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Characteristics of Canary Hair Sheep (Pelibuey) Lamb's Carcass Fed with Banana (*Musa acuminate*) By-products

Research Article

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ABSTRACT

The use of alternative feeds for animal nutrition has widely been recommended in the last years. Banana (*Musa acuminate*) is a predominant culture in many tropical and subtropical regions of the world with an estimated world production of 116 million tons. Banana by-products could be used as alternative feeds for ruminant nutrition. The present study assessed the effects of replacing ryegrass hay with banana by-products on carcass characteristic and composition in Canary hair sheep lambs. The animals (N=22, weighted 14.8±0.5 kg body weight (BW)) were divided into 2 groups receiving a mixture of fresh banana by-products and commercial ryegrass hay, respectively. A commercial concentrate feed was also added to both groups. After a 58-day trial, 14 animals (n=14) were slaughter at weights of 25.0 ± 0.6 kg BW. Carcass weight, dressing weight, composition and tissue weight were not significantly different for both groups, except for the weights of the empty digestive tracts (P=0.001) and livers (P=0.002). The results confirm that banana by-products could be used as alternative forage source for Canary hair sheep lambs raised in sub-tropical conditions.

KEY WORDS banana by-product, Canary hair sheep breed, carcass quality, Pelibuey sheep.

INTRODUCTION

The use of alternative feed resources in animal nutrition has been great interest in the last years. In the tropical and sub-tropical regions, the greatest challenge for sustainable animal production is probably the use of local by-products and forages, because of the high cost and low availability of conventional forages, cereals and oleaginous. Likewise, the competitive conflict with human nutrition is some of the main reasons why alternative feeds must be proposed (Ben Salem *et al.* 2008; Vasta *et al.* 2008). One of the human feed is bananas (*Musa acuminate*) that are a predominant culture in many tropical and subtropical areas, mainly produced between twentieth parallels North (20 ˚N) and South (20 ˚S). World harvested area and world production of bananas in 2020 was about 5.7 million ha and 116 million tons, with a progressive increase since 2000 (1.2 million ha and 48.5 million tons) (FAOSTAT, 2020). It is convenient to highlight that integrating banana crops in animal farms and animal feed gives an opportunity to diversify the economy of animal farms, on one hand, using bananas products (banana fruit, leaves, pseudo-stems) to feed animals and, on the other, taking advantage of animal waste (manure) to fertilize crops, reducing culture and feeding costs on farms (Archimède *et al.* 2010; Barbera *et al.* 2018).

By-products of banana crops include leaves (5 to 10 kg per plant), pseudo-stems (25 to 50 kg per plant) and raceme stems (2 to 3 kg per plant), making between 5 to 10 tons of dry matter (DM) per Ha, depending on the intensification of the cultivation. By-products of banana could be utilized in

sun-dried or fresh form as animal feed. Pseudo-stems and leaves can be used separately or mixed together, whole or chopped for feeding ruminants (Barbera *et al.* 2018; Pieltain *et al.* 1999). Experiments conducted to evaluate the nutritional properties of banana by-products are common in pigs, but are scarce in ruminants. Pieltain *et al.* (1999) reported than diets based on banana leaves should cover about 0.85 of the maintenance energy requirements of goats. Concerning sheep nutrition, green banana and banana by-products has been evaluated as an alternative feed with promising results (Archimède *et al.* 2010; González-García *et al.* 2008; Barbera *et al.* 2018). Banana leaves and pseudo-stems have also been tested in Martinik sheep, concluding that these by-products can be recommended as sources of forage (Marie-Magdaleine *et al.* 2009). Banana leave alone resulted in improvement in intake (dry matter (DM), organic matter (OM), and crude protein (CP)) and digestibility in sheep, moreover when banana leaves is used as a supplement to poor quality grass, better body weight gain is obtained (Chali *et al.* 2018).

The Canary hair sheep (Pelibuey) has a marked aptitude for meat and a great rusticity, reasons by which they are widely distributed on tropical areas of Latin America and some African countries. The knowledge of the use of banana by-products as available feed resources for this sheep breed is scare and there no studies related with its effect on lamb's carcass.

