

Case Report

Effect of banana peel and sweet potato vines on the fur of growing rabbits

**Efeito da casca de banana e baração de batata-doce na pelagem de coelhos
em crescimento**

**Efecto de la cáscara de banana y hojas de batata-dulce en el pelaje de
conejos en crecimiento**

Diuly Bortoluzzi Falcone^{1*}, Ana Carolina Kohlrausch Klinger², Caroline Tavares Cardoso³,
Geni Salete Pinto de Toledo⁴, Leila Picolli da Silva⁴

¹ Doutoranda do programa de pós-graduação de Zootecnia – Universidade Federal de Santa Maria (UFSM)

² Doutora do programa de pós-graduação de Zootecnia – Universidade Federal de Santa Maria (UFSM)

³ Graduanda do curso de Zootecnia da Universidade Federal de Santa Maria (UFSM)

⁴ Professora, Doutora e Pesquisadora da Universidade Federal de Santa Maria (UFSM)

*E-mail: diulybortoluzzi@gmail.com

ABSTRACT

Rabbits' skin is considered an excellent by-product and has several purposes, such as making clothes and artifacts in general. The aim of this study was to evaluate the effect of the inclusion of banana peel (BP) and sweet potato vines (SPV) on the length of the fur of rabbits fed different levels of these ingredients. Twenty-five New Zealand White rabbits, of both sexes, weaned at 35 days old, were randomly distributed in individual cages, in five treatments with five replications each, in a completely randomized design. The animals received one of the following diets: control (0BP+SPV) without BP and SPV; (25BP+SPV) experimental diet with 25% BP and SPV replacing maize and alfalfa hay; (50BP+SPV) experimental diet with 50% BP and SPV replacing maize and alfalfa hay; (75BP+SPV) experimental diet with 75% BP and SPV replacing maize and alfalfa hay; and (100BP+SPV) experimental diet with 100% BP and SPV replacing maize and alfalfa hay. The biological assay lasted 49 days, where food and water were provided *ad libitum*. At the end of the test, a portion of hair was removed from the nape, loin and thigh region to measure the length. Means were compared through analysis of variance, followed by Tukey test (0.05). The hair length results obtained showed that there were no differences between treatments. In this way, it is concluded that it is possible to completely replace maize and alfalfa hay by the combination of BP+SPV in rabbit rations, for fur generation, without changing the characteristics of the fur.

Keywords: alternative ingredients, pelage, rabbit production

RESUMO

A pele do coelho é considerada um excelente subproduto e possui diversas finalidades, como confecção de roupas e artefatos em geral. O objetivo deste estudo foi avaliar o efeito da inclusão de casca de banana (CB) e baração de batata-doce (BBD) no comprimento do pelo de coelhos alimentados em níveis diferentes destes ingredientes. Foram utilizados 25 coelhos da raça Nova Zelândia Branco, de ambos os sexos, desmamados aos 35 dias, distribuídos aleatoriamente em gaiolas individuais, em cinco tratamentos com cinco repetições cada, em arranjo inteiramente casualizado. Os animais receberam uma das seguintes dietas: controle (0CB+BBD) sem CB e BBD; (25CB+BBD) dieta experimental com 25% CB e BBD em substituição ao milho e feno de alfafa; (50CB+BBD) dieta experimental com 50% CB e BBD em substituição ao milho e feno de alfafa; (75CB+BBD) dieta experimental com 75% CB e BBD em substituição ao milho e feno de alfafa; e (100CB+BBD) dieta experimental com 100% CB e BBD em substituição ao milho e feno de alfafa. O ensaio biológico durou 49 dias, onde ração e água foram fornecidas *ad libitum*. No final do ensaio, foi retirada uma porção de pelos da região da nuca, lombo e coxa para medir o comprimento. Os dados foram tabulados e analisados, As médias foram comparadas por meio de análise de variância, seguida de Teste de Tukey (0,05). Os resultados de comprimento do pelo obtidos mostraram que não houve diferenças entre os tratamentos. Desta forma, conclui-se que é possível substituir totalmente milho e feno de alfafa pela combinação de CB+BBD em rações para coelhos, para geração de peles, sem alterar negativamente as características da pele.

