Journal of Animal Production, 30 (2), 24-31, 2018

Productive Behavior of Rabbits Fed Spent Mushroom Substrates

Osmar Martínez Ramírez, Rosa C. Bermúdez Savón*, Román Rodríguez Bertot**, Nora García Oduardo**

***Center for Industrial Biotechnology Studies, Faculty of Natural Sciences, University of Oriente, Santiago de Cuba**

****Center for Animal Production Studies (CEPA), University of Granma, Granma, Cuba**

catalina@uo.edu.cu

ABSTRACT

Thirty male rabbits (Cuban Brown) were studied for 35 days to determine their production indicators. The animal diet included spent mushroom substrate (SMS). The animals were distributed in a completely randomized design with three treatments and five replications. Two treatments were analyzed: control (balanced diet including maize, soy, sugar cane meal, and mulberry leaf meal), and substitution of the mulberry leaves for milled SMS (20 and 10% inclusion). The final live weights (1.54, 1.50, and 1.52 kg), mean daily gains (17.41, 15.98, and 16.70 g/rabbit/day), feed consumption (70.04, 76.94, and 74.50 g/rabbit/day), and feed conversion (4.36, 4.81, and 4.46, respectively) showed no differences ($P > 0.05$) among the treatments. The substitution of mulberry leaves for SMS did not affect the productive behavior of the animals. These results suggest the inclusion of up to 20% SMS in the diet of fattening rabbits.

Key words: *sugar cane, mulberry leaves, coffee pulp, spent mushroom substrate*

INTRODUCTION

Rabbit production is one important alternative for human nutrition, due to low investment costs per production area, the possibility of using cheaper, locally based foods (Mora Valverde, 2012), high prolificness, low generational interval, and high meat yields (Martínez, Santos, Ramírez and Sarmiento, 2010; Palma and Hurtado, 2010). Additionally, it can improve the living standards of highly depressed rural areas both socially and economically, where it can be used as a source of self-consumption and income (Nieves, 2009).

However, in Cuba, the nutrition of monogastric animals is essentially based on imported raw materials, thus increasing the costs of production (Adedeji *et al.*, 2013). Moreover, Montaño, Quiñonez, Iglesias and Sagaró (2016), said that the livestock model in tropical countries is, in many cases unsustainable, mainly because of poor use of local resources, and not due to high dependence on imports.

Therefore, it is important to do and promote research oriented to new alternative sources based on low inputs and lower costs, which may ensure quality diets in the quantities required (Safwat, Sarmiento-Franco, Santos-Ricalde, and Nieves, 2014).

Leyva (2012) and Medugu *et al.* (2012) recommended the use of mulberry (*Morus alb*a) as a potential alternative source of protein for rabbits. It can adapt well to the agroecology and has a high capacity to produce biomass with elevated nutritional values (Martín, 2004). Another alternative source is sugar cane (*Saccharum officinarum*), with important levels of cellulose and hemicellulose for rabbits. Both are necessary to maintain the gastrointestinal transit speed, as well as general animal health (Savón, 2002; Nicodemus *et al.*, 2004). Furthermore, Dihigo *et al.* (2008), in a plant characterization study, reported the energy contents of mulberry (14.55 MJ/kg DM; 40.51% NDF; 26.89 ADF), and sugar cane (16.60 MJ/kg DM energy; 59.60% NDF and 34.60 % ADF), and La O *et al.* (2015) reported the use of sugar cane as a source of energy for rabbits.

Biotechnology is another tool that can contribute to these alternatives, with solid state fermentation (SSF), widely used in bulky material recycling through simple technologies to increase protein contents, by improving the amino acid balance and the digestibility of the raw materials used (Luna Fontalvo, Córdoba López, Gil Pertuz and Romero Borja, 2013).

One of the most feasible technologies for bioconversion of lignocellulosic residues is Pleurotus mushroom production, through SSF. This technology is used to convert agricultural by-products into food for humans (mushrooms), and animals (spent substrate) (Chang, 2007).