To know if a diet is suitable for animals destined to produce meat, it is necessary also to assess the results of feeding in the characteristics and composition of the carcass and to know the effect of the diets on the dressing weights. The aim of this work was to evaluate the effect of banana by-products (leaves and pseudo-stems) on the carcass weight, dressing percentages, and characteristics and composition of the carcass, in Canary hair sheep lambs as alternative feed source in local conditions by looking and comparing the differences on lamb's carcass replacing ryegrass (*Lolium* spp.) hay by banana (*Musa acuminata*).

MATERIALS AND METHODS

Animal experiments described comply the guidelines of the European Union Council (2010/63/EU) for the use of experimental animals.

The study was conducted in the University of Las Palmas de Gran Canaria, Faculty of Veterinary Sciences, locate (Latitude 27˚ 55´ 45´´; Longitude 15˚ 23´ 20´´), Canary Islands, Spain. The climate conditions are subtropical with average temperatures from 18 to 24 ˚C (64. 4 and 75. 2 ˚F). Temperatures vary according to the seasons (15.5 ˚C minimum and 25.9 ˚C maximum) and precipitations range from 150 to 600 mm annually.

Animals and feeding management

A total of 22 Canary hair sheep breed lambs were used in this study. After weaned at 3 months old (average weight 14.8±0.5 kg BW), lambs were assigned by weight and randomly allotted into two groups of 11heads each. After the adaptation period (10 days), lambs were dewormed (Ivermectina®), housed in individual pens (3 m×2 m) and fed *ad libitum* for 58 days in March and April. Each group received different feed: the first group (experimental diet) a mixture of banana (*Musa acuminata*) by-products composed by leaves and pseudo-stem; the second group (conventional diet) received commercial ryegrass hay. Banana by-products were collected daily, chopped (10-15-cm long particles), dried and mixed just before they were offered to the animals. Banana by-products and ryegrass hay were administered *ad libitum*.

A commercial concentrate feed (CON) was also administered to both groups *ad libitum*. Salt blocks Wurth® (salt 94.4%, magnesium oxide 2.4%, calcium carbonate 0.8%) and water were freely available. Chemical compositions of the diets are summarized in Table 1 (Barbera *et al.* 2018).

During this 58-days trial, the body weight, and intake of the animals was recorded initially and at 5-day intervals until slaughtered. Daily feed intake, total intake, and digestible energy intake of both diets were calculated. Finally, total body weight gain, average daily gain (ADG), and feed conversión ratio (FCR) of lambs were calculated (Table 1).

Analytical methods of feedstuffs

Forages and concentrates were sampled weekly to determine dry matter (DM) and to be chemical analyzed by AOAC methods (AOAC, 2003). *In vitro* digestibility of the organic matter (IVOMD) of duplicate samples of each feed was estimated according to Van Soest *et al.* (1966) following the modification by Ankom Tecnology Corporation. Digestible energy (DE) was estimated at 0.0185 × IVOMD (MJ/kg DM) (NRC, 1988) and metabolizable energy (ME) as ME/DE= 0.82 (MJ/kg DM) according to NRC, (2007).

Slaughter and carcass evaluations

The slaughter weight at 58 days was 25.0 ± 0.6 kg live body weight (LBW). Fourteen (n=14) lambs were slaughtered in the experimental slaughterhouse of the Faculty of Veterinary Sciences, University of Las Palmas de Gran Canarias. After slaughter, the head was removed at the atlanto occipital joint and fore and hind feet removed at the carpal and tarsal joints, respectively. The animals were partially skinned lying on their back on the floor. Thereafter, the animals were suspended by the hind legs for further skinning. Blood, the rest of the internal organs of the animals were also collected for further assessment.

Table 1 Ingredients, chemical composition and nutritive value of experimental diets (Barbera *et al.* 2018)

Ingredient (%)	Banana by-products	Conventional diet
Ryegrass	0	35
Banana pseudostems	18	0
Banana leave	18	0
Corn	40	40
Barley	14	15
Soybean meal	10	10
Chemical composition (g/kg DM)		
Organic matter	905.7	943.7
Crude Protein	125.4	126
Neutral detergent fibre	360	369
Acid detergent fibre	188	229
Estimated metabolizable energy (MJ/kg DM)[1]	10.1	10.2
Growth performance		
Total dry matter intake (g/day)	681.6	722.5
Total digestible energy intake (MJ/day)	9	9.5
Average daily gain (g/day)	153	173
Feed conversión ratio (FCR)	4.5	4.2

[1] Estimated digestible energy (MJ/kg DM was estimated at 0.0185 × IVOMD (NRC, 1988) and estimated metabolizable energy (MJ/kg DM): ME/DE= 0.82 (NRC, 2007).