Palavras-chave: cunicultura, ingredientes alternativos, pelagem

RESUMEN

La piel de conejo se considera un excelente subproducto y tiene varios propósitos, como la confección de ropa y artefactos en general. El objetivo de este estudio fue evaluar el efecto de la inclusión de cáscara de banana (CB) y hojas de patata dulce (HBD) sobre la longitud del pelaje de conejos alimentados con diferentes niveles de estos ingredientes. Se utilizaron 25 conejos de la raza Nueva Zelanda Blanco, de ambos sexos, destetados a los 35 días, distribuidos aleatoriamente en jaulas individuales, en cinco tratamientos con cinco repeticiones cada uno, en arreglo completamente casualizado. Los animales recibieron una de las siguientes dietas: control (0CB+HBD) sin CB y HBD; (25CB+HBD) dieta experimental con 25% CB y HBD en sustitución del maíz y heno de alfalfa; (50CB+HBD) dieta experimental con 50% CB y HBD en sustitución del maíz y heno de alfalfa; (75CB+HBD) dieta experimental con 75% CB y HBD en sustitución del maíz y heno de alfalfa; y (100CB+HBD) dieta experimental con 100% CB y HBD en sustitución del maíz y heno de alfalfa. El ensayo biológico tuvo una duración de 49 días, donde se proporcionó ración y agua *ad libitum*. Al final del ensayo, una porción de pelos de la región de la nuca, lomo y muslo para medir la longitud. Los datos se tabularon y analizados. Las medias se compararon mediante análisis de varianza, seguido de Prueba de Tukey (0.05). Los resultados de longitud obtenidos mostraron que no hubo diferencias entre los tratamientos. Así, se concluye que es posible reemplazar completamente el maíz y el heno de

alfalfa por la combinación de CB+HBD en las raciones de conejo, para la generación de pelaje, sin alterar negativamente las características del pelaje.

Palabras-clave: cunicultura, ingredientes alternativos, pelaje

Introduction

In rabbit production, most of the ingredients used in rabbit feeding occupy agricultural areas that could be used for growing food for human consumption. In addition, especially in developing countries, it is essential to find ingredients that provide good productive performance and economic viability for producers (AKANDE, 2015). In this context, studies aiming at the use of alternative ingredients are necessary, due to the increase in prices and in order to produce low-cost feeds that meet the needs of animals (COELHO et al., 2016).

In rabbit feeding, it is known that the cost of feeding represents about 60-70% of the total cost of rabbit production. The challenge for feed formulation is to obtain lower cost diets that fully meet the needs of the animals, something that could be provided by using cheaper non-traditional feed ingredients (EL-MAATY et al., 2017). In this context, it is important to know the nutritional value of available raw materials, in the case of alternative ingredients, to be included in rabbit diets.

Banana (*Musa spp.*) is among the most important crops in the world, and it is

also among the most produced and consumed fruits. Banana peels (BP) are the residue of banana production, being a crop that sends a large part of the product to industrialization, producing a large volume of BP where they are usually discarded inappropriately in the environment (ZHANG, et al., 2005). BP has high nutritional value and a rich source of carbohydrates, presenting a wide range of vitamins and minerals and containing antioxidants and carotenoids (ROMELLE et al. 2016; JUNG et al. 2019). The approximate chemical composition of BP is dry matter 7.7 to 21.4%, crude protein 6.3 to 11.2%, ether extract 2.2 to 10.9% and mineral matter 6.4 to 12.8% (CONTE, 2017). In addition, BP is widely used by small producers as complementary feed for animals, mainly in tropical regions (EMAGA et al., 2011).

Sweet potato (*Ipomoea batatas*) is among the main crops used in culinary and in the production of biofuels. Sweet potato vines (SPV) are the residue of sweet potato production, being a crop grown mainly for the tubers, but leaving a large volume of SPV (stems and leaves) after harvest (LI et

al., 2017). SPV has a high nutritional value, provides a dietary source of vitamins, minerals, antioxidants, carotenoids and fiber, and rabbits have a good tolerance for this residue as a source of fiber, so this ingredient can be used to compose their diet. (KLINGER et al., 2018; SAURACALIXTO; GOÑI, 2006). The SPV has a nutritional composition suitable for rabbit diets approximately: 16% protein, 40% crude fiber and 3% ether extract in dry matter (KLINGER et al., 2018).

The rabbit production is a livestock activity that aims to exploit various products from domestic rabbits, with meat as the main product and skin and hair as a by-product, as well as leather, paws, manure, etc. This activity is relatively simple, easy and capable of generating a good economic return to the producer (ALMEIDA and SACCO, 2012). Rabbit skin is considered an excellent by-product and can be used for various purposes, such as making clothes, quilts, handicrafts and other items, as they have acceptable characteristics such as softness and beauty.