The Center for Industrial Biotechnology Studies (CEBI) has implemented the technology to generate Pletorus mushroom on coffee pulp, which in addition to mushrooms, it can also produce large amounts of spent substrate (SMS). According to Philippoussis and Diamantopoulou (2011), Bermúdez Savón, García, and Serrano (2013), the substrate is made of detoxified coffee pulp by fermentation. It has adequate protein contents and increased digestibility, so it can be used as a complement in animal diets.

The aim of this research was to evaluate the effect of diets with 10 and 20% spent mushroom substrate (SMS) on the productive indicators of rabbits in the growth-fattening stage.

MATERIALS AND METHODS

The experiments were made at Conejera del Caney, Santiago de Cuba. The SMS from the production plant at the Experimental Agroforestry Station, Tercer Frente, Santiago de Cuba, was used. It was produced on February 2015 with 65% biological efficiency (percent ratio of fresh harvested mushrooms and the dry weight of the spent substrate). Details of the chemical composition of SMS (Table 1).

Thirty animals (53 day-old male Cuban Brown) were distributed in a completely randomized design with three treatments and five replications. The rabbits were lodged in galvanized wire cages measuring 76 x 76 x 45 cm (length, width, and height, respectively). They were placed serially, 1.5 m high from the soil, and 2 m below the roof. The diets were made according to the requirements for the species (Riverón *et al.*, 2005), and adaptation lasted 7 days.

The raw materials were crushed in a hammer mill with a 3 mm sieve. Treatments: control diet (balanced diet including maize, soy, sugar cane, and mulberry); and inclusion diet (10 and 20% SMS meal) (Table 2). The experimental period lasted 35 days. The food was administered twice a day (8:00 am and 5:00 pm). Water was supplied *ad libitum* in clay water and food troughs.

The initial and final weights were determined separately (60 and 95 days), always at the same time, before the first meal of the day. Food consumption was measured daily by the difference between the amounts offered and rejected. The initial and final live weights, and the experimental days were taken into consideration to determine the mean daily gain (MDG). Food conversion was calculated using the ratio between food consumption and weight increase. A 10 kg (±5 g) pan balance was used to determine weight.

The chemical composition of SMS (Table 1) was determined according to the method described by AOAC (1995) for dry matter, organic matter, crude protein, crude fiber, ashes, phosphorous, and potassium.

The diet energy balance (Table 2) was made using the method described by Riverón *et al.* (2005), multiplying the inclusion percent of the raw material in the diet by the tabulated energy value, then dividing the result by 100%.

The data were processed through IBM SPSS, version 23. The mean and standard deviations were estimated for all the variables analyzed. Additionally, simple ANOVA was made to compare the response of the treatments studied. Mean comparison tests were made *a posteriori*, using the Tukey´s test. In all the cases, normality was determined according to Kolmogorov-Smirnov and Levene´s variance homogeneity. The significance criterion was $\alpha = 0.05$.

RESULTS AND DISCUSSION

The nutritional value of a food is directly related to its chemical composition because the nutrients in the dry matter (DM) are in charge of deciding greater or lesser animal production, adequate biological performance, or health (Santana, 2000).

The dry matter contents of SMS (Table 1) guarantee long storage periods, and lower risk of contamination by fungi (López *et al.*, 2014). The protein, fiber, and energy levels were suitable for rabbit consumption.

Although it is a fact that agroindustrial products are a source of biomass for animal nutrition through processes like SSF, which improve nutritional values and digestibility (Ajila *et al.*, 2012), the occurrence of toxicity must be considered, regardless of the presence of secondary metabolites.

Their presence is not the only condition (or necessary in certain cases), to affect animal health (García, Medina, Soca and Montejo, 2005).

The inclusion of alternative foods in practical diets is limited due to insufficient information available about their digestive use (Nieves, Araque, and Terán, 2006). They are utilized to reduce the costs of feedstuffs, taking advantage of the quality of the supplement (Mora-Valverde, 2010); hence, the inclusion of SMS was limited to 20%.

No deaths or signs of food rejection were observed in the animals. Table 3 shows the productive indicators of rabbits that received two inclusion levels of SMS during the growth-fattening stage.

