PERFORMANCE AND ORGAN WEIGHTS OF GROWING RABBITS FED DIETS WITH EXTRUDED BROKEN BEAN AT VARIOUS LEVELS

Santinoni, J.T.[1], Miranda, V.M.M.C.[1], Angelo, S.S.[1], Souza J.H.A.[1], Ribeiro L.B.[1], Castilha L.D.[1]*

[1]Dept. of Animal Science, Maringá State University, Colombo Avenue, 5790, 87.020-900, Maringá, Brazil
*Corresponding author: ldcastilha@uem.br

ABSTRACT

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 from 31 to 70 days of age 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%.

Keywords: Alternative feed, protein ingredient, rabbit production.

INTRODUCTION

One of the great challenges to increase the intake of rabbit meat in Brazil is to exceed Brazilian cultural habits, added to the little supply of rabbit meat, that increases the production cost and promotes market restriction (Ferreira *et al.*, 2012). There is a continuing interest in the search for alternative foods that can reduce the cost of feed, however, without compromising the performance (Furlan *et al.*, 2004). According to Furlan *et al.* (1997), soybean meal is the main protein food used in Brazil and in some other countries in diets for non-ruminants. However, the demand for alternative foods must meet the requirements without affecting performance. In this context, broken common beans (*Phaseolus vulgaris*) can be used as an alternative to substitute soybean meal, but it can influence the performance of these animals since it contains antinutritional factors such as protease inhibitors and hemagglutinins, which can decrease the nutritional use of the feed and cause health disorders (Lajoto *et al.*, 1996). However, the processing of beans by extrusion can reduce the deleterious effects of antinutritional factors, enabling their use in non-ruminant animal feed, as these factors are thermolabile and can be denatured during extrusion (Anton *et a*l., 2009), process that associates high temperatures, pressure and humidity. The objective with this study was to evaluate different levels of inclusion of Extruded Broken Bean (EBB) in rabbits diets on performance, economic viability, organ weights and plasma urea.

MATERIALS AND METHODS

Animals, diets and experimental design

The experiment was carried out in the Rabbit Breeding Sector of State University of Maringá, located in Paraná State, Brazil (23°21'S, 52°04'W and altitude of 564 m). The entire experimental procedure

was previously approved by the Committee of Ethical Conduct for Experimental Animal Use (Protocol number 5979130218). Fifty 31-day old New Zealand White rabbits (25 males and 25 females) were distributed, following a completely randomized design, in five treatments, with ten replicates per treatment (5 males and 5 females). Treatments were based on five increasing levels of EBB in diet (0, 5, 10, 15 and 20%), with EBB increase being offset by soybean meal, wheat bran, alfafa hay, star grass hay and corn. Animals were individually housed in metabolism cages with automatic drinking nipples. The experimental diets were formulated based on corn, soybean meal, alfalfa hay, star grass hay, extruded broken bean, wheat bran, amino acids, minerals and vitamins to fulfil the requirements for growing rabbits (De Blas and Mateos, 2010), as expressed in Table 1. After mixing the ingredients, the feed was pelletized using a Commercial Industry Pelletizer (Chavantes™, model 40 HP) with capacity from 800 to 1,700 kg/h, with a 4.5 mm matrix and without addition of steam, at an average temperature of 70 °C (60 to 80°C) for about 50 seconds.

Table 1: Experimental diets for growing rabbits with increasing levels of extruded broken bean (natural matter)

Ingredients	Levels of Extruded Broken Bean (g/kg)				
	0	**5**	**10**	**15**	**20**
Corn	300	279	238	197	155
Soybean Meal	133	122	116	109	102
Wheat Bran	240	232	221	209	198
Star Grass Hay	158	143	161	179	196
Alfafa Hay	150	153	145	137	129
Extruded Broken Bean	0	50	100	150	200
Limestone	7.5	7.7	7.7	7.8	7.8
Salt	4.0	0.40	4.0	4.0	4.0
Dicalcium phosphate	0.2	0	0	0	0
Mineral and vitamin premix[1]	5.0	5.0	5.0	5.0	5.0
DL-Methionine	1.2	1.4	1.7	2.0	2.4
L-Lysine HCl (78.5%)	1.1	0.8	0.3	0	0
Coccidiostatic[2]	0.6	0.6	0.6	0.6	0.6
Chemical composition calculated					
Dry matter (g/kg)	886	896	885	886	886
Crude protein (g/kg)	160	160	160	160	160
Digestible energy (Mcal/kg)	2.5	2.5	2.5	2.5	2.5
Acid detergent fibre (g/kg)	158	152	152	153	154
Neutral detergente fibre (g/kg)	310	310	310	310	310
Calcium (g/kg)	6.0	6.0	6.0	6.0	6.0
Total phosphorus (g/kg)	4.5	4.5	4.5	4.5	4.5
Methionine + Cysteine (g/kg)	6.0	6.0	6.0	6.0	6.0
Lysine (g/kg)	8.0	8.0	8.0	8.0	8.0