In this sense, it should be noted that for production purposes, rabbits must have good carcass characteristics and skin quality for marketing (SOUZA et al. 2016). Thus, it is necessary to know the quality,

such as length, of the skin in order to better use this raw material for the manufacture of different products. In this context, the aim of this study was to evaluate the effects of BP + SPV on the length of the fur of rabbits fed different levels of replacement of maize and alfalfa hay in diets for growing rabbits.

Materials and methods

Animals

To develop this study, the biological essay took place at the Laboratory of Rabbits breeding in Federal University of Santa Maria. A total of 25 rabbits, New Zealand White (NZW), from both sexes (12 males and 13 female), was used, and they were weaned at 35 days old.

The animals were allocated randomly, in five groups (5 rabbits per group), in a completely randomized design. The animals were housed in a shed for rabbits, in individual galvanized wire cages, with a dimension of 50x50x50cm, with ceramic feeders and drinkers. Each animal was considered an experimental unit.

Experimental diets and feeding management

The BP and SPV used in the diets – of the Nanica and BRS-Cuia varieties, respectively – were previously dried in

forced-air circulation at 55°C-60°C for 72h. Subsequently, the ingredients were crushed, mixed until complete homogenization and kept in a dry and airy place.

Five experimental diets were formulated. The control diet (0BP+SPV) without BP and SPV; (25BP+SPV) experimental diet with 25% BP and SPV as maize and alfalfa hay substitute; (50BP+SPV) experimental diet with 50% BP and SPV as maize and alfalfa hay substitute; (75BP+SPV) experimental diet with 75% BP and SPV as maize and alfalfa hay substitute; and (100BP+SPV) experimental diet with 100% BP and SPV as maize and alfalfa hay substitute. The diets were formulated containing similar nutritional levels (Table 1), in order to match the needs of the corresponding category, according to the AEC (1987). Banana peels and sweet potato vines were obtained free of charge in Santa Maria, and its chemical composition was analyzed by AOAC (1995). Composition of dry BP: 6.7% crude protein, 6.44% crude fat and 12% crude fiber and composition of dry SPV: 14% crude protein, 3% crude fat and 20% crude fiber.

Rabbits received, *ad libitum*, water and non-peletized ration. Each rabbit received randomly one of the five diets, during 49 days. When the animals were 84 days old, the collect of fur for analysis was performed. The age of 84 days was chosen to collect fur because that is the average age for slaughter in a family farming system.

Fur collection

At the end of the biological essay, five rabbits per treatments were randomly selected, and a little portion of fur was removed from nape, loin and thigh, and submitted to length analysis. The sample of fur was removed through section with a blade, in order to obtain a length from the skin bottom. Measurement of fur length was carried out with a digital pachymeter. The fur length is defined as the distance between point of insertion in the epidermis and the extreme superior tip (Maia et al. 2003).

Statistical analysis

The fur length was tabulated through the Microsoft® Office Excel® 2013 program. Then, these parameters were analyzed by the statistical software SAS, through Analysis of Variance, followed by Tukey test (0.05) and by analysis of correlation and regression curves.

Table 1 – Ingredients of ration with banana peels and sweet potato vines in replacement to maize and alfalfa hay for rabbits.

Ingredients (%)	Experimental diets				
	0	25	50	75	100
Maize	18.00	13.50	9.00	4.50	-
Banana peels	-	4.50	9.00	13.50	18.00
Alfalfa hay	30.00	22.50	15.00	7.50	-
Sweet potato vines	-	7.50	15.00	22.50	30.00
Wheat meal	25.00	25.00	25.00	25.00	25.00
Soy-bean meal	17.00	17.50	18.00	18.00	18.05
Soy-bean oil	2.50	2.50	2.50	2.50	2.50
Rice hull	5.75	5.25	4.75	4.75	4.25
Dicalcium phosphate	0.80	0.80	0.80	0.80	0.80
Calcitic limestone	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50
Premix*	0.20	0.20	0.20	0.20	0.20
Chemical composition of feed mixtures (%)					
Dry Matter	87.50	87.40	87.20	87.90	87.45
Crude Protein	17.71	17.54	17.52	17.35	17.27
Crude Ash	9.52	9.60	9.85	9.90	9.95
Crude Fiber	15.16	15.28	15.47	15.61	15.83

