	1243^{a}	132.2	***
omega6/omega3[(1)]	12.61^{a}	8.11^{b}	4.80^{c}	2.54^{d}	1.92^{e}	0.38	***
requirement % ANC (male/ female)[(2)]	8.6/10.7	14.9/18.6	21.5/26.9	45.9/57.4	55.8/69.1		

[(1)]ratio C18:2n-6/C18:3n-3; [(2)]ANC suggest a consumption of 2 and 1,6 g/d of C18:3n-3 for men and women respectively; Means with different letters on the same line/row differ significantly; NS: non significant, ** <0.01; ***<0.001; MSE: Mean square error

CONCLUSIONS

These results suggest that an increase in linoleic acid content has no consequence on growth performance and slaughter yield. As it can be observed, our results offer 3 possibilities to the industry to promote rabbit meat. First, by feeding standard diet the resulting meat can carry the "source of omega 3" label. If the omega 3^{+} diet is chosen, the meat can be labelled as above and in addition contains the optimal omega 6/ omega 3 ratio (4.8). Finally, the "rich in omega 3" label can be used and a better omega 6/omega 3 ratio obtained when feeding the omega 3^{++} (finishing or continuous) diet. The next step is to identify the optimum conditions (feed quantity and/or feeding period) to obtain the required dietary results at the lowest cost.

ACKNOWLEDGEMENTS

We would like to thank staff from the animal feed producer group: Chantal Davoust, Antoine Bretaudeau, Luc Grenet, Bertrand Renouf, and Joël Duperray; Christophe Souchet and Pascal Galliot for the use of the experimentation at the ITAVI's experimental unit for rabbits. This project received financial support from "l'Office de l'élevage", the "CLIPP" and "AFSSA".

REFERENCES

Dal Bosco A., Castellini C., Bianchi L., Mugnai C. 2004. Effect of dietary alpha-linolenic acid and vitamin E on the fatty acid composition, storage stability and sensory traits of rabbit meat. *Meat Sci., 66, 407-413.*

Martin 2001. Apports nutritionnels conseillés pour la population française. *Technique et Documentation (3ème édition), Paris, France, pp. 650.*

Verdelhan S., Bourdillon A., Renouf B., Audoin E. 2005. Effet de l'incorporation de 2% d'huile de lin dans l'aliment sur les performances zootechniques et sanitaires de lapins en croissance. *In: Proc. 11èmes Journées de la Recherche Cunicole Paris, France, 209-212.*