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UTILISATION OF FIELD BEANS BY GROWING RABBITS 1 - EFFECTS OF SUPPLEMENTATIONS AIMED AT IMPROVING THE SULFUR AMINO ACID SUPPLY.

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SUMMARY : One hundred New Zealand White rabbits distributed into five dietary groups were fattened between 35 and 77 days in individual cages. The diets were SOJ (soybean control), FEV (26.5 % field beans), FEVM (FEV diet supplemented with *dl* methionine), FEVF (FEV diet supplemented with field beans up to a total of 37 %) and FEVT (FEV diet supplemented with sunflower cake) provided *ad libitum*. The mean protein content was 14.5 % in the SOJ, FEV and FEVM diets and 16.3 % in the FEVF and FEVT diets. The digestible energy content varied little between diets (2256 to 2324 kcal DE / kg). The fibre content of each diet was 14.5 %. Apparent digestibility of dry matter was comparable in all five diets (58.9 to 60.3 %). Apparent digestibility of crude proteins was lower in the FEVF diet (66.2 %) than in the SOJ (70.8 %), FEVM (70.0 %) and FEVT (73.3 %) diets. The daily growth rate of rabbits fed the FEV diet (38.9 g / d) was lower than that in the other groups (40.7 to 44.5 g / d) but their feed conversion ratio was similar. The diet did not affect dressing percentage (mean : 57 %) or the relative weight of the skin and of the full gastrointestinal tract. However, it did affect several carcass composition parameters : the muscle to bone ratio was highest under the FEVM diet (5.29) and lowest under the FEV diet (4.34) and relative liver weight was lowest under FEVT and highest under FEVF. Finally, there was no difference in the sensory quality of meat between SOJ and FEVF diets. In conclusion, field beans were a good source of proteins for rabbits that could totally replace soybean meal but did require supplementation with sulfur amino acids (*dl* methionine or another plant source) in order for performance to be adequate.

RÉSUMÉ : Valorisation de la féverole par le lapin en croissance. 1 - Effet de complémentations destinées à améliorer l'apport d'acides aminés soufrés.
Cent lapins de race Néo Zélandaise Blanche, répartis en 5 lots ont été engraissés entre 35 et 77 j , en cages individuelles, avec l'un des aliments expérimentaux SOJ (témoin soja), FEV (féverole 26,5 %), FEVM (aliment FEV supplémenté en dl méthionine), FEVF (aliment FEV supplémenté en féverole jusqu'à un total de 37 %) ou FEVT (aliment FEV supplémenté en tourteau de tournesol), distribués à volonté. La teneur moyenne en protéines étaient de 14,5 % pour les aliments SOJ, FEV et FEVM et de 16,3 % pour les aliments FEVF et FEVT. La teneur en énergie digestible variait peu entre aliments (2256 à 2324 kcal ED / kg). La teneur commune en cellulose était de 14,5 %. Le coefficient de digestibilité apparente (CUDa) de la matière sèche était comparable pour les 5 aliments (58,9 à 60,3 %). Le CUDa de l'azote de l'aliment FEVF (66,2 %) était plus faible que celui des aliments SOJ (70,9 %), FEVM (70,0 %) et FEVT (73,3 %). Les lapins ayant reçu l'aliment FEV ont eu une vitesse de croissance (38,9 g / j) inférieure à celle des lapins des autres lots (40,7 à 44,5 g / j), mais un indice de consommation équivalent. Le régime alimentaire n'a pas influencé le rendement à l'abattage (57 % en moyenne), les poids relatifs de la peau et du tractus digestif plein; mais il a influencé certains critères de composition de la carcasse : le rapport muscle/ os d'un membre postérieur, plus élevé dans le lot FEVM (5,29) et plus faible dans le lot FEV (4,34), le poids relatif du foie, plus faible dans le lot FEVT et plus élevé dans le lot FEVF. Enfin, les régimes alimentaires SOJ et FEVF n'ont pas eu d'effets différentiels sur la qualité organoleptique de la viande. Il a été conclu que la féverole était une bonne source de protéines pour le lapin, qui pouvait remplacer totalememt le tourteau de soja, mais que sa supplémentation en acides aminés soufrés (dl méthionine ou autre source végétale) était nécessaire pour assurer de bonnes performances.