Note: 0: Diet without banana peels and sweet potato vines; 25, 50, 75, 100: Diets with 25%, 50%, 75%, 100% of replacement of maize and alfalfa hay for banana peels and sweet potato vines, respectively. *Premix Composition (per diet kilogram): Vitamin A 600,000 IU; Vitamin D 100,000 IU; Vitamin E 8,000; Vitamin K3 200 mg; Vitamin B1 400 mg; Vitamin B2 600 mg; Vitamin B6 200,00 mg; Vitamin B12 2,000 mg; Pantothenic acid 2,000 mg; Choline 70,000 mg; Fe 8,000 mg; Cu 1,200 mg; Co 200 mg; Mn 8,600 mg; Zn 12,000 mg; I 65 mg; Se 16 mg.

Results and discussion

The hair length of rabbits fed different experimental diets did not show different mean values (Table 2).

The data related to the correlation test showed that the ρ value was positive, indicating a weak correlation, with $\rho = 0.20$, $\rho = 0.18$, and $\rho = 0.11$ in the nape, loin, and thigh, respectively. In this sense, for each

1% of BP+SPV replacing maize and alfalfa hay, hair length increased: 0.0012cm on the nape, 0.001cm on the loin and 0.0009cm on the thigh, which is not zootechnically

expressive although mathematically smaller (Figure 1).

Table 2 – Fur length of rabbits fed different levels of banana peels and sweet potato vines in replacement to maize and alfalfa hay.

	Experimental diets (BP+SPV)					P-value
	0	25	50	75	100	
Nape (cm)	2.18±7.53	2.26±8.03	2.36±7.09	2.32±10.73	2.30±15.06	0.78
Loin (cm)	2.94±6.63	3.16±5.29	3.04±10.55	3.02±2.77	3.14±6.97	0.47
Thigh (cm)	3.00±14.52	3.10±7.90	3.18±6.04	3.00±14.14	3.16±6.56	0.83

Note: 0: Diet without banana peels and sweet potato vines; 25, 50, 75, 100: Diets with 25%, 50%, 75%, 100% of replacement of maize and alfalfa hay for banana peels and sweet potato vines, respectively. Means followed by coefficient of variation.

Rabbits are covered by a skin that has several functions, such as protection of the environment, temperature regulation, among others. Three layers, the epidermis, dermis and hypodermis, with mechanical properties, mainly incorporated by the dermis, the thickest layer, constitute this tissue. It contains the hair follicles, which are responsible for producing hair or wool, which consists of a fibrous protein called keratin. Regarding this, Zhao et al. (2017) verified that non-genetic factors such as nutrition are important and influence the quality of the hair. The hair development process is directly related to the availability of amino acids, which are the most important nutrients for the hair growth process.

In this context, Ke-liang et al. (2004) studied different levels of crude protein (CP) in diets for rabbits, the aforementioned authors found positive results at similar levels of CP for good hair growth. Our results are also attributed to the similar level of crude protein (Table 1), with 18% present in the five treatments.

Fur from the New Zealand white rabbit (NZW) strain is highly desirable as it offers strength, good elasticity and other unique attributes that differentiate it from fur from other species (SOUZA et al., 2016). In addition, rabbit skin has attractions such as being a durable material, imitating other skins, having a low production cost, in addition to the possibility of colors (MACHADO, 2012). In this context, our

study is in line with these quotes, as we used NZW rabbits and this substitution proved to be viable, as an alternative was sought to

