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Carrot tops as a partial substitute for alfalfa hay on diets for growing rabbits

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Additional keywords

Alternative foods.
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SUMMARY

The aim of this study was to evaluate the feasibility of partially replacing alfalfa hay with carrot tops (Daucus carota) in diets for broiler rabbits. The assay was composed of 30 New Zealand rabbits, weaned at 35 days of age, divided into 3 groups and submitted to one of three dietary treatments: T0CT – Diet without the inclusion of carrot tops; T25CT - diet with replacement of alfalfa hay by 25% carrot tops; and T50CT - diet with replacement of alfalfa hay by 50% carrot tops. Water and feed were offered ad libitum. The biological assay lasted for 49 days and took place during the months of December and January (summer season). The following parameters were evaluated: weight gain, feed conversion, feed intake and economic viability of the diet. Means were statistically analyzed by analysis of variance (ANOVA) followed by Tukey test (0.05). The average daily weight gain of the rabbits was 23.93 g for T0CT, 22.65 g for T25CT and 22.16 for T50CT (p>0.05). Feed intake was 86.71 g in T0CT, 88.43 g in T25CT and 89.57 g in T50CT (p>0.05). The feed conversion ratio was 3.62 for T0CT, 3.09 for T25CT and 4.04 for T50CT (p>0.05). The cost per kg of diet linearly reduced with the inclusion carrot tops, and the T0CT diet was the most expensive (R$ 0.74/kg or US$0.22) and T50CT (R$ 0.60/kg or US$0.18) the most economically viable. It can be concluded that carrot tops can replace up to 50% of the alfalfa hay in diets for growing broiler rabbits, optimizing the cost of diet without negatively affecting animal performance.

Topos de cenoura como substituto parcial para o feno de alfafa em dietas para coelhos

Palavras-chave adicionais

Alimentos alternativos.
Granja dos coelhos.
Nutriçao animal.
Sustentabilidade.
Resíduos em ração animal.

RESUMO

O objetivo deste estudo foi avaliar a viabilidade da substituição do feno de alfafa por topos de cenoura (Daucus carota) em dietas para coelhos de corte. Conduziu-se para tal um ensaio biológico com 30 coelhos, da raça Nova Zelândia, desmamados aos 35 dias de idade, divididos em três dietas experimentais: T0CT – Dieta sem inclusão de topos de cenoura; T25CT – dieta com 25% de topos de cenoura em substituição ao feno de alfafa; e T50CT – dieta com 50% de substituição do feno de alfafa por topos de cenoura. Água e ração foram fornecidas à vontade durante todo o período experimental, que compreendeu 49 dias, e ocorreu nos meses de dezembro e janeiro (período de verão). Os parâmetros analisados foram: ganho diário de peso vivo, conversão alimentar, consumo diário de ração e viabilidade econômica da dieta. As médias foram analisadas estatisticamente através de análise de variância (ANOVA) seguida pelo Teste de Tukey (0.05). A média do ganho de peso vivo dos coelhos figurou em 23.93 g no T0CT, 22.65 g no T25CT e 22.16 no T50CT (p>0.05). O consumo diário de ração figurou em 86.71 g no T0CT, 88.43 g no T25CT e 89.57 g no T50CT (p>0.05). A conversão alimentar foi de 3.62 no T0CT, 3.09 no T25CT e 4.04 no T50CT (p>0.05). Já o custo por kg de dieta reduziu linearmente com a inclusão de topos de cenoura, sendo a dieta T0CT a mais onerosa (R$ 0.74/kg ou US$ 0.22/kg) enquanto a T50CT (R$ 0.60/kg ou US$ 0.18/kg) a mais econômica. Concluiu-se que os topos de cenoura podem substituir até 50% o feno de alfalfa em dietas para coelhos de corte otimizando os custos produtivos e sem influenciar negativamente a performance dos animais.

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INTRODUCTION

In developing countries, there growing demand for lower cost animal-protein sources. The fact that rabbits have early sexual maturity, short gestation and can be slaughtered for meat at as early as 74 days in addition to the fact that they require reduced living spaces and a relatively easy management with minimum environmental impact makes rabbit meat one of the best low-cost animal protein (Molina *et al*., 2015).

