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Research article

The optimal rate of soybean (*Glycine max)* pods in rabbit (*Oryctolagus cuniculus*) feed: digestibility study and growth performances

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Abstract

A study was undertaken to determine the optimal rate of soybean pods in the growing rabbit feed. Soybean pods were incorporated in balanced feed at 0, 5, 10 and 15% to evaluate the digestibility of diets and its effect on the bioeconomic performances of growing rabbits. A total of 80 young rabbits of 42 to 49 days-old and weighting on average 605g to 611g were kept during 8 weeks. The experimental design was a randomized complete block with 4 treatments and 5 replications of 4 rabbits each. The results showed that the average body live weight (1290g) and daily weight gain (12g) of rabbits fed the control diet (F0) were significantly lower ($P<0.05$) than those of rabbits fed F5 (1843g; 22g) and F10 (1848g; 22g). However, no significant difference ($P>0.05$) was found between the average body weight and the average daily gain of rabbits fed F0 and F15 (1612g; 18g). Feed intake of rabbits fed F0 (42g) was significantly lower ($P<0.05$) than that fed F5 (67g), F10 (70g) and F15 (65g). The feed conversion ratio was similar ($P>0.05$) in F0 (4.75), F5 (3.00), F10 (3.18) and F15 (3.83). The mortality rate was also similar ($P>0.05$) in F0 (25%), F5 (20%), F10 (25%) and F15 (25%). At the end of the growth period, 6 rabbits per treatment were sampled for a digestibility study. The apparent digestibility of the dry matter and organic matter in F5, F10 and F15 was lower ($P>0.05$) than in F0. The digestibility of crude protein was also lower ($P>0.05$) in F0 (63.20%) than in F5 (67.55%), F10 (72.23%) and F15 (66.94%). Economically, no significant difference ($P>0.05$) was noticed concerning the feeding cost and the economic feed efficiency. Furthermore, F5 and F10 diet improved these economic variables compared to F0 and F15. Thus, up to 10% of soybean pods can be used efficiently in the growing rabbit feed.

Keywords: Digestibility; feed; growth; rabbit; soybean pod

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Introduction

Protein malnutrition is a major problem in developing countries (Oluyemi and Robert, 2007) which can be solved by increasing the meat production. Small and prolific animal species (both by practice and by the investment cost) such as rabbit constitute a mean to compensate the deficiency of meat in developing countries (Djago and Kpodekon, 2007). One of the critical factors of success in rabbit breeding is the modification of diet that represents 60-67% of the production cost (Branckaert et al., 2000; Djago and Kpodekon, 2007). Fibers are one of the main components of a rabbit's diet; because they play a key

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role in rabbit feeding by contributing to caecum activity for efficient digestion (Gidenne, 1992). Unfortunately, the forages which constitute main sources of fiber is low in peri-urban areas, and farmers have difficulty to provide rabbits with suitable grasses (Houndonougbo et al., 2012); thus they use cheap and available by-products such as palm kernel fiber to reduce the feed cost. Soybean pods are left after removing soya beans are available in sufficient quantity in Benin. According to Badou (2013) soybean residues are either burned or cleared out of the plot during the harvest period. They may serve as another source of fiber and nutrients in the rabbit's diet. The purpose of this study was to evaluate the nutritional quality of soybean (*Glycine max*) pods in weaned growing rabbits' diet by determining its optimal rate in balanced feed.

Materials and Methods

Growth performance study

A total of 80 local weaned rabbits, aged 42-49 days were divided into 4 groups of 20 rabbits each. Each group was divided into 5 repetitions of 4 rabbits each. At the beginning of the experiment, the average weight of rabbits was between 605 and 610 g ± 2.5 g. The rabbits in each repetition were housed in cages ($75\times45\times33cm^3$). These cages were arranged in "FLAT-DECK" at 1m above the ground. Four experimental feeds were used containing 0% (F0, control diet), 5% (F5), 10% (F10), and 15% (F15) of soybean pods (Table 1). They had similar digestible energy and crude proteins (Table 1). During the test, feed and water were delivered *ad-libitum* and refusals were weighed weekly. The rabbits were weighed at the start (day 0) and at the end of each of the 8 experimental weeks. Mortalities were recorded if any.

Digestibility study

A total of 24 rabbits of 3 months-old were divided into 4 dietary groups of 6 rabbits each and housed in individual cages. An experimental design was set up for total faeces collection. Rabbits were fasted for 24 hours to empty their digestive tract. During fasting, water and vitamin was delivered as anti-stress. Daily, 100 g of feed and 500 ml of water were given to each rabbit. Refusals and faeces were weighed daily per rabbit during 5 days. The data were used to calculate apparent digestibility coefficient of dry matter (dDM), organic matter (dOM) and crude protein (dCP) according to following equations:

$$dDM\ (\%) = \frac{DM\ intake - DM\ excreted\ in\ faeces}{DM\ intake} X100$$

$$dOM\ (\%) = \frac{OM\ intake - OM\ excreted\ in\ faeces}{OM\ intake} X100$$

$$dCP\ (\%) = \frac{CP\ intake - CP\ excreted\ in\ faeces}{CP\ intake} X100$$

Table 1: Composition in ingredients and prices of growing rabbits feeds as formulated and fed