INTRODUCTION

Field beans could replace virtually all imported soybean meal used for feeding rabbits. This protein-rich legume has a crude protein content as high as 25 to 30 %. Investigations by COLIN and LEBAS (1976), LEBAS (1981), SEROUX (1984) and JOHNSTON *et al.* (1989) all indicated that rabbits can use field beans efficiently without pre-treatment, unlike poultry and pigs, which are sensitive to anti-nutritional factors (LEUILLET, 1978; LACASSAGNE, 1988). However, the level of incorporation of this protein-rich legume into rabbit feed has not been studied since the aim of initial investigations was to estimate the overall usability of field beans by supplementing the experimental diets with pure *dl* methionine. BERCHICHE and LEBAS (1994) showed that field beans proteins had to be supplemented with sulfur amino acids (SAA).

The aim of this study is to compare three ways of increasing the SAA supply : supplementing with

dl methionine or increasing the protein content, either with field beans or with another SAA–rich source of proteins. In addition to the standard production performance parameters, i.e. growth and feed efficiency, the slaughter value and meat quality were also taken into consideration.

MATERIALS AND METHODS

Animals and rearing conditions

One hundred New Zealand White rabbits of both sexes, that had been weaned one week previously and were 35 days old were distributed into 5 equivalent groups with respect to live weight and litter origin. They were then kept in individual wire cages located within the same rearing cell at the Station de Recherches Cunicoles at the INRA Research Centre in Toulouse. They were fed the experimental diets *ad libitum* up to the age of 77 days.

Experimental diets

Diets were formulated so that the basal diets (SOJ and FEV) contained a moderate amount of crude protein, i.e. about 14.5 % (Table 1). The crude fibre content of all five diets met the requirements of growing rabbits (LEBAS, 1989).

– SOJ diet : 45 % of the proteins were provided by soybean meal. This diet was the control diet. The calculated SAA content was 0.55 %.

– FEV diet : In this diet, field beans (Ascott variety) containing 24.4 % crude protein substituted all soybean meal. This diet was not supplemented with methionine. As a result, its SAA content (around 0.43 %) was close to the lower limit of requirements as defined by CHEEKE (1971), ADAMSON and FISHER (1973) and COLIN (1978). This diet was also used as a control for the following diets.

– FEVM diet : Formulation was similar to the FEV diet, but was supplemented with methionine so as to increase the SAA content up to 0.55 %, i.e. the same value as in the SOJ diet.

– FEVF diet : The basal diet was similar to that of FEV but the field beans content was increased to improve the SAA supply by increasing the protein content (+2 %). The total field beans content of the FEVF diet (37 %) was near the maximum level of incorporation tested previously (BERCHICHE, 1985). However, because field beans contain only little SAA (2 %) (INRA, 1989), the SAA content of the FEVF diet was small (0.46 %).

– FEVT diet : The base diet was also similar to that of FEV. Sunflower meal, which has a higher SAA content than field beans (4.3 % of the proteins *vs*

Table 1 : Constituents of the experimental diets

	SOJ	FEV	FEVM	FEVF	FEVT
Constituents (%)					
Soybean meal	15	–	–	–	–
Field beans	–	26.5	26.5	37	20
Lucerne	15	25	25	25	20
Barley	29	16.5	16.5	08	17
Oats	12	10	10	10	10
Wheat bran	10	11	11	11	11
Sunflower meal	–	–	–	–	14
Wheat straw	16	8	8	8	8
Minerals and vitamins	2.93	3	3	3	3
dl methionine	0.07	–	0.12	–	–
Composition (% as fed)					
Dry matter	88.3	89.3	89.4	88.0	88.2
Crude protein	14.6	14.3	14.4	16.2	16.5
Crude fibre	14.3	14.7	14.7	14.1	14.8
Crude energy (kcal / kg)	3850	3859	3863	3809	3868
Calculated AA (% as fed)					
SAA	0.55	0.43	0.55	0.46	0.55
Lysine	0.69	0.71	0.71	0.83	0.73
Threonine	0.51	0.50	0.50	0.56	0.56

2.0 %), was added in order to increase the SAA content to the same value as in the SOJ control diet. Incorporation of sunflower meal markedly increased the protein content, similarly to the FEVF diet.