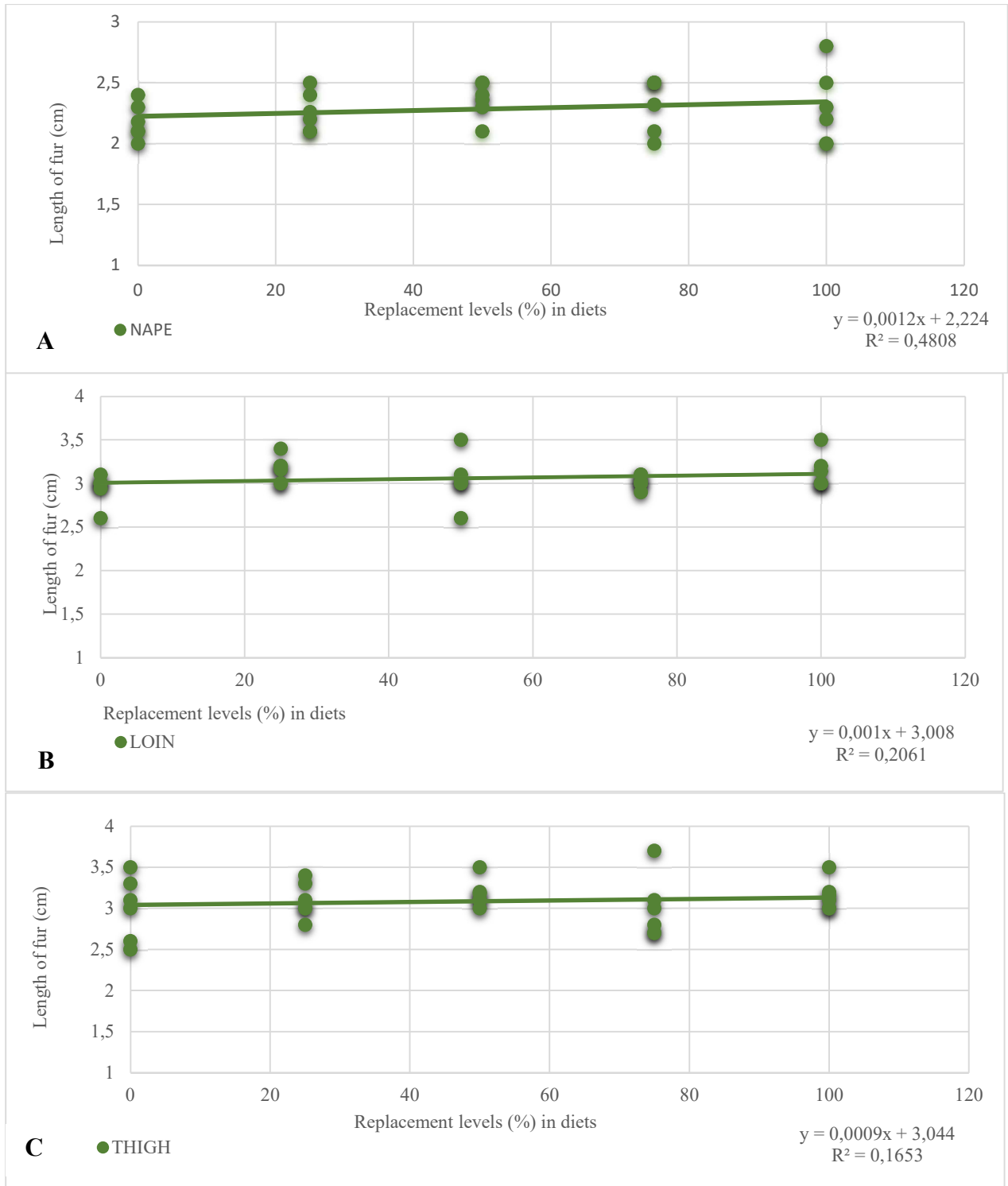


Figure 1 – Rabbit's fur length (y) due to levels banana peels and sweet potato vines as a replacement to maize and alfalfa hay, respectively (x) in the diets. A) Nape , B) Loin and C) Thigh.

reduce the production cost (based on the substitution of ingredients), and also because there were no differences in length from the hair.

Studies related to hair length have already been studied and indicated to be feasible, Falcone et al. (2020), in their research on the inclusion of BP in diets for rabbits, report that replacing BP with maize did not affect any skin characteristics. Furthermore, Klinger et al. (2018), in their study on the inclusion of SPV replacing alfalfa hay in diets for rabbits, concluded that there was no negative change in the skin. In this context, the use of alternative ingredients (BP and SPV) in rabbit diets represents a viable production strategy due to the possibility of reducing feed costs.

After this research, it was found that the results obtained based on the possibility of using alternative ingredients – BP and SPV –, which are usually discarded and have a low cost or with no cost, in diets for rabbits with the intention of maintaining the standard of desired quality of hides. In this context, different unconventional ingredients have shown promise in rabbit farming, in addition to being sustainable, as they help producers with cheaper diets,

minimize environmental impacts and are important in income generation (Oseni and Lukefhar, 2014; Potrich et al., 2017).

CONCLUSION

After this study, it was concluded that alternative ingredients such as banana peel and sweet potato vines, which have high nutrient density, could be used in diets for rabbits. Therefore, banana peel and sweet potato vines can replace maize and alfalfa hay by up to 100% in diets for growing rabbits, without affecting any pelage traits.

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