Evaluation of the performance of female rabbits fed on canola meal in partial and total substitution of crude protein by soybean meal

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ABSTRACT. The effect of partial and total substitution of soybean meal crude protein (SBM) by canola meal (CM) on live weight (LW), daily weight gain (DWG), daily feed intake (DFI) and feed conversion (FC) in female rabbits are provided. Rabbits were evaluated from weaning period (43 days of age) to adult life when they are capable of reproduction (150 days of age). Forty-eight White New Zealand females were used and distributed in four treatments. SBM was substituted at 00%, 33%, 66% and 100% levels by CM. The partial or total substitution of SBM by CM did not change ($P>0.05$) the LW after 70 days old. Dunnett's test showed that, independently of substitution level, FC of animals fed on meal with 33% SBM substitution by CM from age 43 to 90 days and 43 to 150 days was worse than that of animals fed on reference meal. LW120, DWG of 43 – 120-day-old animals receiving 33% SBM substitution by CM and LW150 and DWG of 43 – 150-day-old animals receiving meal with SBM substitution by 33% and 66% of CM were lower than those for animals that received reference meal. Excluding the reference meal, SBM substitution by CM during the periods in which animals were 43 - 120 days old and 43 - 150 days old caused an increase of DFI. Independently of level of inclusion as a substitute for SBM, results show that CM worsened the animals' performance.

Key words: feed conversion, feed intake, rabbits, reproduction.

RESUMO. Avaliação do desempenho de coelhas alimentadas com farelo de canola em substituição parcial ou total ao farelo de soja. Objetivando-se avaliar os efeitos da substiuição parcial e total do farelo de soja pelo farelo de canola sobre o peso, ganho médio diário (GMD), ingestão de alimentos (IA) e conversão alimentar (CA) em coelhas do desmame (43 dias) até a idade de reprodução (150 dias), quarente e oito coelhas da raça Nova Zelândia, foram distribuídas, inteiramente ao acaso, em um experimento com quatro tratamentos e doze repetições. O farelo de soja foi substituído em 00, 33, 66 e 100% pelo farelo de canola. A substituição parcial ou total do farelo de soja não alterarou o peso após os 70 dias de idade. Por meio do uso do teste de Dunnett's, verificou-se que, independentemente do nível de substituição, a CA dos animais que receberam o farelo de canola dos 43 aos 150 dias de idade foi pior em relação às dos animais que receberam farelo de soja. O peso aos 120 dias e GMD, dos 43 aos 120 dias de idade dos animais que receberam 33% de farelo de soja em substituição ao farelo de canola, e o peso aos 150 dias e o GMD, dos 43 aos 150 dias de idade dos animais que receberam farelo de soja nos níveis de 33 e 66% ao farelo de canola, foram menores do que o dos animais que receberam apenas farelo de soja. O farelo de canola incluído das dietas das coelhas no período, compreendido entre os 43 e 120 dias de idade e 43 e 150 dias de idade, foi responsável pelo aumento apenas na IA. O farelo de canola afeta piorando os parâmetros de desempenho de coelhas, independentemente do seu nível de inclusão.

Palavras-chave: conversão alimentar, consumo, coelha, reprodução.

Recently Brazil became a producer country and manufacturer of canola (*Brassica napus* and *Brassica campestris*), an oleogineous plant that has been used as a protein source in animal nutrition and as a substitute for soybean meal because of its lower commercial cost.

Compared to soybean meal, canola meal has less concentration of crude protein and lysine, even though it contains more concentration of cystine and methionine (Aherne *et al.*, 1986, *apud* Matras *et al.,* 1990). Canola meal has a lower rate of digestible energy probability owing to its higher content of

crude fiber and better development of tegument (Bell and Keith, 1987).

With regard to nutrients, canola meal has 70% - 75% of the nutritional value of soybean meal, with 44% of crude protein for fowls and approximately 75% - 80% for swines and ruminants (Baudet *et al.*, 1988). Consequently, the recommendation for rates of canola meal inclusion would not go beyond 18% of the dry matter for diets given to monogastric animals.

