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BEER RESIDUE IN DIETS FOR GROWING RABBITS

(*Resíduo de cervejaria em dietas para coelhos de corte*)

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ABSTRACT

Conventional foodstuffs like alfalfa hay have high cost, mainly in developing countries. Due to that there has been a search for unconventional low-cost local ingredients. The purpose for this research was to evaluate performance and dry matter digestibility (DMD) of growing rabbits which were fed diets containing different levels of beer residue (BR) as a substitute for alfalfa hay. Thirty New Zealand rabbits were weaned at 35 days, weighing 650g, and assigned in a completely randomized experimental design to one of the following diets: 0BR - control diet without inclusion of BR; 25BR - diet with 25% of BR as a substitute for alfalfa hay; 50BR - diet with 50% of BR as a substitute for alfalfa hay. The experimental period comprised 42 days. For five days, stool was collected in order to obtain the DMD of the ration. Means were compared statistically by Analysis of Variance of Means and Tukey Test ($p<0.05$). None of the studied parameters presented differences by the statistical methods used, except for feed consumption in initial phase (from 35 to 56 days) ($p=0.001$); feed consumption in the final phase (from 56 to 77 days) ($p=0.04$); and overall performance ($p=0.01$) that was reduced linearly with the inclusion of BR. It was concluded, based on feed conversion, that it is possible to use up to 50% of BR as a substitute for alfalfa hay in diets for growing rabbits.

Key words*:* Alternative ingredients, rabbits nutrition, by-products.

RESUMO

Alimentos convencionais, como o feno de alfafa, têm alto custo, principalmente nos países em desenvolvimento, o que justifica a busca por ingredientes locais menos dispendiosos e não convencionais. Objetivou-se avaliar o desempenho e a digestibilidade da matéria seca (DMS) de coelhos em crescimento alimentados com dietas contendo diferentes níveis de resíduo de cerveja (RC), em substituição ao feno de alfafa. Trinta coelhos da raça Nova Zelândia foram desmamados aos 35 dias, com peso inicial de 650g, e distribuídos em delineamento experimental inteiramente casualizado, para serem submetidos às seguintes dietas: 0RC - dieta controle sem inclusão de RC; 25RC - dieta com substituição de 25% do feno de alfafa por RC; 50RC - dieta com substituição de 50% do feno de alfafa por RC. O período experimental foi de 42 dias. Durante cinco dias, as fezes foram coletadas para obter o DMS da ração. As médias foram comparadas estatisticamente pela análise de variância de médias (ANOVA), seguida pelo teste de Tukey ($p<0,05$). Nenhum dos parâmetros estudados apresentou diferenças pelos

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métodos estatísticos utilizados, exceto o consumo de ração, na fase inicial (35 aos 56 dias) (p=0,001), na fase final (56 aos 77 dias) (p=0,04), e considerando todo o período experimental (p=0,01), que diminuiu linearmente com a inclusão da RC. Concluiu-se, com base na conversão alimentar, que é possível utilizar até 50% de substituição do feno de alfafa por RC em dietas para coelhos em crescimento.

Palavras-chave: Ingredientes alternativos, nutrição de coelhos, subprodutos.

INTRODUCTION

Nowadays, agricultural waste is abundant worldwide. Transforming raw material into final products produce residues, besides their pollutant effect, may also affect the balance of the ecosystem if they are not properly disposed of. In this sense, using these residues in animal nutrition provides a use for ingredients that could not be used for human nutrition. The usage of alternative ingredients to feed cattle has been studied by several researchers (DE BLAS *et al*., 2015; CARVALHO *et al*., 2017; MOLINA *et al*., 2015; ALAGON *et al*., 2014; KLINGER *et al*., 2017; KLINGER *et al*., 2018) in order to reduce environmental liabilities and production costs since animal nutrition comprises 70% of the cattle raising costs (FALCONE *et al*., 2020; GIDENNE *et al*., 2017).

In this context, brewing industry uses barley along with other materials, generating residues that could be promising for animal nutrition (BROCHIER, 2009). According to annual data from the National Supply Company, Brazil produced about 263,000 tons of barley in 2016, which, unlike crops worldwide, is essentially designated to the brewing industry (DE MORI *et al*, 2007). The country is ranked as the third largest beer producer, with 14 billion liters produced per year, generating around 2.8 million tons of beer brewing residue (BR).

The BR may be used in diets for herbivorous animals, and it is composed of 85% dry matter, 35% crude protein, 18% crude fiber, 6% ether extract, and 2628 kcal/kg (SILVA and FERREIRA, 2017). Although BR is abundant in Brazil, there is not enough data about its inclusion in rabbit diets, which justifies researching information about it to support scientific and productive outcomes. As alfalfa hay is an ingredient of high cost in rabbit diet, replacing it with BR would reduce both environmental impact and productive costs for farmers.