No significant differences were observed ($P > 0.05$) in the productive indicators of the treatments; therefore, this diet could be a nutritional alternative for breeders who cannot afford commercial feedstuffs, which also increase costs.

The final weights of animals corresponded to reports made by González (2007) for this stage, the weight at sacrifice was also similar to the one established for the species.

López *et al.* (2014) published higher levels for this indicator using alternative foods (mulberry meal) at different proportions in commercial feeds, with the best results for the 30% inclusion of 2.37 kg. Nieves, Araque, and Terán (2006) also reported 2.70 kg of live weight on the 90th day.

Lara, Itzá, Sanginés, and Magaña (2012) found an average final weight of 1.68 kg, using diets with 30% mulberry meal. Furthermore, Marín (2013) reported final live weight values of 1.86, 1.94, and 1.77 kg in the 15, 25, and 35% inclusion treatments.

The mean daily gain was around 16 g/rabbit/day (Table 3), which according to García (2005), can be achieved in Cuba with milled feedstuffs or feedstuffs plus foliage. La O (2007) and Leyva (2010) achieved daily gain rates of 17 g/rabbit (typical of fattening animals), using alternative and sustainable feeding systems for tropical regions (Silva, Terán and González, 2002). Terrero (2005) reported 16.56 and 15.03 g of daily gains, by substituting the commercial feeds for *Leucaena leucocephala* forage. Meanwhile, Nieves *et al.* (2009) reported 26 g of MDG in rabbits fed tropical foliage diets.

The results of this study (Table 3) are encouraging for tropical regions. According to Pérez (1990), Marai, Habeeb, and Gad (2002), the high temperatures and ensuing heat stress have negative effects on the animal mean daily gain. Lukefahr and Cheeke (1991) considered these gains as satisfactory for tropical or arid climates, using alternative feeding systems, which resulted in varying daily weight gains of rabbits raised in highlands between 10 and 20 g, whereas it is between 30 and 40 g for temperate regions.

In terms of food consumption, the results were similar to the ones reported by Nieves, Silva, Terán, and González (2002), when they included 20 and 30% of *Leucaena leucocephala* foliage meal for rabbits, with 71.39 and 74.36 g/rabbit/day, respectively. However, these authors noted that for 10 and 40% inclusions of that plant, consumption was 58.82 and 52.67 g/rabbit/day, respectively.

Regarding the use of alternative sources of nutrition for rabbits, Caro *et al.* (2013) reported daily consumption values of 102, 95, and 92 g for the 0, 15, and 30% inclusions, respectively, using *Moringa oleifera*, whereas Nieves, Cordero, Terán, and González (2004) evaluated the 30% inclusion of mulberry meal in the diet, and found no significant differences in consumption, compared to the commercial feed.

The differences observed in the comparison study may have been determined by multiple factors that affect animal response. Growth may be influenced by the quality of the diet, environmental conditions, and genetic aspects. In addition to it, fiber has physiological effects along the gastrointestinal tract of monogastric species, depending on the physico-chemical properties of the soluble and insoluble components (Caro and Dihigo, 2012). The insoluble flora (hemicelluloses, cellulose, and lignin) can influence on the speed of intestinal transit, they are the substrate for microorganisms; therefore, they regulate growth and the digestive health of rabbits (Gidenne, Carabaño, García, and de Blas, 2010).

The most important physiological effects take place on voluntary consumption, digestive secretions, intestinal transit absorption, and lipid metabolism (Savón, 2002). According to Gidenne (2003), the inclusion of fiber increases food consumption in order to keep digestible energy waste, due to its low energy contents. However, in this research, no increases in food consumption were observed because the levels of this component were within the values required for the species (Riverón *et al.*, 2005).

The values for food conversion (Table 3) corroborated the results of Dihigo (2005) and Carabaño *et al.* (2008) concerning the adaptability of this species to different alternative resources, and are comparable to reports of other studies based on non-conventional food sources for rabbits in Cuba. For instance, Flores (2005) reported conversion values (meat kg/consumed food kg) of 4.05; Caro Bustamante, Dihigo, and Ly (2013), 4.30; Leyva (2010) 4.81; La O (2007) 4.06 and 4.11 kg/kg. Meanwhile, Isert del Toro (2007) achieved food conversion values of 3.46 kg/kg, using mulberry in Cuban Brown rabbits.