In cuniculture, feed can make up to as much as 70% of the total costs (Scapinello *et al*., 2003; De Blas *et al*., 2015) and the alfalfa hay is the most expansive ingredient. In order to lower production cost, an alternative is to replace this costly ingredient with an ingredient of lower commercial value, such as carrot tops (Ngoshe *et al*., 2013; Owolek *et al*., 2016), which can be easily and cheaply acquired and has protein content (20%) similar to the ones found in the alfalfa hay (Sharma *et al*., 2012).

Studies addressing the use of kitchen waste - such as carrot tops (*Daucus carota*) and other by-products considered waste by the food industry - are rare and practically unheard of in Brazil. Thus, the aim of this study was to evaluate the effect of using carrot tops, in place of alfalfa hay, in growing rabbits in Brazil.

MATERIAL AND METHODS

This experiment was carried out in December and January (2014/2015) at the Cuniculture laboratory at the Federal University of Santa Maria (Brazil). 30 Animals were kept in cages within a barn with minimum and maximum temperatures ranging from 23ºC to 31°C with no artificial light schedule.

Experimental diets

The animals were evenly separated and assigned one of three diets. The control diet (T0CT) with 100% alfalfa hay; diet T25CT with 75% of the alfalfa hay and 25% carrot tops and diet T50CT, with 50% alfalfa hay and 50% carrot tops **(table I)**. Diets were formulated as to have a similar crude protein (18%) and digestible energy (2323 Kcal/Kg) content and to comply with the growth requirements. No antibiotics were added either to the diets or to the water. Vitamins and minerals was offered by vitamin/mineral premix (0.20%).

The feed was offered as a pure mash and placed in woven galvanized wire mesh feeders. Twice daily residual feed was removed from the feeders, homogenized and again offered to the animals as a strategy to prevent the animals from selecting the larger particles.

Animals and measurements

A total of 30 mixed-sex New Zealand White rabbits, weaned at 35d and weighing on average 789±37.49g, were randomly assigned to one of the 3 experimental groups (10 rabbits/diet), according to weaning weight.

Rabbits were kept in individual galvanized wire cages (50×50×50 cm) and fed *ad libitum* until the end of the experiment. Fresh water was always available. The biological assay lasted 49 days during which, animal live weight and feed consumption were registered weekly, whereas, the mortality was verified daily, according to the guidelines for applied nutrition experiments in rabbits (Fernandez-Carmona *et al*., 2005 apud Lounaouci-ouyed *et al*., 2014). At the end of the bioassay all rabbits were 84d old. The following parameters were evaluated: daily weight gain, feed conversion, and daily feed intake.

Economic analyses

The efficiency index of the diets was assessed by multiplying the total cost of the ingredients in the diet by feed conversion.

Statistical analyses

Data were analyzed as a completely randomized design with the Statistical Analysis System (SAS, 1988) using the general linear model (GLM procedure). The variance analysis was performed with the diet as the sole source of variation. Each animal was considered to be an experimental unit. The means were compared by variance analysis followed by Tukey test ($p<0.05$).

Table I. Composition of control and experimental diets (Composição das dietas experimentais).

	Experimental diets		
	T0CT	T25CT	T50CT
Ingredients (% as fed)			
Corn	17.25	17.25	17.25
Wheat meal	25.00	25.00	25.00
Soy-bean meal	17.50	17.50	18.00
Soy-bean oil	2.50	2.50	2.40
Rice hulls	6.00	6.00	5.45
Alfafa hay	30.00	22.50	15.00
Carrot tops	-	7.50	15.00
Dicalcium phosphate	0.80	0.80	0.80
Calcitic limestone	0.25	0.25	0.40
Salt	0.50	0.50	0.50
Vitamin/mineral premix	0.20	0.20	0.20
Nutritional levels in dry matter			
Crude protein (%)	18.00	18.00	18.00
Ether extract (%)	4.39	4.58	4.67
FDA (%)	20.78	19.84	18.05
FDN (%)	35.30	33.37	31.10
Calcium	1.05	1.00	1.00
Phosphorus	0.60	0.54	0.52

T0CT: Treatment without carrot leaves and stems; T25CT: Treatment with 25% of carrots leaves and stems as replacement for alfafa hay; T50CT: treatment with 50% carrots leaves and stems as replacement for alfafa hay. Levels calculated according to INRA (2004).