Initial available information in literature shows that rabbits in the growing and finishing periods fed on canola meal in partial or total substitution of soybean meal had no performance problem (Baudet *et al.*, 1988). Similarly, Scapinello *et al.* (1994) studied increasing levels of soybean meal protein substitution by canola meal on rabbits' nutrition until slaughter (92 days of age). Results showed that substitution of soybean by canola meal was viable up to 60% level. In a more recent trial, Scapinello *et al.* (1996) showed that the total substitution of soybean meal by canola meal at the finishing period (40-90 days of age) of rabbits reserved for slaughter is possible.

However, the effects of partial or total substitution of the soybean meal by canola meal on the nutrition of female rabbits over 90 days of age, reserved for reproduction, are unknown.

It is thus necessary to evaluate the effect of partial and total substitution of soybean meal by canola meal on weight gain, feed intake and feed conversion of female rabbits from weaning (43 days of age) until adult life when they are capable of reproduction (150 days of age).

Material and methods

This study was carried out at the rabbit sector of the Iguatemi Experimental Farm (IEF) of the Universidade Estadual de Maringá (UEM), State of Paraná, Brazil, with forty-eight 43 to 150-day-old White New Zealand female rabbits, distributed in individual cages in a completely randomized design, with four treatments and 12 replications.

Four experimental diets were formulated in which the crude protein (CP) of soybean meal (SBM) was gradually substituted (33.0, 66.0 and 100.0%) by canola meal (CM) with reference diet at 0.0%. Besides SBM and CM, the diets were formulated with corn, wheat meal, coast cross, minerals and vitamins. The dietaries were iso-energetic and iso-proteic. Percentage and chemical compositions of experimental diets are shown in Table 1.

Table 1. Percentual and clinical composition of experimental diets

Ingredients	Replacing of SBM crude protein by CM (%) 00	33	66	100
Soybean meal	14.00	9.333	4.667	-
Canola meal	-	5.392	10.675	15.986
Corn	23.432	23.432	23.432	23.432
Bran wheat	24.00	24.00	24.00	24.00
Hay coast cross	5.16	5.16	5.16	5.16
Alfalfa hay	28.00	28.00	28.00	28.00
Salt	0.40	0.40	0.40	0.40
Dicalcium phosphat	0.80	0.684	0.567	0.45
Limestone	1.00	1.014	1.027	1.04
Vit.+min..mix [1]	1.00	1.00	1.00	1.00
Coccidiostat	0.08	0.08	0.08	0.08
Zinc bacitracin	0.05	0.05	0.05	0.05
DL Methionine 99	0.11	0.074	0.038	0.002
Vegetable oil	0.468	0.312	0.156	-
Lysine	-	0.0162	0.0324	0.0486
Rice hull	1.50	1.00	0.50	-
Sand	-	0.0528	0.216	0.3514
Total	100.00	100.00	100.00	100.00
Calculated chemical composition of experimental diets				
Crude protein	16.00	16.00	16.00	16.00
Crude fiber	13.00	13.00	13.00	13.00
Digestible Energy (Kcal/Kg of DM)	2.600	2.600	2.600	2.600
Calcium	1.00	1.00	1.00	1.00
Phosphorus	0.50	0.50	0.50	0.50
Methionine+cystine	0.60	0.60	0.60	0.60
Lysine	0.80	0.80	0.80	0.80

1-Vitamin-mineral premix. Composition per Kg: vit. A, 300000 IU; vit.D, 50000 IU; vit.E, 500 mg; vit.K, 100 mg; vit.B_1, 200 mg; vit.B_2, 300 mg; vit. B6, 100 mg; vit. B12, 1000 mcg; nicot. ac., 1500 mg; pantothenic ac., 980 mg; choline, 35000 mg; iron, 4,000 mg; cooper, 600 mg; cobalt, 100 mg; zinc, 6000 mg; manganese, 4300 mg;iodine, 32 mg; selenium, 8 mg; methionine, 30000 mg; growing prom., 3000 mg; coccidiostat, 12500 mg; sinox, 10000 mg

The period of data collection of current study was 107 days, with weight determination at 43, 70, 90 and 150 days of age. At the same period feed intake for calculation of daily average intake and dry matter conversion were registered.