Therefore, this study aimed to evaluate the zootechnical performance and dry matter digestibility in rabbits which were fed different levels of BR as a substitute for alfalfa hay in their diets during the growth phase.

MATERIALS AND METHODS

Location of the study and animals

This study was approved by the Biosecurity and Ethics Committee, and the project was registered under the number of 098/2011. The biological assay was carried out in January and February at the Animal Husbandry Laboratory of the Zootechny Department at the Federal University of Santa Maria (UFSM), located at 29°41'S latitude and 53°48'W longitude.

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Thirty male New Zealand White rabbits, weaned at 35 days old and weighing 650g, were used. They were housed in individual 50x50cm cages in a rabbit barn, without any control of humidity, temperature, and artificial lighting, in a completely randomized design. Afterwards they were randomly distributed in the cages and submitted to one of the three diets (10 rabbits per group).

Diets and feeding management

Three diets were prepared to contain similar levels of nutrients (Tab. 01): control diet (0BR), in which no beer residue (BR) was included; 25BR - diet with 25% of alfalfa hay which was substituted for BR; and 50BR - diet with 50% of alfalfa hay which was substituted for BR. The BR used in the 25BR and 50BR diets was previously dried in a forced air recirculation oven at 56°C for 36 hours (MUSSATO *et al*., 2006).

Table 01: Ingredients and chemical composition of diets for growing rabbits containing beer residue as a substitute for alfalfa hay.

Ingredients	Experimental diets		
	0BR (%)	**25BR (%)**	**50BR (%)**
Corn	17.25	17.25	17.25
Wheat meal	25.00	25.00	25.00
Soy-bean meal	17.50	17.50	17.50
Soy-bean oil	2.50	2.50	2.50
Rice hulls	6.00	6.00	6.00
Alfafa hay	30.00	22.50	15.00
Beer residue	-	7.50	15.00
Dicalcium phosphate	0.80	0.80	0.80
Calcitic Limestone	0.25	0.25	0.25
Salt	0.50	0.50	0.50
Vitamin/mineral premix*	0.20	0.20	0.20
Nutritional Levels			
Dry matter (%)	86.28	85.26	88.27
Crude protein (%)	17.25	17.63	18.00
Crude Fiber (%)	14,61	13,56	12,50
Crude Ash (%)	8.05	7.15	7.05
Calcium (%)	0.55	0.50	0.50
Phosphorus (%)	0.60	0.54	0.52

0bs.: 0BR = Treatment without beer residue; 25BR = Treatment with beer residue replacing 25% of alfalfa hay; 50BR = treatment with 50% beer residue replacing alfalfa hay.

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The mineral and vitamin Premix supplied (per kg of diet) were: Vitamin A = 600 IU; Vitamin D = 100 IU; Vitamin E = 8.0mg; Vitamin K3 = 200mg; Vitamin B1 = 400mg; Vitamin B2 = 600mg; Vitamin B6 = 200mg; Vitamin B12 = 2.0mg; Pantothenic acid = 2.0mg; Choline = 70.0mg; Fe = 8.0mg; Cu = 1.2mg; Co = 200mg; Mn = 8.6mg; Zn = 12.0mg; I = 65mg; Se = 16mg.

Performance and Digestibility analysis

The performance parameters obtained were daily gain, feed intake and feed conversion. Throughout the test, animal weight and feed intake were recorded at 56 and 77 days. Therefore, measurements were itemized in two distinct phases: initial (from 35 to 56 days) and final (from 56 to 77 days), as well as overall performance (35 to 77 days).

In the second experimental week, a digestibility test was performed when the animals received a known amount of feed, and the respective excreta of experimental units were set apart according to the presence of a marker (chromium picolinate). Rabbits' feces were collected for five days. The feces were dried in an air recirculation oven and then weighed to obtain the dry matter digestibility coefficient (CDMD). To obtain the CDMD, the following equation was used:

$$\mathrm{CDMD} = \frac{\mathrm{IDM(g)} - \mathrm{EDM(g)}}{\mathrm{IDM(g)}}$$

IDM means ingested dry matter, while EDM represents excreted dry matter.

Statistical Analysis

Data were analyzed by analysis of variance (ANOVA), followed by Tukey test (0.05), with three treatments and ten repetitions each, totaling 30 animals. Dry matter digestibility was examined through the statistical method of correlation coefficient.