Recorded variables

Nutrients digestibility.

The apparent digestibility coefficients (ADC) of dry matter, total crude protein, crude fibre and energy in each of the diets was measured *in vivo* in six 35 d old rabbits after a 12 d adaptation period (COLIN and LEBAS, 1976).

Production performance.

Live weight and voluntary feed intake of the rabbits were measured every week during the six weeks of the fattening period. The following variables were calculated from these values : average daily gain (ADG), feed conversion ratio, energy efficiency, protein efficiency from 35 d to 77 d of age.

Slaughter traits.

All rabbits were slaughtered at the end of the fattening period (77 days). Slaughter and carcass traits were recorded as recommended in BLASCO, OUHAYOUN and MASOERO (1993). The following were weighed : skin, full gastrointestinal tract, hot carcass and commercial carcass after chilling for 24 h at +2°C. Dressing percentage was calculated from commercial carcass values in each dietary group. Further values were recorded in 10 representative rabbits, according to their live weight : liver weight, perirenal fat weight, hind leg weight. The hind leg was separated into meat and bone components by cooking, following the technique described in OUHAYOUN and CHERIET (1983).

Organoleptic quality of the meat.

The meat of rabbits fed the SOJ diet (control) was compared to that of rabbits fed the FEVF diet, which contained the highest amount of field beans (37 %), according to the triangular test NF V 09–013 (AFNOR, 1984) (equivalent to ISO 4120). Twelve sets of three pieces of loin (part of the trunk between the 3rd and 7th lumbar vertebrae) weighing about 50 g each contained one piece of loin from a SOJ carcass and two pieces from FEVF carcasses. Each piece was cooked separately, in glass jars with no added ingredients, for 90 min in an oven at 200°C. Each set of three pieces of loin was served to one of the twelve assessors of a panel asked to identify which piece differed from the others (i.e. the SOJ meat) and to describe its main sensory properties, using the questionnaire of TOURAILLE (1977). The results from this triangular test were interpreted following the method of BENGTSSON and HELM (1952).

Statistical analysis

The variables describing production performance and slaughter traits of the rabbits were analysed using analysis of variance (diet factor), with or without introducing as a covariable the initial live weight (35 d) or the final live weight (77 d) (SAS/ Stat., 1990).

RESULTS

Nutritional characteristics of the diets (Table 2)

The dry matter apparent digestibility coefficients (ADC) (between 58.5 and 60.3 %) did not differ significantly between diets. The energy ADC (58.6 to 60.1 %) did not differ either, and consequently, neither did the digestible energy content (2256 to 2324 kcal DE / kg). The cellulose ADC was comprised between 8.5 and 10.1 %. The protein ADC of the SOJ diet was

Table 2 : Nutritional characteristics of the experimental diets.

	SOJ	FEV	FEVM	FEVF	FEVT	F(1)
Apparent digestibility coefficients (%)						
Dry matter	58.5	59.7	60.3	58.6	59.3	NS
Crude protein	70.9ab	68.9b	70.0b	66.2a	73.3c	*
Energy	58.6	59.3	60.1	59.0	59.8	NS
Crude fibre	8.5	10.5	10.8	09.9	09.8	–
Digestible Energy (kcal / kg)	2256	2288	2324	2245	2312	–
Digestible Proteins (g / 100 g)	10.3	09.8	10.1	10.4	12.1	–
DP / DE (g / 1000 kcal)	45.7	42.3	43.5	46.3	52.3	–

(1) NS : not significant (P > 0.05); * : significant (0.01 < P < 0.05); different letters on the same line indicate that means differ significantly (P < 0.05).