CONCLUSIONS

The substitution of mulberry meal for spent mushroom substrate SMS in the proportions studied did not affect the indicators of productive behavior.

These results suggest the inclusion of up to 20% of SMS in the diet of fattening rabbits.

REFERENCES

ADEDEJI, O. S.; AMAO, S. R.; AMEEN, S. A.; ADEDEJI, T. A. y AYANDIRAN, T. A. (2013). Effects of Varying Levels of *Leucaena Leucocephala* Leaf Meal Diet on the Growth Performance of Weaner Rabbit. *Journal of Environmental Issues and Agriculture in Developing Countries*, *5* (1), 5-9.

AJILA, C.M.; BRAR, S.K.; VERMA, M.; TYAGI, R.D.; GODBOUT, S. y VALERO, J. R. (2012). Bioprocessing of Agro-Byproducts to Animal Feed. *Critical reviews in biotechnology*, *32* (4), 382-400.

AOAC (1995). *Official Methods of Analysis*. Washington, D. C.: Ass. Off. Agric. Chem.

BERMÚDEZ, R C.; GARCÍA, N. y SERRANO, M. (2013). Una tecnología sostenible, aportando a la seguridad alimentaria. *Tecnología Química, 33* (2), 147-155.

CARABAÑO, R.; BADIOLA, I.; CHAMORRO, S.; GARCÍA, J.; GARCÍA-RUIZ A.; GARCÍA-REBOLLAR, P.; *et al.* (2008). Review. New Trends in Rabbit Feeding Influence of Nutrition on Intestinal Health. *Spanish Journal of Agricultural Research*, *6* (1), 15-25.

CARO, Y. y DIHIGO, L. E. (2012). Comportamiento productivo de conejos alimentados con dietas que incluían harina integral de dólico y mucuna. *Revista UNELLEZ de Ciencia y Tecnología, 30* (1), 29-35.

CARO, Y.; BUSTAMANTE D.; DIHIGO, L. E. y LY, J. (2013). Harina de forraje de moringa (*Moringa oleifera*) como ingrediente en dietas para conejos de engorde. *Revista Computadorizada de Producción Porcina, 20 (4),* 218-222.

CHANG, S. (2007). Mushroom Cultivation using the "ZERI" Principle: Potential for Application in Brazil. *Micología aplicada internacional, 19* (2), 33-34.

DIHIGO, L. (2005). Avance en los estudios de fisiología digestiva del conejo en Cuba con el uso de fuentes de alimentos no tradicionales. Consideraciones fisiológicas. *VIII Encuentro de Nutrición y Producción de Animales Monogástricos*. Guanare. Venezuela.

DIHIGO, L; SAVÓN, LOURDES.; HERNÁNDEZ, YASMILA; DOMÍNGUEZ, MARBELIS y MARTÍNEZ, MADELEIDY (2008). Caracterización físico-química de las harinas de morera (*Morus alba*), pulpa de cítrico (*Citrus sinensis*) y harina de caña (*Saccharum officinarum*) para la alimentación de los conejos. *Revista Cubana de Ciencia Agrícola, 42* (1), 66-68.

FLORES, R. (2005). *Utilización de la harina de caña proteica en la alimentación de conejos en la etapa de crecimiento-ceba*. Tesis de maestría en Nutrición Animal, Facultad de Ciencias Veterinarias, Universidad de Granma, Cuba.

GARCÍA, D.; MEDINA, M.; SOCA, M. y MONTEJO, I. (2005). Toxicidad de las leguminosas forrajeras en la alimentación de los animales monogástricos. *Pastos y forrajes, 28* (4), 279-289.

GARCÍA, Y. (2005). *Fuentes de variación genética en cruces simples y a cuatro líneas de conejos*. Tesis presentada en opción al título de Máster para la zona tropical, Instituto de Ciencia Animal, La Habana, Cuba.

