Conjecturas

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Banana pell pellets for animal feed

Pellest de casca de banana para alimentação amimal

Cristian Ferreira[1], Miguelangelo Ziegler Arboitte[1]*, Franciele de Oliveira[1], Juliana Muliterno Thurow[1], Liliane Cerdotes[1], Leandro Lunardi[1], Letícia de Castilhos[1]

ABSTRACT

The objective was to determine the exact moisture percentage for the formation of pellets from the banana peel, residues of banana candies, and the bromatological analysis of the final product. For the of the peel of banana, 10 different dehydration times were performed: zero; two; four; six; eight; ten; twelve; fourteen; sixteen and eighteen hours of dehydration, with four replicates each treatment. The exact moisture percentage for pellet formation was 18.84% moisture. The final product presented in its bromatological composition 81,16% of DM, 8,59% of CP, 26,8% of TND , 71,48% of NDF, 54,64% ADF, 0,8% of EE, 13,43% MM, 86,54% of OM, 0,22% of P e 0,068% of K. Evaluations in animal models should be performed in place of corn to determine the replacement levels in the diets and the performance of the animals.

Keywords: Food; Musa ssp.; Pelleting; By-products

RESUMO

O objetivo foi determinar a porcentagem de umidade exata para a formação dos pellets da casca de banana, resíduos da fabricação das balas de banana e a análise bromatológica do produto final. Para a peletização das cascas foram testados 10 diferentes tempos de desidratação: zero; duas; quatro; seis; oito; dez; doze; quatorze; dezesseis e dezoito horas de desidratação, com quatro repetições cada tratamento. A porcentagem de umidade exata para a formação dos pellets foi de 18,84% de umidade. O produto final apresentou na sua composição bromatológica 81,16% de MS, 8,59% de PB, 26,8% de NDT, 71,48% de FDN, 54,64% FDA, 0,8% de EE, 13,43% MM, 86,54% de MO, 0,22% de P e 0,068% de K. Avaliações em modelos animais devem ser realizadas em substituição ao milho para determinação dos níveis de substituição nas dietas e o desempenho dos animais.

Palavras-chave: Aliemntação; *Musa* ssp.; Peletização; Co-produto;

[1] Instituto Federal Catarinense Campus Santa Rosa do Sul 1.
*E-mail: Miguelangelo.arboitte@ifc.edu.br

INTRODUÇÃO

Produced in most tropical countries banana (*Musa* spp.) in Brazil accounts with 6% in world production (DOSSA and FUCHS, 2017), placing Brazil in fourth place, with an average production of 6.7 million tons (FAO, 2017), the most consumed fruit in the country, where more than 98% of national production is absorbed in domestic consumption (ABF, 2018).

To increase production, local techniques and research are invested, with the objective of offering a better quality product to the consumer market aiming at greater financial return. Associations and partnerships between farmers and research centers increasingly enable improvements in this production chain. The state of Santa Catarina has stood out with regard to productivity, although the volume of production is lower than the states of São Paulo and Bahia, producing an average of 21,784 mil kg.hectare^{-1} (PIMENTEL, 2006).

As a result of the high production of this fruit, the exploitation of its potential by the industries has intensified. As a result, it increased the commercial range for producers, enabling choices for the sale of (AQUINO, 2013). Of the fruit, about 2.5% to 3.0% are industrialized, in the form of jams and bullets, in which the resulting product 33% are absorbed into the domestic market and the remainder is exported (BORGES and SOUZA, 2004).

During the transformation of the fruit into other more elaborate products, such as the bullet, it is estimated that 40% of the production is waste (LEOBET, 2016) where 85% are barks, 15% are peduncles and less than 1% are worthless fruits, waste in which no correct destinations are given, may lead to problems of environmental contamination.

Banana crop residues have desirable physical-chemical characteristics (ALKARKHI et al., 2011), being taking advantage of various parts of the plant in the feeding of cattle with that observed by Souza et al. (2016) and Casas et al. (2020), nutritional value is considerable for ruminant feeding, residues "in natura" may present in its bromatological composition, crude protein values between 6.3 and 16.0%, ether extract of 2.2 10 the. 9%, carbohydrates of 26 the 46%; mineral matter de 6,4 the 12,9%, gross energy of 4,01 the 4,35 Mcal.kg^{-1} in DM (EMAGA et al., 2007; LEOBET, 2016), can be stored in the form of silage for use as bulky, and the obstacle to this form of conservation is the water content that may represent 92.3 a 78.6% of weight. It can be ensiled in mixture with other residues for the feeding of ruminants as demonstrated by DORMOND et al. (1998), CONTE (2017) and MORAES et al. (2021).