Carcass and non-carcass component weighed immediately after slaughter and carcasses were chilled 24 hours at 4 ˚C. Lungs and trachea were weighed as one piece. Non carcass components included head, skin, feet, digestive tract, liver, spleen, kidney, heart, pancreas and lungs and trachea. Weight of digestive contents was computed as the difference between full and empty digestive tract.

Afterwards, empty body weight (carcass without gastrointestinal tract) was recorded as well as the weight of the hot carcass (immediately after slaughtered) and the cold carcass (after 24 hours at 4 ˚C). Commercial dressing percentage was estimated as the ratio between cold carcass weight and live weight multiplied by 100 and true dressing percentage was estimated as the ratio between hot carcass weight and empty body weight multiply by 100 (Charpentier, 1967).

Statistical analysis

Data on carcasses and meat quality traits from the slaughter of fourteen (n=14) lambs were subjected to analysis of variance. There were two defined groups with the same number of samples each (n=7): the control diet with ryegrass hay (RGHAY) *vs*. the experimental diet with banana by-products (BBP). Based on mean comparison using LSD test, and a level of $P < 0.05$ was chosen as the minimum for statistical significance using Statistical package version 20 (SPSS, 2011). Results were expressed as the mean of determinations ± standard error of the mean (SEM).

RESULTS AND DISCUSSION

Results of the nutritive value of banana by-products and conventional diet in Canary hair sheep was shown in the Table 1.

Chemical composition of diets and digestibility were analyzed, and metabolizable energy (ME) (MJ/kg DM) was estimated. Feed intake, body weight gain, ADG, and FCR of both diets in lambs were calculated and were described and recorded in previous study (Barbera *et al*. 2018). The results obtained in this study suggest the possibility to integrate banana by-products in ruminant feeding. Different results have been reported by Pieltain *et al*. (1999) feeding goats with banana leaves (125 g of CP per kg DM; 6.5 MJ/kg DM of metabolizable energy), and pseudo-stems, whose value are lower (70 g CP/ kg DM; 6.6 MJ/kg DM of metabolizable energy).

In a previous study, González-García *et al*. (2008) using adult castrated Pelibuey and banana by-products, found that the nutritive value of leaves (20% DM; 142 g of CP per kg DM) was considered acceptable, while these values were lower for pseudo-stems (6.5% DM and 25 g CP/kg DM). Thus, some nutritional aspects of the pseudo-stems such as low DM, CP and microbial protein to be synthesized from degraded dietary N when energy is not limiting (PDIMN) could affect the voluntary intake in the lambs. Nevertheless, these parameters were within normal ranges for tropical lambs fed low energy-density and reported by Marie-Magdaleine *et al.* (2009) feeding Ovine Martinik sheep with banana by-products. Moreover, Chali *et al.* (2018) reported than banana leaves used as a supplement to poor quality grass, resulted in improvement in intake (DM, OM, and CP), better body weight gain and digestibility in sheep. Parameters related to dressed carcasses are summarized in Table 2.

Weights and carcass performance for both studied groups did not show statistically significant difference. Slaughter weight (25.0±0.6 kg) was reached in 58 days, a shorter time than described by Marie-Magdeleine *et al.* (2009) using

banana by-products and Ovin Martinik sheep, in which lambs spent 90 days to reach 22-24 kg.

Although were not statistically significant difference on empty body weight (kg) of lambs, it was higher on lambs feed conventional diet (22.49 kg) compare with empty body weight (19.98 kg) of lambs feed banana by products. This may be due to liver weight, which showed significant higher weight (P<0.05) in the conventional group (Table 3), and has to be related to the higher DM, digestible energy intake and average daily gain of lambs of conventional group (Table 1).