GIDENNE, T. (2003). Fibres in Rabbit Feeding for Digestive Troubles Prevention: Respective Role of low-Digested and Digestible Fibre. *Livestock Production Science*, *81* (2), 105-117.

GIDENNE, T.; CARABAÑO, R.; GARCÍA, J.; DE BLAS, C. (2010). Fibre Digestion. En: De Blas C., Wiseman J. (Eds.). *The* Nutrition *of the Rabbit*. (2nd ed.). Wallingford Oxon, UK: CABI Publishing, CAB International.

GONZÁLEZ, P. (2007). *Taller de Cunicultura*. Departamento de Ciencias Agroforestales, Área de Producción Animal, Universidad de Sevilla.

ISERT, MAYDELIS (2007). *Sustitución parcial de concentrado comercial para conejos por diferentes niveles Harina de Morera* (*Morus alba*). Tesis de maestría en Nutrición Animal, Facultad de Ciencias Veterinarias, Universidad de Granma, Cuba.

LA O, A.; VALDIVIÉ, M.; MORA, M. y ACOSTA, Y. (2015). Alimentación cunícola con follajes tropicales y caña de azúcar. *Rev. Producción Animal, 27* (1), 43-48.

LA O, M. L. (2007). *Alimentación de conejos (Oryctolagus cuniculus) con follajes tropicales, caña de azúcar y semillas de girasol*. Tesis de doctorado en Ciencias Veterinarias, Instituto de Ciencia Animal, La Habana, Cuba.

LARA, P.; ITZÁ, M.; SANGINÉS, J. y MAGAÑA, M. (2012). *Morus alba* and *Hibiscus rosa-sinensis* as Partial Substitute of Soybean in Rabbit's Diets. *Avances en Investigación Agropecuaria, 16* (3), 9-19.

LEYVA, CORALIA (2010). *Caracterización química de harinas de frutos y hojas del árbol del pan (Artocarpus altilis) y su empleo en la alimentación de pollos, conejos y ovinos de ceba*. Tesis de doctorado en Ciencias Veterinarias, Instituto de Ciencia Animal, La Habana, Cuba.

LEYVA, J. (2012). *La harina de morera como fuente de proteína en la producción de huevo de codorniz, en la región de Coatepec, Veracruz*. Trabajo de diploma, Facultad de Ciencias Agrícolas, Universidad Veracruzana, México.

LÓPEZ, B.; ISER, MAYDELIS; CISNEROS, M.; RAMÍREZ, J.; VALDIVIÉ, M. y SAVÓN, L. (2014). Inclusión de la harina de Morera (*Morus alba*) en el desempeño productivo de conejos. *Rev. Producción Animal, 26* (2), 1-7.

LUKEFAHR, S. y CHEEKE, P. (1991). Rabbit Project Development Strategies in Subsistence Farming Systems: 2 Research Applications. *World Animal J., 69* (4), 26-35.

LUNA, J. A.; CÓRDOBA, L. S.; GIL, K.I. y ROMERO, I. M. (2013). Efecto de residuos agroforestales parcialmente biodegradagradados por *Pleurotus ostreatus* (PLEUROTACEAE) sobre el desarrollo de plántulas de tomate. *Acta Biológica Colombiana, 18* (2), 365-374.

MARAI, F. M.; HABEEB, A. M. y GAD, E. (2002). Rabbits' Productive, Reproductive and Physiological Performance Traits as Affected by Heat Stress: A Review. *Livestock Production Science, 78* (2), 71-90.

MARÍN, R. (2013). *Sustitución parcial del pienso comercial por harina de (Morus alba) en la ración de conejos en crecimiento y ceba*. Tesis de maestría en Nutrición Animal, Facultad de Ciencias Veterinarias, Universidad de Granma, Cuba.

MARTÍN, G. J. (2004). *Evaluación de los factores agronómicos y sus efectos en el rendimiento y la composición bromatológica de Morus alba Linn*. Tesis de doctorado en Ciencias Agrícolas, Universidad de Matanzas Camilo Cienfuegos, Matanzas, Cuba.

MARTÍN, P. C. (1982). Relación entre el contenido de nutrimentos, digestibilidad y concentración de energía en gramíneas tropicales. *Revista Cubana de Ciencia Agrícola, 16 (2)*, 153-157.