[1] Premix provided per Kg of diet: vitamin A, 600,000 IU; vitamin D, 100,000 IU; vitamin E, 8,000 mg; vitamin K3, 200 mg; vit. B1, 400 mg; vitamin B2, 600 mg; vitamin B6, 200 mg; vitamin B12, 2 mg; vitamin B5, 2,000 mg; vitamin B7, 70,000 mg; Fe, 8,000 mg; Cu, 1,200 mg; Co, 200 mg; Mn, 8,600 mg; Zn, 12,000 mg; I, 64 mg; Se, 16 mg; Methionine – 120,000 mg; antioxidant, 20,000 mg; [2] Robenidine, 66 mg.

Broken bean obtaining

The broken bean was purchased at the bean processing industry in Maringá, Paraná State, Brazil, and processed at the extrusion unit in the same city, using an extruder (INBRAMAC, model IMBRA 120), which conditioner outlet temperature (measured with an infrared thermometer) was 75-80ºC, and the extruder jacket was approximately 60ºC (internal temperature between 110 and 130ºC). The water flow was 200 mL/min (12 L/h). The average productivity obtained was 80 kg/h, and after processing the EBB was ground in a 1.2 mm sieve. To characterize the anti-nutritional potential of EBB, urea activity and protein solubility in KOH were determined, according to the methodology of ANFAR (1992). The levels of trypsin inhibitors in the samples of fresh broken beans and EBB were determined analytically at the Food Science and Quality Center, in Campinas, São Paulo State, Brazil.

Growth Performance

Throughout the experimental period (from 31 to 70 days of age), feed and water were provided *ad libitum*. Feed provided, leftovers and 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 calculate feed intake, weight gain and feed conversion. To calculate the production cost of the treatments (in American dollars, U$), the average prices of the inputs from Maringá-Brazil were used. The production cost of diets per kilogram of live weight gain (Yi) was determined, according to Bellaver *et al.* (1985), as follows:
Yi = (Qi x Pi) / Gi, where:

Yi = feed cost per kilogram of live weight gain for the i-th treatment;
Pi= price per kilogram of feed used for the i-th treatment;
Qi= amount of feed intake for the i-th treatment;
Gi= weight gain for the i-th treatment;

Organ Weights

At the end of the experimental period, the animals were subjected to a 6-hour fast for slaughter, which started with stunning in the occipital region and subsequent bleeding, followed by skinning and evisceration. The absolute weights of edible organs (Heart, Liver and Kidneys) were recorded, as well as their relative weights, calculated in relation to the weight of the entire carcass.

Statistical analysis

The UNIVARIATE procedure was applied to evaluate the presence of outliers. The normality of experimental errors and the homogeneity of variances between treatments for the various variables were previously evaluated using the Shapiro-Wilk and Levene tests (SAS, 2010), respectively. Analysis of variance (ANOVA) was performed using the procedure General Linear Models of the statistical software SAS (SAS Inst. Inc., Cary, NC, USA). For performance variables, the initial weight was used as a covariate. The degrees of freedom regarding the extrude broken bean increased levels in the diets were split into orthogonal polynomials to obtain the regression equations, according to the best fit. For all analyses, a significance level (P) of 0.05 was adopted.

RESULTS AND DISCUSSION

The analyzes performed for the anti-nutritional characterization of EBB (Table 2) resulted in values within the recommended parameters for similar foods, such as soybean meal. In general, the urea activity index was within the range recommended by ANFAR (1992), between 0.05 and 0.30 pH units.

Table 2: Anti-nutritional characterization of fresh and extruded beans.

Variables	Fresh	Extruded
Urea activity index – (Δ pH)	1.98	0.24
Protein solubility in KOH 0.02% – (%)	88.0	68.0
Trypsin inhibitors – (ITU/mg)	4.95	0.72

The protein solubility in KOH 0.02% was 68%, being slightly below that proposed by Mendes *et al.* (2004) for soybeans, which vary between 70 and 85%, with values below 70% indicating overheating and above 85% refer to subprocessed soy. It assesses the degree of thermal processing and indicates the percentage of protein available for absorption by the animal. Regarding trypsin inhibitors, the values obtained for EBB denote that the extrusion process was effective in reducing the average content of this anti-nutritional factor, which was 4.95 ITU/mg in unprocessed beans, whereas after extrusion this content was 0.72 ITU/mg, which corresponds to a reduction of 89.05%. Although trypsin inhibitors are thermolabile compounds, the temperature, humidity and pressure provided by the extruder were not efficient enough for the total inactivation of the inhibitors present in beans.