RESULTS AND DISCUSSION

Due to performance data (Tab. 02), it was verified that average daily gain (ADG), animal mass and feed conversion (FC) did not present differences. Feed intake (FI) was lower for the 50BR group in the three studied phases (initial, final and general). Although no significant differences were found, animal weight decreased and FC improved linearly with the inclusion of BR. Dry matter digestibility coefficient (CDMD) was 0.69 in the 0BR diet, 0.71 in the 25BR diet and 0.72 in the 50BR diet. The correlation coefficient between increasing inclusion of BR and CDMD was p = 0.98.

The diversification of production and the use of all available resources (such as by-products and residues) are alternatives which generate earned-value and economic growth of organizations (SORDI *et al*., 2016). We are reaching stages of stagnation of arable land, and, as consequence, there will be a need to increase food production around the world (FAO, 2014).

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In this sense, it is important to optimize land mobilization and use of agro-industrial by-products and residues in animal nutrition, which could result in a promising alternative.

Table 02: Performance of rabbits fed diets containing beer residue as a substitute for alfalfa hay.

	Experimental diets			*P* value *
	0BR	**25BR**	**50BR**	
Initial phase – 35 to 56 days				
Mass at 35 days (g)	647	650	648	0.99
Mass at 56 days (g)	1460	1409	1352	0.20
Daily gain (g/day)	38.71	36.11	33.53	0.06
Feed intake (g/day)	121[a]	121[a]	106[b]	0.0012
Feed conversion b(g/g)	3.15	3.39	3.22	0.21
Final phase – 56 to 77 days				
Mass at 56 days (g)	1460	1409	1352	0.20
Mass at 77 days (g)	2010	1927	1866	0.22
Daily gain (g/day)	26.16	24.66	24.43	0.69
Feed intake (g/day)	104[a]	106[a]	94[b]	0,04
Feed conversion (g/g)	4.00	4.29	3.85	0,15
Overall Performance – 35 to 77 days				
Daily gain (g/day)	32.44	30.39	28.98	0.10
Feed intake (g/day)	113[a]	114[a]	100[b]	0.01
Feed conversion (g/g)	3.57	3.84	3.53	0.05

0bs.: 0BR: Treatment without beer residue; 25. **BR:** Treatment with beer residue replacing 25% of alfalfa hay; 50BR: treatment with 50% beer residue replacing alfalfa hay. *Obtained by Analysis of variance of the means (ANOVA). [ab]Different letters on the same line indicate differences by Tukey test (0.05).

Performance results corroborate other studies, as Mufwa *et al*. (2011) who observed that 40% BR levels in rabbit diets improve FC when compared to the control diet. Researchers who have replaced palm oil with BR have obtained increases in intake and feed efficiency, and they also suggest levels of inclusion up to 25% without major damage to the rearing system (ETCHU *et al*., 2012).

In addition to that, differences about performance data in similar biological assays are found in the literature: Lounaouci-Ouyed *et al*. (2008) and Lima (2017) show the differences in the composition of BR according to the source of origin. Consequently, considering the level

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and the quality of the fiber in alternative foodstuffs is of utmost relevance, due to the fact they may cause a decrease in animal performance if given empirically (LIMA, 2017).

Furthermore, digestibility, palatability, anti-nutritional factors and toxic substances adversely interfere in the use of nutrients by animals (LIMA, 2017). The decrease of FI in the 50BR diet corroborates studies in which rabbits were fed pelleted diets with a 50% substitution level of neutral detergent fiber (NDF) for BR, that led to a decrease in intake (VIEIRA, 2009). In this context, the reduced intake possibly occurs because of the higher energy level and the higher digestibility due to the addition of BR, as it contains lower levels of acid detergent fiber (ADF) and higher levels of hemicellulose (VIEIRA, 2009).

Palatability may be one of the factors which are responsible for the difference in ingestive behavior of animals (SORDI *et al*., 2016). In this regard, some researchers have observed a reduction in FI, ADG and final weight in rabbits receiving a diet composed by up to 30% BR (SORDI *et al*., 2016). Also, rabbits fed with BR present worsening in FC due to low palatability and high levels of crude fiber (CF) in BR, which decreased the acceptance of the diet (AMAKIRI and OWEN, 2013). The improvement of CDMD with the increased inclusion of BR corroborates the results obtained by other studies (VIEIRA, 2009).

CONCLUSION

Based on the feed conversion, we concluded that beer residue may substitute up to 50% of alfalfa hay in diets for rabbits which are between 35-77 days old, without compromising performance indices. However, the composition of the residue should be studied before being offered to the animals since it may vary according to the raw material to be used.

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