EFFECTS OF DEHYDRATED SAINFOIN IN RABBIT DIET ON THE PERFORMANCE OF DOES AND GROWING RABBITS

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ABSTRACT

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 (2.91 vs. 2.98 respectively for DS0 and DS26, P<0.05).

Key words: Dehydrated sainfoin, Rabbit feeding, Growth, Reproductive performances

INTRODUCTION

To cover the nutritional needs of the rabbit, a feed must contains not only energy and protein, but also fibre and more especially lignins for the digestive health of the growing rabbit (Gidenne *et al*., 2020). Thus, plant resources are sought to cover these requirements. Sainfoin (*Onobrychis viciifolia*) is a legume used traditionally as pasture, hay or ensilage for livestock (Aufrère *et al.*, 2013). Dehydrated pelleted sainfoin (DS) seemed a good candidate for rabbit feeding, since it contains a high concentration of fibre and especially of lignins (Legendre *et al.*, 2018). Being a legume, DS has a high protein level (over 160 g/kg). Nowadays, DS (Perly cultivar) is available (Multifolia company), and its nutritive value was recently studied for the growing rabbit (Gayrard *et al*., 2021). However no information are available concerning the optimal level of DS in balanced feeds and the performances of growing rabbit and does. Thus, the current study aimed at measuring the effect of the DS incorporation rate (0-13-26%) in balanced diets on intake, growth, and health of rabbits, and on the reproductive performances of does for 3 consecutive cycles of reproduction.

MATERIALS AND METHODS

Animals and experimental design

The trial was carried out at the INRAE experimental farm on 3 consecutive reproductive cycles (figure 1), with initially 70 nulliparous does (genotype INRAE 0171) having a similar weight when the first cycle started (insemination 1). All animals (does and litters) were housed in conventional cages (length: 68cm - width: 62cm - height: 48cm). Ten does were kept to replace doe losses and infertility for cycle 2 or 3. Ten days before parturition (D0, figure 1), 60 does were allotted in 3 equal groups: DSO (control), DS13 and DS26 and fed freely one of the 3 feeds for reproductive does "R" (table 1): control group without dehydrated sainfoin "DS0" (feed R0) and groups DS13 and DS26 fed with R13 (13% DS) and R26 (26% DS) feeds respectively. Litters were equalised to 8 pups at D4, and at 25

days old (D25) doe and litters were freely fed till weaning (D33) a fattening "F" feed containing either 0, 13, 26 % of DS (feeds F0, F13, F26: table 1).
At weaning, the litters were moved in a fattening unit and they were housed collectively (6 rabbits per cage: length: 68cm - width: 62cm - height: 48cm). The growing rabbits were fed with F feeds until 70 d old, and under a restriction program: 90 g during the week after weaning, that was weekly increased by 20 g. Meanwhile does remained in their cage and switched back to R feeds to start their 2nd cycle (Figure 1). A third cycle was performed in the same conditions.

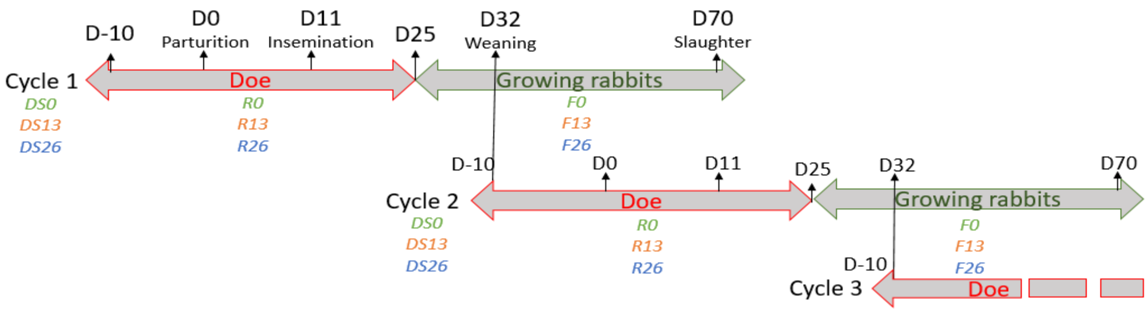

Figure 1: Experimental design

Dehydrated sainfoin (DS) was obtained from a first cut harvested in May 2019 and provided by Multifolia company (Viapres-le-Petit, France). R and F feeds (table 1) were formulated to meet the requirements of the reproductive does and growing rabbits respectively. They were isonutritive and differed essentially by their DS incorporation rate. The 6 feeds were formulated by Arrivé-Béllanné company (Nueil-les-Aubiers, France). Diets did not contain drugs or coccidiostatic supplementation.