RESULTS AND DISCUSSION

The experimental diets T0CT and T25CT were significantly different from the T50CT diet for feed conversion, average daily gain, and weight at 49 days in the post-weaning period (35d - 49d). However, no were significant differences were found in daily weight gain (DWG); feed conversion (FC), and feed intake (FI) in other growth periods or considering the entire period of the assay **(table II)**. These results corroborate with Gidenne *et al*. (2010) which states that diets of growing rabbits can include up to 30% of carrot tops. However, El Medany *et al*. (2008) state that carrot greens can make up more than 50% of a diet for growing rabbits without altering animal performance. Also according Bakshi *et al*. (2016) dried carrot pomace could be used up to 50% in diets of growing rabbits without any adverse effects on the productive performance, nutrient digestibility and blood components.

In study with isoprotein diets (18.13%) formulated to contain five different levels of carrot leaf meal (0, 15, 30, 45 and 60%), Abdu *et al*. (2012), found a significant ($p<0.05$) difference with the increase in levels of carrot leaf meal inclusion in the experimental diets. Nonetheless, these authors state that the treatment with 15% carrot leaf meal had the highest daily FI (81.68 g), which is similar to the control treatment.

A marked difference between this experiment and recent studies of the same nature was found for the absolute values of feed conversion. Alves (2013) studied the performance of four groups of rabbits between the ages of 21 and 63 days, fed diets with two different levels of neutral detergent fiber (37% and 30%) with and without carrot tops and found an average feed conversion of 2.38; 2.65; 2.02 and 2.18. One reason for this discrepancy in the conversion is the fact that the average temperature during the bioassay was around 31°C (maximum) and 23ºC (minimum) which may have thermally stressed rabbits,, lowering energy intake and weight gain and consequently, increasing conversion.

Another reason for the differences in feed conversion from similar studies is the fact that rabbits in this study were fed pure mash. In this sense, it is likely to have occurred more waste and less use of the same animals by virtue of their physical form. However, there was no mortality during the experimental period. This study was found that the inclusion of carrot leaves in

Table II. Effect of the substitution of alfafa hay by carrots tops on live weight gain (LWG), feed intake (FI), feed conversion (FC) of growing rabbit (Efeito da substituição do feno de alfafa pela parte aérea de cenouras no ganho de peso (LWG), consumo de ração (FI) e conversão alimentar (FC) de coelhos em crescimento).

	Experimental diets		
	T0CT	T25CT	T50CT
Number of rabbits	10	10	10
Post-weaning period (35-49 d):			
Body weight at 28 d (g)	789.00	787.00	787.00
Body weight at 49 d (g)	1133.89[a]	1138.33[a]	1066.1[b]
Daily weight gain (g/d)	24.57[a]	25.09[a]	19.94[b]
Daily feed intake (g/d)	70.24	70.75	65.87
Feed conversion rate (g/g)	2.85[a]	2.82[a]	3.30[b]
Intermediate period (49-70 d):			
Body weight at 49 d (g)	1133.89	1138.33	1066.11
Body weight at 70 d (g)	1690.00	1658.33	1607.22
Daily weight gain (g/d)	26.48	24.76	25.76
Daily feed intake (g/d)	89.76	92.38	91.00
Feed conversion rate (g/g)	3.40[a]	3.73[a]	3.54[a]
Finishing period (70-84 d):			
Body weight at 70 d (g)	1690.00	1658.33	1607.22
Body weight at 84 d (g)	1961.67	1897.22	1872.77
Daily weight gain (g/d)	19.40	17.06	18.96
Daily feed intake (g/d)	98.61	106.94	104.02
Feed conversion rate (g/g)	5.10[a]	6.26[a]	5.50[a]
Whole fattening period (35-84 d):			
Daily weight gain (g/d)	23.93	22.65	22.16
Daily feed intake (g/d)	86.71	88.43	89.57
Feed conversion rate (g/g)	3.62[a]	3.90[a]	4.04[a]

T0CT: Treatment without carrot leaves and stems; T25CT: Treatment with 25% of carrots leaves and stems as replacement for alfafa hay; T50CT: Treatment with 50% carrot leaves and stems as replacement for alfafa hay.
[a,b]Mean values in the same row with a different superscript differ at $p<0.05$.

the diet of growing rabbits may ultimately reduce overall. The cost per kg of diet linearly reduced with the inclusion carrot tops, and the T0CT diet was the most expensive (R$ 0.74/kg or US$ 0.22/kg) and T50CT (R$ 0.60/kg or US$ 0.18/kg) the most economically viable.

CONCLUSIONS

It was concluded that carrots tops can replace up to 50% of alfalfa hay in the diet of growing rabbits without hindering animal performance. However, we encourage further research on the topic.

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