For rabbits fed diets containing increasing levels of EBB (Table 3), performance variables did not differ among the levels (P> 0.05). Only the production cost was 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.

Table 3: Performance of rabbits fed diets containing different levels of Extruded Broken Beans.

Variables	Levels of Extruded Broken Beans (%)					SEM[1]	P-value
	0	5	10	15	20		
31 to 50 days of age							
Initial weight (g)	934	923	973	881	893	7.7	-
Final weight (g)	1790	1743	1870	1724	1768	14.9	0.857
Weight gain (g/d)	42.8	41.0	44.9	42.1	42.9	0.7	0.785
Feed intake (g/d)	94.2	90.2	98.2	87.0	98.1	1.7	0.742
Feed conversion	2.22	2.21	2.20	2.17	2.29	0.04	0.995
Production cost (U$/kg gained)[2]	0.36	0.38	0.39	0.39	0.44	0.05	0.033
31 to 70 days of age							
Initial weight (g)	934	923	973	881	893	7.7	-
Final weight (g)	2451	2378	2513	2495	2496	19.5	0.371
Weight gain (g/d)	38.2	36.4	38.5	40.0	39.7	0.49	0.177
Feed intake (g/d)	107	105	111	109	112	1.39	0.237
Feed conversion	2.81	2.88	2.89	2.73	2.83	0.03	0.720
Production cost (U$/kg gained)[3]	0.46	0.49	0.52	0.50	0.54	0.03	0.001

1- Standard error of mean (10 rabbits per treatment).
2- Linear effect (P-value = 0.012): Y= 0.017x + 0.341 (r^2=0.83).
3- Linear effect (P-value = 0.011): Y= 0.020x + 0.436 (r^2=0.78).

There was no effect (P > 0.05) of EBB on relative organ weights or plasma urea of rabbits (Table 4). It can indicate no harmful effects of organs development or nitrogen metabolism in levels evaluated.

Table 4: Relative organ weights and plasma urea of rabbits fed diets containing different levels of Extruded Broken Beans.

Variables	Levels of Extruded Broken Beans (%)					SEM[1]	P-value
	0	5	10	15	20		
Heart (%)	0.62	0.61	0.61	0.59	0.62	0.01	0.784
Liver (%)	5.89	5.15	4.71	5.75	5.62	0.14	0.944
Kidneys (%)	1.12	1.30	1.19	1.16	1.28	0.02	0.713
Plasma Urea (mg/dL)	32.5	31.1	33.2	28.4	29.2	0.7	0.201

1- Standard error of mean (10 rabbits per treatment).

CONCLUSIONS

Inclusion levels up to 20% of EBB in rabbit diets do not change performance and organ weights but increase costs of production up to about 22%.

REFERENCES

Anton A., Fulcher R.G., Arntfield S.D. 2009. Physical and nutritional impact of fortification of corn starch-based extruded snacks with common bean (Phaseolus vulgaris L.) flour: Effects of bean addition and extrusion cooking. *Food Chemistry, 133, 1636-1639.*

Associação Nacional de Fabricantes de Rações – ANFAR. 1992. *Métodos analíticos de controle de alimentos para uso animal. Ministério da Agricultura e Reforma Agrária.*

Bellaver C., Fialho E.T., Protas J.F.S., Gomes P.C. 1985. Radícula de malte na alimentação de suínos em crescimento e terminação. *Pesquisa Agropecuária Brasileira, 20(8), 969-974.*

De Blas C., Mateos G.G. 2020. Feed formulation. In: *Nutrition of the rabbit – 3rd edition. de Blas, C.; Wiseman, J. (Eds). CAB International, UK, p. 368.*

Ferreira W.M., Machado L,C., Jaruche Y,G., Carvalho G.G., Oliveira C.E.A., Souza J.D.S., Caríssimo A.P.G. 2012. *Manual prático de cunicultura.* Bambui.

Furlan A.C., Marcos F.M., Scapinello C., Murakami A.E. 1997. Substituição do farelo de soja por hidrolisado protéico de raspa de couro em rações de coelhos em crescimento. *Revista Unimar, Maringá, 19(3), 905-912.*

Furlan A.C., Monteiro R.T., Scapinello C., Moreira I. Murakami A.E. Martins, E.N. 2004. Avaliação nutricional do triticale extrusado ou não para coelhos em crescimento. *Acta Scientiarum. Animal Sciences., 26 (1), 49- 55.*

Lajoto F.M., Genovese M.I., Menezes E.W. 1996. Qualidade Nutricional. In: *Cultura do feijoeiro comum no Brasil. Piracicaba: Potafós 23-56.*

Mendes, W. S., et al. 2004. Composição química e valor nutritivo da soja crua e submetida a diferentes processamentos térmicos para suínos em crescimento. *Arq. Bras. de Med. Vet. e Zoo.,56, 207-213.*