Feed samples collected for laboratory analyses were homogenized, samples were put in aluminum packing and taken to a stove of forced ventilation from 50ºC to 55°C during a 72-hour period. After drying, content of dry matter (DM), crude protein (CP), organic matter (OM), crude fiber (CF), calcium (Ca), phosphorus (P), methionine + cystine and lysine were determined. The DM was obtained in a 105°C stove during 16 hours. The CP was determined by Silva (1990) methodology. Ashes were obtained in oven of 550°C during 6 hours. OM was calculated by difference.

Statistical analysis was undertaken using SAEG (System for Statistical and Genetical Analyses) program, developed by Euclydes (1983), according to the following model:

$$Yij = \mu + b_1 (Ni - N) + b_2 (Ni - N)^2 + b_1 (LW_{43} - LW) + eij$$

Yij = registered data of studied variables, relative to each animal *j*, receiving *i* level of CM on dietaries;
μ = general constant;
b_1 = linear coefficient of regression of Y variable in function of *i* levels of CM inclusion on dietaries, substituting the CP of SBM.
b_2 = quadratic coefficient of regression of Y variable in function of *i* levels of CM inclusion on dietaries, substituting the CP of SBM.
N_i = substitution levels of CP of SBM by CM *i*, and *i* = 1, 2 and 3, and i_1= 33%, i_2= 66% and i_3= 100%;
N = average of substitution level of CP from SBM by CM;
LW_{43}= individuals life weight at 43 days of age;
LW= average life weight at 43 days of age;
eij = randomized error mixed to each observation.

Dunnett's test was used for control comparison with each inclusion level of CM.

Results and discussion

Weight average (W) of 70-day old females and averages of daily weight gain (DWG), daily feed intake (DFI) and feed conversion (FC) in the period in which animals were 43 days - 70 days old are shown in Table 2. Females were fed on canola meal (CM) with an increasing substitution of crude protein of soybean meal (SBM). Dunnett's test was applied and no difference (P>0.05) was observed in animals receiving reference diet and those receiving meals with increasing levels of CM with regard to items studied during the period. Excluding the reference diet, no difference (P>0.05) was found in their performance when crude protein of SBM was gradually substituted by CM inclusion. Results suggest that CM substituted efficiently the crude protein of SBM in rabbit diet during the period in which animals were 43 days - 70 days old. Baudet *et al*. (1988) did not find any negative effect on performance of rabbits fed on CM which substituted partially or totally SBM during growth-finishing and reproduction periods. Scapinello *et al*. (1996) had the best results with rabbits fed on CM. They substituted 60% of soya meal protein during the periods in which animals were 40 days - 70 days old. However, the same authors verified that substitution may even be total in the period in which animals were 70 days - 90 days old without any negative influence on animal performance.

Averages of W of 90-day old females and averages of DWG, DFI and FC of 43 day- 90-day old females are given in Table 3. Dunnett's test show that only animals which received CM with a 66% substitution of crude protein of SBM had the worst (P>0.05) FC when compared to animals receiving reference diet. Excluding reference diet, during this period only DFI increased linearly (P<0.07) with increasing inclusion of CM. These results are in contrast to those found by Castell and Spurr (1984) and Bell and Keith (1987) in swines fed of canola during growth-finishing period. These studies showed a decrease in feed intake proportionately to the level increase of canola inclusion. The authors attribute this fact to CM's lesser palatableness compared to that of SBM.

Table 2. Average of live weight at 70 (W70) days of age and daily weight gain (DWG), daily feed intake (DFI) and female rabbits feed conversion (FC) from 43 to 70 days of age, according to the substitution levels of soybean meal crude protein (SBM) by canola meal (CM)

		Replacing of SBM crude protein by CM (%)				
Characteristics	Reference	33	66	100	average	VC[1]
W70 (g)	1713	1613	1704	1653	1671	11.74
DWG (g)	23.54	19.81	23.21	21.30	21.96	32.93
DFI (g)	70.12	70.35	80.02	78.11	74.65	22.12
FC[2]	3.06	3.65	3.80	3.93	3.61	28.39

[1]Variation coefficient

Table 3. Average of live weight at 90 (LW90) days of age and daily weight gain (DWG), daily feed intake (DFI) and female rabbits feed conversion (FC) from 43 to 90 days of age, according to the substitution levels of soybean meal crude protein (SBM) by canola meal (CM)