MARTÍNEZ, R.; SANTOS, R.; RAMÍREZ, L. y SARMIENTO, L. (2010). Utilización de Ramón (*Brosimum alicastrum* Sw.) y Cayena (*Hibiscus rosa-sinensis* L.) en la alimentación de conejos. *Zootecnia Tropical, 28* (2), 153-162.

MEDUGU, C. I.; MOHAMMED, G.; RAJI, A. O.; BARWA, E. y ANDI, Z. A. (2012). Utilization of Different Forages by Growing Rabbits. *International Journal of Advanced Biological Research, 2* (3), 375-381.

MONTAÑO, C.; QUIÑONEZ, L.; IGLESIAS, K. y SAGARÓ, F. (2016). Alternativa de alimentación para cerdos en ceba. Condiciones locales de producción. *Investigación y saberes, 5* (2), 78-83.

MORA-VALVERDE, D. (2010). Usos de la morera (*Morus alba*) en la alimentación del conejo. El rol de la fibra y la proteína en el tracto digestivo. *Agronomía mesoamericana, 21* (2), 357-366.

MORA-VALVERDE, D. (2012). Evaluación de cuatro niveles de morera (*Morus alba*) en engorde de conejo bajo normativa orgánica 1. *Agronomía Mesoamericana, 23* (2), 311-319.

NICODEMUS, N.; PÉREZ-ALBA, L.; CARABAÑO, R.; DE BLAS, C., BADIOLA, I. y PÉREZ, A. J. (2004). *Effect of Fibre and Level of Ground of Fibre Sources on Digestion and Ileal and Caecal Characterization of Microbiota of Early Weaned Rabbits*. Proc. 8th World Rabbit Congress, 7-10 septiembre, Puebla, México.

NIEVES, D. (2009). *Forrajes promisorios para la alimentación de conejos en Venezuela. Valor nutricional. Alimentación no convencional para monogástricos en el trópico*. VIII Encuentro de nutrición y producción de animales monogástricos, Univ. Nac. Exp. Ezequiel Zamora, Venezuela.

NIEVES, D.; TERÁN O.; VIVAS, M.; ARCINIEGAS, G.; GONZÁLEZ, C, y LY, J. (2009). Comportamiento productivo de conejos alimentados con dietas basadas en follajes tropicales. *Revista Científica FCV-LUZ, 19* (2), 173-180.

NIEVES, D.; ARAQUE, H. y TERÁN, O. (2006). Digestibilidad de nutrientes del follaje de morera (*Morus alba*) en conejos de engorde. *Revista UNELLEZ de Ciencia y Técnica, 16* (4), 364-370.

NIEVES, D.; CORDERO, J.; TERÁN, O.; GONZÁLEZ, C. (2004). Aceptabilidad de dietas con niveles crecientes de morera (*Morus alba*) en conejos destetados. *Zootecnia Tropical, 22* (2), 183-190.

NIEVES, D.; SILVA, B.; TERÁN, O. y GONZÁLEZ, C. (2002). *Aceptabilidad de dietas con inclusión de Leucaena leucocephala y Arachis pintoi en conejos de engorde*. Segundo Congreso de Cunicultura de las Américas, La Habana, Cuba.

PALMA, O. y HURTADO, E. (2010). Comportamiento productivo de conejos durante el período de crecimiento-engorde alimentados con frutos de mango (*Mangifera indica*) en sustitución parcial del alimento balanceado comercial. *IDESIA (Arica), 28* (1), 33-37.

PÉREZ, R. (1990). *La cría del conejo en Cuba*. La Habana, Cuba: Dpto. Prod. Complementaria, Ministerio del Azúcar.

PHILIPPOUSSIS, A. y DIAMANTOPOULOU, P. (2011). *Agro-Food Industry Wastes and Agricultural Residues Conversion into High Value Products by Mushroom Cultivation*. Proceedings of the 7th international conference on mushroom biology and mushroom products (ICMBMP7), France.