Table 1: Chemical composition of the diets

	Diets of reproducing does			Diets of growing rabbit			Dehydrated sainfoin
Chemical composition g/kg as fed	R0	R13	R26	F0	F13	F26	1st cut 2019
Dry matter	887	890	89.1	886	891	893	894
Crude Protein	172	180	171	142	154	155	158
Crude fat	36	3.8	38	36	35	35	230
NDF	320	320	320	377	388	392	386
ADF	170	166	164	232	226	221	275
ADL	54	48	43	81	79	73	70
Phenols	-	-	-	-	-	-	29
Tannins	-	-	-	-	-	-	28

Health and performance measurements

Mortality was daily checked. For each cycle, the does' live weight was measured at D10, D4, D14, D24 and D32, while litters weight was measured at D4, D14 and D24. Feed intake was checked on the same dates than doe live weight. Individual live weight of growing rabbits was measured at weaning (D32) and at 49 and 70 days old, while feed intake was checked weekly for each cage. Reproductive performances such as insemination rate, alive kits at birth, stillborn rate were measured at each cycle.

Chemical analyses

Chemical composition of the 6 feeds and of DS was performed at INRAE (dry matter, crude ash, organic matter and crude protein) and Arrivé-Bellanné (crude fibre, crude fat, pellets hardness and durability). DM content were determined at 103°C for 24 h and ash at 550°C for 5 h. Crude proteins was analysed according to Dumas combustion method. Total phenols and tannins were analysed according to the Folin-Ciocalteu method (Makkar, 2000) by the laboratory Inovalys (Nantes, France).

Statistical Analyses

Data were first screened to detect outliers. No outlier was found for animal performance measurements. All data were analysed using R software. Shapiro-Wilk test was used to check normality. For each cycle, a single factor variance analysis was used to estimate the diet effect on performance traits (live weight and growth), reproductive traits and mortality rate. Then, a two factors (diet X cycle and interaction) model was used to estimate the diet effect on the cumulated 3 cycles. Tukey multiple mean comparison test was used to compare the means between diet groups.

RESULTS AND DISCUSSION

Reproductive performances of the does

As expected, the doe live weight increased along the study, from the cycle 1 to the cycle 3 (table 2). Throughout the whole study, the does live weight was similar among the three diet groups, which testifies that the does keep a good body state after three reproductive cycle.
Doe feed intake was similar between diets and averaged 356 g/d (table 4), and logically increased by 20% (P<0.05) from cycle 1 to cycle 3.

Table 2: Doe live weight along the reproductive cycle and according to dietary sainfoin incorporation.

Doe	Cycles				Diets				P levels		
Live weight (g)	1	2	3	*RSD*	DS0	DS13	DS26	*RSD*	Cycle	Diets	C. x D.
D-10*	5168a	5454b	5560c	35.0	5447	5372	5346	37.6	<0.001	0.45	0.85
D4	5031a	5298b	5408c	30.9	5296	5282	5159	33.4	<0.001	0.13	0.74
D33	5225	5383	5348	37.5	5366	5358	5239	37.6	0.18	0.28	0.60
Doe feed intake (D-10 to D25), g/d	319a	365b	384c	3.83	364	352	351	4.48	<0.001	0.31	0.88

* D-10: 10 days before parturition (D0). D4: 4 days after parturition. D33: 33 days after parturition.

Insemination rate was similar between diets or cycles (table 3) and averaged 78%. The mean number of live pup at birth was also similar among the three groups, and it tended to be slightly lower in the cycle 1 (P=0.07) since it was the first pregnancy of the does. Significant interaction was detected between the cycle and diet effects for the stillborn rate (table 3). During the first cycle the stillborn rate was higher than for the two subsequent cycles. For cycles 1 and 3, the stillborn rate was linearly reduced (P<0.001) with incorporation of the DS (20.5 vs. 13.3 vs. 8.8% respectively for DS0, DS13, DS26), while the stillborn rate was lower in cycle 3 (12.1 vs. 16.7%, P=0.01). In return, for the cycle 2, the stillborn rate was low (6.6%) and did not differ among the three diets (P=0.10).