Ingredients (%)	F0	F5	F10	F15
Maize	22	31	31	34
Wheat bran	28	15	10	3
Soybean meal	9	12	14	17
Cotton meal	7	7	7	7
Palm-kernel meal	30	27	25	21
Oyster shell	3	1.7	1.7	1.7
Lysine	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1
Bi-calcium Phosphate	1	1	1	1
Salt (NaCl)	0.3	0.3	0.3	0.3
Premix[1]	0.2	0	0	0
Iron Sulphate	0.1	0.02	0.02	0.02
Soybean pod	0	5	10	15
Total	100.8	100.2	100.2	100.2
Feed price (FCFA/kg)[2]	213.7	210.8	210.8	210.8
Chemical components				
Dry matter (%)	89.1	88.6	88.8	89.0
Total crude fibre (%)	9.25	9.94	11.27	12.25
Crude fat (%)	7.46	7.07	6.80	6.28
Digestible energy (kcal/kg DM)	2643	2667	2568	2502
Crude proteins (%)	17.57	17.24	17.08	17.00
Lysine (%)	0.82	1.20	1.59	1.98
Methionine (%)	0.38	0.38	0.38	0.38
Methionine + cystine (%)	0.71	0.70	0.69	0.69
Calcium (%)	0.93	0.78	0.72	0.64
Phosphate (%)	0.16	0.14	0.14	0.14
Sodium (%)	1.62	1.26	1.36	1.53

[1]Premix contained per kg - Vitamins: A 4000000 UI, D3 800000 UI, E 2000 mg, K 800 mg, B1 600 mg, B2 2000 mg, niacin 3600 mg, B6 1200 mg, B12 4mg, choline chloride 80000 mg; Minerals: Cu 8000 mg, Mn 64000 mg, Zn 40 000 mg, Fe 32000 mg, and Se 160 mg ; [2]Republic of Benin Currency: 1€ = 655.9 FCFA; [3]Soybean pod

Chemical analyses

Chemical analyses were carried out on soybean pods, feed and faeces. Dry matter (24h at 105°C), ash (6h at 550°C) and nitrogen (N by Kjeldahl method) were determined and crud protein (CP) was estimated as following: CP = N×6.25.

Statistical analysis

Statistically, data were analyzed using General Linear Model (GLM) in SAS version 9.2. The performances of rabbits were compared using each cage of four rabbits as repetition. Thus, analyses were performed according to the following model:

$$Yi = \mu + F_i + \varepsilon_i,$$

Where, Yi is the observation for dependent variables; μ is the general mean; F_i is the fixed effect of the feed; ε_i is the residual error.

Mean values were presented in tables with the standard error of the mean (SEM). The significant effect of feed on variables were reported when P-value <0.05.

Results

Feed intake of growing rabbits

During the experimental period, the average daily feed intake (DFI) of rabbits (Fig. 1) fed with the control diet F0 (42.15g) was significantly lower (P<0.05) than that of rabbits fed F5 (66.46g), F10 (69.48g), and F15 (65.44g). The DFI of rabbits fed F5, F10, and F15 were similar (P>0.05). Rabbits fed F10 had highest DFI. These results demonstrate a significant effect of soybean pods on rabbits' feed intake.

Digestibility of diets

Incorporation of soybean pod in feed had no significant effect (P>0.05) on the digestibility of dry matter (dDM), organic matter (dOM) and crude protein (dCP) (Table 2). However, the dDM and dOM were higher in F0 than in all the three soybean pod based diets and opposite for the digestibility of crud protein (dCP).

Growth performance and feed efficiency

The daily weight gain (Table 3) and the live body weights (Figure 2) of rabbit fed F0 were significantly lower (P<0.05) than those of F10 and F5 but similar to that in F15. The feed conversion ratio, the mortality rate, feeding costs, the economic feed efficiency were similar (P>0.05) between dietary treatments. The lowest feed conversion ratio and feeding cost (Table 3) were recorded in rabbits fed F10 and F5 diets; consequently, the highest economic feed efficiency was recorded in these dietary treatments.

Discussion

The intake of feed containing soybean pods is significantly higher than that of the control diet. Soybean pod improved therefore the feed intake in growing rabbits. These results confirmed the findings of Gidenne (2000) according to which the fibers improved the feed intake of rabbits. Houndonougbo et al. (2012) evaluated the optimal rate of palm-press fibres in growing rabbits' diet and they found an increased feed intake in rabbits fed with palm press fibres-based diets. This study confirmed a positive correlation between the feed intake and the level of soybean pod up to 10% in rabbit diet. Above that level the feed intake decreased as in F15.

The results obtained in dDM and dOM show that the incorporation of soybean pods in feed did not significantly change the level of digestibility in rabbit. These results are in accordance with those of Cunha and Freire (1993) who reported a non-significant difference between in dDM and dOM between the control diet and experimental diets containing 20% and 40% of *Vicia benghalensis* seed.