Commercial dressing percentage ranged from 43.6% to 45.3%, while true dressing percentage ranged from 52.9% to 54.5%, this latter showed a higher variation between groups probably caused by the empty digestive tract and liver, which showed significant higher weight (P<0.05) in the conventional group (Table 3). Dressing percentage ranges are similar than those reported by Sen *et al.* (2004) and by Chali *et al.* (2018) using local sheep, banana by products and feed resources on semiarid regions. Commercial dressing percentages, however, were higher than reported by Marie-Magdeleine *et al.* (2009) feeding Ovin Martinik lambs with banana by-products, while hot and chilled carcass weights showed similar results.

Variable concerning carcass composition and tissue weight obtained from both groups (Table 3) did not show statistically significance difference except for the weight of the empty digestive tracts (P=0.001) and livers (P=0.002). The weight of the liver was higher (P<0.05) for the lambs feed on the conventional diet, different results were found by Chali *et al.* (2018) showing that the weight of the liver was higher (P<0.05) in lambs fed banana diets when compared to those receiving the control diet. The increased liver weight could be due to higher energy available, higher intake of DM in the conventional diet and higher ADG in lambs feed conventional diet. Full and empty digestive tract were higher than reported by Sen *et al.* (2004) using local sheep and feed resources on semiarid regions. Chali *et al.* (2018), also reported that lambs fed on banana leave alone and in combination with silver leaf desmodium to the basal diet of grass hay improved weight gain and carcass characteristics. The weight of the internal organs correlate with the diet received and are in general proportional to the body weight at slaughter. Additionally, some experiments have demonstrated the antihelmintic properties of banana by-products in sheep (Gregory *et al.* 2015), which would support the use of these alternative feeds in commercial sheep flocks in a more sustainable way.

Table 2 Effect of the diets on the weight, dressing and carcass characteristics in the Canary hair sheep

Parameter	Type of diet		
	Banana by-products	Conventional	P-value
Initial live weight (kg)	15.30±3.00	14.30±3.22	NS
Final live weight (kg)	24.40±2.20	25.60±2.30	NS
Empty body weight (kg)	19.98±2.87	22.49±4.55	NS
Hot carcass weight (kg)	10.90±1.80	11.91±2.03	NS
Cold carcass weight (kg)	10.66±1.73	11.61±2.02	NS
Commercial dressing %	43.67±1.90	45.36±2.00	NS
True dressing[1] %	54.55±1.68	52.95±1.53	NS

[1] True dressing %= ratio between hot carcass weight and empty body weight multiply by 100.
NS: no statistical significance.

Table 3 Carcass composition and tissue weight (as % of final live weight) of lambs fed experimental diets

Variable	Type of diet		
	Banana by-products	Conventional	P-value
Blood	4.22±0.40	4.22±0.44	NS
Skin	8.68±1.62	9.55±0.93	NS
Autopod	2.22±0.13	2.14±0.12	NS
Full digestive tract	22.36±2.33	23.01±1.95	NS
Empty digestive tract	9.62±0.17	11.11±0.50	0.001
Liver	1.68±0.13	1.94±0.13	0.002
Spleen	0.18±0.01	0.18±0.03	NS
Kidney	0.14±0.01	0.15±0.01	NS
Head	6.28±0.54	6.09±0.70	NS
Lungs plus trachea	1.60±0.23	1.61±0.26	NS
Heart	0.59±0.23	0.55±0.07	NS
Thymus gland	0.22±0.01	0.21±0.01	NS

NS: no statistical significance.

CONCLUSION

The use of alternative feed resources is highly justified nowadays as world harvested area and world production of bananas in 2020 was about 5.7 million ha and 116 million tons, which would represent available by-products for livestock in those tropical and subtropical banana-producing areas. Many alternative feeds have been tested in animal nutrition including banana by-products but few studies have been conducted to know the effect of feeding banana by-products on the characteristics and the composition of the sheep carcass. Although there was difference in lambs feed conventional diet with higher energy available, higher intake of DM and higher ADG, carcass performance in lambs feed both diets were similar. In this sense, banana by-products used in Canary hair sheep lambs seem appropriate as a forage source as the weights, dressing traits, characteristics, and composition of the carcass for both studied groups, did not show significant differences. Moreover, the results would indicate that banana by-products would also be recommendable for other meat sheep raised in subtropical and tropical conditions. However, these by-products must be evaluated analyzing the effect on the quality of the carcass, using different sheep breeds and other environmental conditions than those from typical tropical areas.