Table 3: Reproductive performances of does according to cycle and dietary sainfoin incorporation

	Cycles				Diets				P levels		
	1	2	3	*RSD*	DS0	DS13	DS26	*RSD*	Cycle	Diets	Cycle x Diet
Fertility rate, %	80.0	71.9	81.4		78.9	78.2	76.1		0.37	0.92	0.88
Live rabbits at birth	8.0a	10.7b	10.0b	0.30	9.0	9.0	10.5	0.3	<0.001	0.05	0.61
Stillborn rate, %	16.7	6.6	12.0		15.7	10.5	8.9		<0.001	0.0082	0.0033

RSD: Residual standard deviation

Mortality rates of does and young rabbits

Doe mortality was low (<5%) and was not affected by the diet or according to the reproductive cycle (table 4). The post-weaning mortality was very low (<1%) and remained unaffected by the treatments. Before and after weaning mortality sourced from digestive troubles (diarrhoea mainly). However, since during cycle 1 we had some losses of does and kits, a veterinary advice identified two pathogenic agents: *Escherichia coli* and *Staphylococcus aureus*. Thus, from D18 to D24 (cycle 1), all animals were cured with 70 g/d of doxycycline, and from D25 to D29 does received in water 0.5 ml/L of colistin.
Before weaning, the mortality rate of the kits averaged 6.2%, but differed according to the diet or the cycle (significant interaction). Most of the mortality was found during the cycle 1 and 2, while it was very low during the cycle 3 (P<0.00, table 4). Whatever the cycle, mortality at nest was very low for the control DS0 diet (meanly: 2.0%). In return, mortality cumulated for cycle 1 and 2, occurred mainly for DS13 diet (meanly 20.3%), compared to the DS26 diet (6.0%). This higher mortality rate in the DS13 diet during cycle 1 and 2 could be correlated to doe mortality from DS13 group. Indeed, it has been frequently observed that a poor health status in does negatively impacted the litter health

(Rashwan and Marai, 2008). Further studies, with a high number of litters are necessary to elicit the potential health impact of incorporating DS in the feeds on doe and litter health status.

Table 4: Mortality of does and growing rabbits according to cycle and dietary sainfoin incorporation

	Cycles			Diets			P levels		
	1	2	**3**	**DS0**	**DS13**	**DS26**	**Cycle**	**Diets**	**Cycle x Diet**
Does	4/53	3/46	0/48	0/52	6/41	1/51	0.67	0.37	0.91
Growing rabbits									
Birth-weaning (D33)	36/392	32/368	3/384	8/408	47/320	16/416	0.010	0.59	<0.001
Weaning-70d old	1/294	1/276	3/288	1/312	2/240	2/306	0.18	0.88	0.81

Performances of growing rabbit, before and after weaning.

Feed intake of litter and doe (D25-D33) was similar among the three diets and averaged 55.5 g/d/rabbit, and accordingly the litter growth was not affected by the diets. In return, the litter growth was 10% lower at the first cycle compared to the two others (P<0.05) since it was done with primiparous does.

Growing rabbits of the three groups were similarly restricted from weaning to D70, and the feed intake averaged 127g/d/rabbit. Any feed refusal was found whatever the diet. The growth rate was 2.5% lower (P<0.05) for DS26 group, without interaction with the cycle (table 5). Similarly, the feed conversion ratio was slightly impaired with DS13 and DS26 diet (+2.2%). Along the study, we observed an increase in growth rate and a better feed conversion.

Table 5: Performances of growing rabbits according to cycle and dietary sainfoin incorporation.

	Cycles				**Diets**				**P levels**		
	1	**2**	**3**	**RSD**	**DS0**	**DS13**	**DS26**	**RSD**	**Cycle**	**Diets**	**C. x D.**
Before weaning (D33)											
Litter+doe feed intake: D25-D33, g/d	737a	796b	866c	6.7	816	790	792	8.1	<0.001	0.18	0.44
Litter daily weight gain: D4-D33, g/d	27.2a	29.3b	30.2b	0.2	29.4	28.2	28.9	0.2	<0.001	0.15	0.87
After weaning											
Daily weigh gain: D33-D70, g/d	39.8a	44.7b	46.3c	0.1	44.2a	43.4ab	43.2b	0.2	<0.001	<0.001	0.76
Feed conversion ratio: D33-D70	3.22a	2.87b	2.76c	0.01	2.91a	2.97ab	2.98b	0.01	<0.001	<0.01	0.72

RSD: Residual standard deviation

CONCLUSIONS

Incorporating dehydrated sainfoin in the doe feeding did not affect the reproductive performances, and even seemed to improve the stillborn rate. However after weaning, incorporating sainfoin in feeds slightly impair the growth rate, without affecting the health status. These first results should be confirmed on larger number of rabbits and under commercial conditions, to analyse the potential impact of incorporating DS in the feeds on doe and litter on their performances and health.

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