RIVERÓN, S.; PONCE, R.; REINALDO, L.; CLAVIJO, A. y CLAVIJO, Y. (2005). *Manejo y explotación del conejo*. La Habana, Cuba: Asociación Cubana de Producción Animal.

SAFWAT, A. M.; SARMIENTO-FRANCO, L.; SANTOS-RICALDE, R. H. y NIEVES, D. (2014). Determination of Tropical Forage Preferences Using Two Offering Methods in Rabbits. *Asian-Australasian journal of animal sciences, 27* (4), 524-529.

SANTANA, A. (2000). *Mejoramiento del valor nutritivo de los ensilajes tropicales mediante mezclas de gramíneas y leguminosas*. Tesis de doctorado en Ciencias Veterinarias, Instituto de Ciencia Animal, La Habana, Cuba.

SAVÓN, L. (2002). Alimentos altos en fibra para especies monogástricas. Caracterización de la matriz fibrosa y su efecto en la fisiología digestiva. *Cuban Journal of Agricultural Science, 36* (2), 91-102.

TERRERO, M. (2005). *Sustitución parcial del pienso comercial por hidroforraje de Leucaena leucocephala*. Tesis de maestría en Nutrición Animal, Facultad de Ciencias Veterinarias, Universidad de Granma, Cuba.

.

Received: 1-10-2018
Accepted: 1-16-2018

Table 1. Chemical composition of spent mushroom substrate (SMS)

Components	Average value
Dry matter (%)	85.38
Crude protein (%)	20.06
Crude fiber (%)	18.41
Organic matter	56.33
** Metabolizable energy (Mcal/kg DM)	2.29
Ashes (%)	9.74
Phosphorous (%)	0.09
Potassium (%)	2.82

** ME (Mcal/kg/DM) = 2.66-0.0199 (%FB), (Martin, 1982)

Table 2. Composition o diets with the inclusion of spent mushroom substrate (MRS)

Raw material[1]	Diets		
	Control	10%	20%
Maize (%)	27.74	28.74	29.54
Soybean (%)	24.76	25.76	26.76
Sugar cane meal (%)	23.50	21.50	19.70
SMS %	---	10.00	20.00
Mulberry %	20.00	10.00	---
Calcium carbonate %	1.5	1.5	1.5
Dicalcium phosphate %	1.0	1.0	1.0
Vitamin pre-mix[1] %	1.0	1.0	1.0

Salt %		0.5	0.5	0.5
Total		100	100	100
Nutrients	Demands		Contribution	
Crude protein (%)	16-17	16.72	16.72	16.72
Crude fiber (%)	13-14	14.16	14.13	14.18
**Metabolizable energy (Mcal/kg DM)	2.5	2.74	2.73	2.74

1: Each kg contains vitamin A 12 000 IU, vitamin D32000 IU, vitamin B24160 IU, niacin 16 700 IU, pantothenic acid 8200 IU, vitamin B63420 IU, folic acid 0.980 g vitamin B12 16 mg, vitamin K 1560 IU, vitamin E 16 µg, BHT 8.5 g, cobalt 0.750 g, copper 3.5 g, iron 9.86 g, manganese 6.52 g, sodium 0.870 g, zinc 42.4 g, selenium 6.6 µg.

Table 3. Productive indicators of rabbits fed with two inclusion levels of SMS as a substitute for mulberry during the growth-fattening stage.

Variables	Inclusion levels (mean ±.DT)				
	Control	10%	20%	F	p
Initial weight (g/rabbit)	938.5 ± 23.45	940.5 ± 18.62	944.5 ± 30.59	0.153	0.859
Final weight (g/rabbit)	1548.0 ± 107.42	1500.0 ± 93.77	1529.0 ± 88.43	0.623	0.544
Daily gain (g/rabbit)	17.41 ± 7.00	15.98 ± 4.52	16.70 ± 9.85	0.046	0.955
Food conversion (kg-kg)	4.36 ± 6.05	4.81 ± 3.13	4.46 ± 3.17	0.040	0.961
Consumption (g/rabbit) day	76.04 ± 11.75	76.94 ± 13.01	74.50 ± 12.46	0.339	0.713