Table 3 : Weight at specific ages (g), daily intake and daily gain (g / d). Mean values adjusted so that initial live weight was 772 g.

	SOJ	FEV	FEVM	FEVF	FEVT	σ_r	F(1)
Weight 35 d	790	778	765	773	753	137.9	NS
Weight 77 d	2518ab	2368b	2526ab	2441ab	2595a	208	*
Intake 35–77 d	42.6ab	38.9b	42.8ab	40.7ab	44.5a	5.0	*
ADG 35–77 d	128.1	118.2	125.8	123.6	129.7	12.6	NS
FCR 35–77 d	3.02	3.05	2.95	3.05	2.92	0.22	NS

(1) NS : not significant ($P > 0.05$); * : significant ($0.01 < P < 0.05$); s_r : standard error of residues; different letters on the same line indicate that means differ significantly ($P < 0.05$).

equal to the mean value of that of the field beans diets (70.8 %). The protein ADC of the latter increase in the following order : FEVF (field beans base + field beans), FEV (field beans base) and FEVM (field beans base + methionine), FEVT (field beans base + sunflower). As a result, the digestible protein content was the same in the SOJ, FEV, FEVM and FEVF diets (9.8 to 10.4 g digestible proteins / 100 g), but was higher in the FEVT diet (12.1 g DP / 100 g). The DP / DE ratio of the FEVT diet (52.3 g DP per 1000 kcal DE) was higher than in any other diet, including the FEV (field beans base) and FEVM (field beans base + methionine) diets (42 and 43.5 g DP per 1000 kcal DE, respectively).

Production performance of the rabbits (Table 3)

The effects of dietary treatment on feed intake and weight gain of the rabbits were studied under constant initial (35 d) weight (covariance analysis). The average feed intake of the whole fattening period (35 to 77 days) over all diets was 124.9 g / d. It did not vary between treatments, although intake of the FEV diet was slightly lower. The growth rate of rabbits fed the SOJ diet (42.6 g / d) was close to that of rabbits fed the field beans based diets (41.7 g / day, on average). The extreme values among the latter were obtained with the FEV and FEVT diets (38.9 vs 44.5 g / d).

Feed efficiency (Table 4)

The mean feed conversion ratio over all diets was 2.99. This value was not significantly affected by the diet. The energy efficiency (6.8 kcal DE per g gained) and the protein efficiency (0.31 g DP per g gained) were not affected either. However, there was a tendency for protein spoilage in the FEVT diet : its protein efficiency was 0.34 g DP per g gained, whereas it was only 0.30 to 0.31 in the SOJ, FEV and FEVM diets.

Slaughter value (Table 5)

The effects of dietary treatment were studied under constant final (77 d) live weight (covariance analysis). The mean commercial yield over all diets (57 %) was similar to values found in the literature using the same definition and measured under the same conditions (OUHAYOUN, 1989). The dietary treatment affected neither commercial yield, nor any of its components : full gastrointestinal tract weight, skin weight, hot carcass weight and commercial carcass weight. As regards to carcass composition, the diet only affected the meat to bone ratio of the hind leg and liver weight. The meat to bone ratio was the same under the SOJ diet (4.84) and the four field beans based diets (mean : 4.79). Among the latter, this ratio was smallest under the FEV diet (4.34) and was increased when the diet was supplemented, especially with pure methionine (FEVM diet) (5.29). Liver weight ranged between 96 g (FEVT diet) and 123 g (FEVF diet).