		Replacing of SBM crude protein by CM (%)				
Characteristic	Reference	33	66	100	Average	VC[1]
W90 (g)	2517	2372	2419	2437	2436	7.00
DWG (g)	30.62	27.54	28.54	28.91	28.90	12.15
DFI (g)[2]	99.97	91.50	103.93	104.70	100.02	15.62
FC	3.27	3.35	3.66[+]	3.61	3.47	11.92

[1]Variation coefficient; [2]Linear effect (P<0.07) - Y= 87.808 + 0.18458 (X) (R^2= 0.85); [+]Reference difference by Dunnett's Test at 7%

Weight averages of 120-day old females and averages of DWG, DFI and FC of 43-day - 120-day-old females are provided in Table 4. During this period LW120 and DWG were worse (P<0.05) when CM substituted 33% of SBM, as compared to values of females receiving reference diet. There was a linear increase (P<0.05) in DFI proportionately to increase in CM inclusion levels.

Table 5 shows that in the period in which animals were 43 days - 150 days old, LW150 and DWG of female rabbits receiving 33% to 66% of CM were worse (P<0.05) than those of animals receiving reference diet. During this period DFI increased linearly (P<0.05) with the increasing substitution of SBM crude protein by CM.

Trials with swines during growing and finishing periods showed that animals performance was lowest

for those fed with 75% or more of CM as substitute for SBM (Baidoo and Aherne, 1987). Similarly, Moreira *et al.* (1996a) observed a linear reduction of weight gain in growing swines when levels of CM changed from 00% to 18%. Similar results were observed by Marangoni *et al.* (1996) when substitution levels of SBM by CM changed from 7% to 28% for growing swines (from 61 days to 107 days old). Moreira *et al.* (1996b), also observed a negative linear effect with increase of CM levels substituting SBM for swines during finishing period. Various authors attribute reduction in swine performance during growing and finishing periods to CM's lower digestible energy and availability of aminoacids when compared to those of SBM. This may explain the low performance of female rabbits in the period in which animals were 43 days - 150 days old and shown by quadratic changes in LW, DGW and DFI. However, with regard to pregnant female swines, CM was administrated with success in total substitution for SBM (Sorrel and Shurson, 1990).

Table 4. Average of live weight at 120 (LW120) days of age and the daily weight gain (DWG), daily feed intake (DFI) and female rabbits feed conversion (FC) from 43 to 120 days of age, according to the substitution levels of soybean meal crude protein (SBM) by canola meal (CM)

		Replacing of SBM crude protein by CM (%)				
Characteristic	Reference	33	66	100	average	VC[1]
W120 (g)	3478	3233[+]	3396	3330	3361	6.65
DWG (g)	31.30	28.00[+]	30.10	29.25	29.66	9.19
DFI (g)[2]	131.00	127.00	133.27	135.84	131.17	6.24
FC	4.20	4.57	4.46	4.70	4.48	10.01

[1]Variation coefficient; [2]Linear effect (P<0.05) - Y=123.2357 + 0.132091 (X) R^2= 0.91; [+]Reference difference by Dunnett's Test at 5%

Table 5. Average of live weight at 150 (LW150) days of age and daily weight gain (DWG), daily feed intake (DFI) and female rabbits' food conversion (FC) from 43 to 150 days of age, according to the substitution levels of soybean meal crude protein (SBM) by canola meal (CM)

		Replacing of SBM crude protein by CM (%)				
Characteristic	Reference	33	66	100	Average	VC[1]
W150 (g)	3937	3655[+]	3766 [+]	3781	3785	5.06
DGW (g)	26.72	24.08[+]	25.12 [+]	25.26	25.30	7.08
DFI (g)[2]	144.10	140.43	143.02	147.23	143.70	4.51
FC	5.40	5.84[+]	5.72[+]	5.83[+]	5.71	5.68

[1]Variation coefficient; [2]Linear effect (P<0.05) - Y= 136.6806 + 0.1032999 (X) (R^2= 0.97); [+]Reference difference by Dunnett's Test at 5%

We may conclude that, independently of CM inclusion levels as a substitute for SBM, results showed that CM worsened the performance of the rabbits.

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