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REFERENCES

AOAC. (2003). Official Methods of Analysis. Vol. I. 17th Ed. Association of Official Analytical Chemists, Arlington, VA, USA.

Chali D., Nurfeta A., Banerjee S. and Olav Eik L. (2018). Effects of feeding different proportions of silver leaf desmodium (*Desmodium uncinatum*) with banana (*Musa paradisiaca*) leaf on nutrient utilization in Horro sheep fed a basal diet of natural grass hay. *Asian-Australasian J. Anim Sci*. **31(9),** 1449-1457.

Archimède H., González-García E., Despois P., Etienne T. and Alexandre G. (2010). Substitution of corn and soybean with green banana fruits and *Gliricidia sepium* forage in sheep fed hay-based diets: effects on intake, digestion and growth. *J. Anim. Physiol. Anim. Nutr*. **94,** 118-128.

Barbera M., Jaber J.R., Ahmed-Salek S., Ravelo-Garcia A., Rodríguez-Ponce E., Rey L. and Ventura M.R. (2018). Effects of replacing rye-grass (*Lolium* spp.) hay by banana (*Musa acuminata*) by-products on feed intake, growth, and feed conversion rate of Canary hair sheep breed (Pelibuey) lambs. *Trop. Anim. Health Prod.* **50,** 1941-1945.

Ben Salem H., Priolo A. and Morand-Fehr P. (2008). Shrubby vegetation and agro-industrial by-products as alternative feed resources for sheep and goats: Effects on digestion, performance and product quality. *Anim. Feed. Sci. Technol*. **147,** 1-2.

Charpentier J. (1967). Calidad de la Canal y de la Carne. Centre for Zootechnical Research, Jouy-en- Jossas, France.

FAOSTAT. (2020). Database of the Food and Agricultural Organization (FAO) of the United Nations. Availabe at: http://www.fao.org/faostat/en/#home.

González-García E., Cáceres O., Archimède H., Arece J., Santana H. and Delgado R. (2008). Nutritional assessment of banana (*Musa paradisiaca*) leaves and pseudostems for ruminants. *J. Anim. Sci.* **86,** 474-484.

Gregory L., Yoshihara E., Ribeiro B.L., Silva L.K., Marques E.C., Meira E.B., Rossi R.S., Sampaio P.H., Louvandini H. and Hasegawa M.Y. (2015). Dried, ground banana plant leaves (*Musa* spp.) for the control of *Haemonchus contortus* and *Trichostrongylus colubriformis* infections in sheep. *Parasitol. Res.* **114,** 4545-4551.

Marie-Magdeleine C., Liméa L., Etienne T., Lallo C.H., Archimède H. and Alexandre G. (2009). The effects of replacing Dichantium hay with banana (*Musa paradisiaca*) leaves and pseudo-stem on carcass traits of Ovin Martinik sheep. *Trop. Anim. Health Prod*. **41,** 1531-1538.

NRC. (1988). Nutrient Requirements of Dairy Cattle. 6th Ed. National Academy Press, Washington, DC., USA.

NRC. (2007). Nutrient Requirements of Small Ruminants, Sheep, Goats, Cervids, and New World Camelids. National Academy Press, Washington, D.C., USA.

Pieltain M.C., Castañon J.I.R., Ventura M.R. and Flores M.P. (1999). The nutritive value of banana (*Musa acuminata*) by-products for ruminant. *Anim. Sci.* **69,** 213-216.

Sen A.R., Santra A. and Karim S.A. (2004). Carcass yield, composition and meat quality attributes of sheep and goat under semiarids conditions. *Meat Sci*. **66,** 757-763.

SPSS Inc. (2011). Statistical Package for Social Sciences Study. SPSS for Windows, Version 20. Chicago SPSS Inc., USA.

Van Soest P.J., Wine R.H. and Moore L.A. (1966). Estimation of the true digestibility of forages by the *in vitro* digestion of cell walls. Pp. 438-441 in Proc. 10th Int. Grasslands Congr. Helsinki, Finland.

Vasta V., Nuddab A., Cannasb A., Lanzac M. and Prioloc A. (2008). Alternative feed resources and their effects on the quality of meat and milk from small ruminants. *Anim. Feed Sci. Technol*. **147,** 223-247.