Meat quality

The meat of rabbits fed the FEVF diet, which

Table 4 : Feed efficiency of rabbits (calculations based on mean values for growth and digestibility)

	SOJ	FEV	FEVM	FEVF	FEVT
Energy efficiency (kcal DE / g gained)	6,78	6,95	6,83	6,82	6,74
Protein efficiency (g DP / g gained)	0,31	0,30	0,30	0,32	0,34

Table 5 : Slaughter performance and carcass composition. Weights (g) adjusted so that slaughtering weight is 2486 g

	SOJ	FEV	FEVM	FEVF	FEVT	σ_r	F(1)
Skin	344	341	348	349	357	29	NS
Full gastrointestinal tract	453	468	458	464	446	38	NS
Hot carcass	1550	1553	1540	1539	1558	41	NS
Commercial carcass	1424	1406	1411	1445	1445	49	NS
Dressing percentage (%)	*57.2*	*56.5*	*56.8*	*56.4*	*58.0*	–	–
Hind leg							
Total	186.7	184.7	191.9	192.3	199.4	13.3	NS
Meat	154.5	150.0	160.9	157.3	166.2	12.2	NS
Bone	32.2	34.7	31.0	35.0	33.2	3.61	NS
Meat/Bone ratio	4.84ab	4.34a	5.29b	4.50ab	5.02b	0.66	*
Perirenal fat	25.4	27.3	28.0	27.0	27.7	6.5	NS
Liver	114ab	116ab	105ab	123a	96b	19	*

(1) NS : not significant ($P > 0.05$); * : significant ($0.01 < P < 0.05$); s_r : standard error of residues; different letters on the same line indicate that means differ significantly ($P < 0.05$).

had the highest field beans content, lost significantly ($P < 0.05$) more water during cooking than that of rabbits fed the SOJ diet (29.9 *vs* 26.6 %). However, the differences in cooking losses did not coincide with significant qualitative differences. Only four of the 12 members of the panel could discriminate the meat of rabbits fed the SOJ or FEVF diet.

DISCUSSION

Supplementing the FEV diet, a field beans based diet, with methionine tended to increase the growth rate of rabbits, in good accordande with previous results (BERCHICHE and LEBAS, 1994). It also improved the meat to bone ratio of the hind leg, which is a good indicator of the meat to bone ratio for the whole carcass (VAREWYCK and BOUQUET, 1982).That is a new result.

Increasing the field beans content of the diet, another attempt at increasing the SAA content of the original field beans based FEV diet, had no positive effects : the SAA content of the FEVF diet was only slightly higher (0.46 vs 0.43 %), growth rate was not improved and protein digestibility was much lower. This drop in protein digestibility was probably not related to the high field beans content of the FEVF diet : digestibility values around 80 % were measured in diets with a field beans content of 36 % (BERCHICHE, 1985). It was probably due to the fact that field beans had been substituted at the expense of barley, a cereal whose proteins are digested more easily (BERCHICHE, 1985). Finally, the high field beans content of the FEVF diet did not lead to any qualitative difference in meat compared to that of rabbits fed the soybean-based SOJ diet.

A sunflower meal supplementation for increasing the SAA content of the FEV diet, the third method tested, improved performance : under the FEVT diet, the protein digestibility was higher and the meat to bone ratio of the hind leg was comparable to that obtained under the FEVM diet (field beans base + methionine supplementation). On the other hand, protein efficiency was worse.

On the whole, all three ways of supplementing the field beans based FEV diet provided a satisfactory growth rate (42.6 g / d) that was better than in the studies by BERCHICHE and LEBAS (1994) and similar to the results obtained by SEROUX (1984) with similar diets, although their crude protein content was somewhat higher (17–18 %). The protein and energy efficiencies of the supplemented diets were of a high standard, corresponding to a good feed efficiency. On the other hand, digestibility of the dietary constituents was very average, as in the studies by BERCHICHE and LEBAS (1994).

CONCLUSION

This study specifies how field beans can benefit the diet of growing rabbits. This protein–rich legume can be used in diets with a moderate protein content.

Among three possible ways for supplementing the field beans with SAA, supplementation with sunflower was the most beneficial in terms of zootechnical performance : sunflower meal simultaneously increases the dietary protein content and improves the protein balance thus improving the biological value of the diet. Supplementing the field beans based diet with *dl* methionine somewhat improved growth performance. The advantage of this method is that less nitrogen is rejected into the environment. Finally, supplementing the base diet with more field beans, which did not rectify the protein balance and hence did not improve the performance of growing rabbits, cannot be recommended.

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