The improvement of dCP in soybean pods based diets indicates the good capacity of rabbits to digest the feedstuff with the help of their micro-flora. Lakabi et al. (2008) also obtained the same results when studying the complete replacement of barley and soybean meal with hard wheat by-products.

The average live body weight and daily weight gain of rabbits fed F0 was significantly lower than in F5 and F10 where rabbits had the best final live body weights at the end of the experiment. This could be related to lower feed intake. Aboh et al. (2012) also recorded the same trend when using pellets *of Moringa Oleifera* leaves. The average live body weight in their control diet (0% of *Moringa Oleifera* leaves), 1956g, was significantly lower than those with 10% (2166g) and 15% (2222g) of *Moringa Oleifera* leaves. According to Gidenne and Lebas (2002), a high-fiber diet leads to energy dilution in the feed. Thus, rabbits increase the intake of soybean pod based diets to meet

Table 2: Digestibility of dry matter, organic matter and crude protein

Parameters	Treatments				SEM	P
	F0	F5	F10	F15		
dDM (%)	85.99	79.79	80.47	77.62	2.62	0.179
dOM (%)	86.07	79.90	80.57	77.74	2.61	0.179
dCP (%)	63.20	67.55	72.23	66.94	4.86	0.637

dDM: digestibility of dry matter, dOM: digestibility of organic matter, dCP: digestibility of crude protein SEM: Standard error of mean, P: probability

Table 3: Daily weight gain (g), feed conversion ratio (g feed/g BWG[1]), feeding cost (FCFA[2]feed/kg BWG), and economic feed efficiency (FCFA BWG/FCFA feed) of rabbits fed soy bean pods based diets

Parameters	Treatments				SEM[3]	P[4]
	F0	F5	F10	F15		
Daily weight gain	12.12[a]	22.02[b]	22.19[b]	17.97[ab]	1.67	0.002
Feed conversion ratio	3,75	3,00	3,18	3,83	0,43	0,460
Feed cost	809,42	634,92	671,12	808,31	92,85	0,430
Economic feed efficiency	2,33	2,67	2,63	2,22	0,27	0,575

[1]Body Weight Gain, [2]Currency: 1€ = 655.9, [ab]Means with unlike superscripts in the same row differ significantly (P<0.05), [3]Standard error of mean, [4]P: probability.

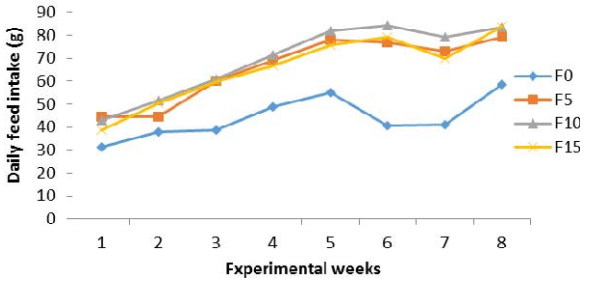

Fig. 1: Average daily feed intake of growing rabbits fed soybean pods based diets

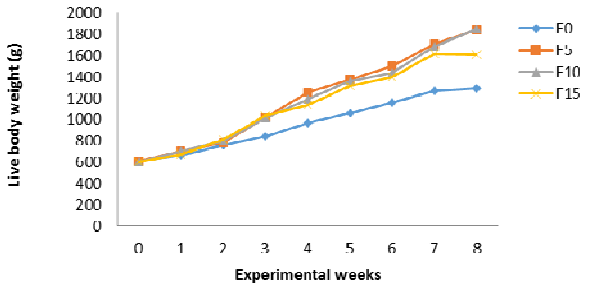

Fig. 2: Growth curves of rabbits fed soybean pods based diets

their energy requirement, resulting in a light decrease of feed conversion ratio in F5 and F10. The rate of 10% can be used at the optimum rate of soybean pod in the growing rabbit feed. Consequently, 15% of soybean pods are too high in their feed. The daily weight gain (DWG) obtained with rabbits fed F5 and F10 are slightly higher than 15.9g and 19.7g obtained by Kpodekon et al. (2010), but similar to 21.2 to 23.3 g obtained by Akoutey and Kpodekon (2012) when using *Pueraria phaseoloides* flour in rabbit diet. Compared to the first months, the feed conversion ratio increased in the second month. This confirms the findings of Lebas et al. (1996) and Lebas (2000) according to whom the feed conversion increases with age of rabbit.

The low feed cost in F5 and F10 were in agreement with that reported by Houndonougbo et al. (2012) when they used palm fibre in rabbit diet. These authors explained the difference by the low cost of palm fibres. It appears that the rearing of weaning rabbit is more beneficial for farmer with 5% to 10% of soybean pods in their feed. This is confirmed by the best values of economic feed efficiency recorded in F5 and F10. The results are in agreement with the improvement in feed efficiency obtained with 5% of palm press fiber based diet by Houndonougbo et al. (2012).

Conclusion

This study demonstrated that 5-10% of soybean pods can be incorporated efficiently in the growing rabbit feed.

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