Another form of conservation is the transformation of waste into pellets, as with citrus pulp, which can be supplied as a supplement to ruminants (ANDRADE et al.; 2015) or mixed in silages to reduce moisture from the ensiled material (GRIZZOTO et al. 2017) or to enrich making hay materials (GAVIOLI and LIMA, 2020).

Nutritional characteristics express economic value for animal feed, especially when used strategically in critical periods, where there is low forage production, complementing the feeding of animals, improving livestock rates, provided that an appropriate form is found for its conservation, as the deterioration occurs very quickly due to the moisture levels in the product, together with the fermentation of carbohydrates associated with high temperature (SOUZA et al., 2016). In the feed market, the use of farm-industry by-products for feed production, reduce production costs by increasing production rates (LINHARES, 2016), in addition to minimizing environmental risks, turning a problem into noble meat and milk products.

The main obstacles in the use of banana peel as animal feed is the high moisture content and the variation that occurs in the composition, hindering the transport, storage and formulation of diets containing this by-product (CONTE, 2017). To improve the use of by-products, the industry uses the transformation process, which consists of the use of dehydration, temperature and pressure, improving the ability to store the product for longer periods without fermentation and deterioration, process that forms a product with particles of specific diameters (SANTOS, 2006), with controlled humidity.

The experiment aimed to determine the percentage of exact moisture for the formation of pellets of residues from the manufacture of banana candies, in addition to performing the bromatological analysis of the final product.

MATERIAL AND METHODS

The material used to conduct the experiment was banana peel, derived from the production of candies. The experiment was initially conducted 11 dehydration times (treatments) determined so that the product used for the production of pellets would have different levels of dehydration from the raw material, being composed by the treatments: control "in natura"; dehydration by: two; four; six; eight; ten; twelve; fourteen; sixteen;

eighteen and twenty-two hours in an air oven at 60°C. Each treatment consisted of four repetitions, and sampled from a 1.250 kg banana peel "*in natura*".

The dehydration procedure was performed in a forced air oven at a constant temperature of 60ºC. Samples before being placed in the greenhouse were weighed and after the end of dehydration time were again weighed and submitted to the fur-eat process carried out with the aid of a manual meat machine Nº10 Coyote® of the brand. In the course of this process the material passes through the snail that performs pressure and boosts its output by a 5 mm disc with numerous perforations. At the end of the procedure, the sample that presented the best pellet texture was dried until it had 82% dry mass, 18% moisture content, and the required by the legislation of the MAPA (2009), and submitted to bromatological analysis.

During the dehydration process, data on how much water the shell lost every two hours was extracted, the data were placed in a table and thus representing a straight through regression equation.

For the bromatological analysis, the samples of the banana pellet with the best texture were identified, crushed in a mill type Willey and analyzed in triplicates the following components: Dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), organic matter (OM) and mineral (MM), phosphor, potassium, at the bromatology laboratory of Instituto Federal Catarinense - *Campus* Santa Rosa do Sul.

The determinations of dry matter, crude protein and ether extract followed the methodology described by Silva e Queiroz (2006). The Neutral detergent fiber and acid detergent fiber were determined according to the procedures described by Senger et al. (2008).

The concentration of total digestible nutrients (TDN) was estimated according to the equation proposed by Capelle et al. (2001) for foods in which it the use the participation of the ADF and concentrate the according to the equation:

$$TDN\% = 60{,}04-(0{,}6083 \times ADF);$$

To determine the share of total carbohydrate (%TCHOT) and not structural carbohydrate (%NSC) the equations described of Sniffen et al. (1992):

$$\%TCHOT = 100 – (\%CP - \%MM – \%EE);$$

$$\%NSC = 100 – (\%NDF - \%CP - \%MM – \%EE);$$

For an analysis to determine the content phosphorus (%P) and potassium (%K) was according to the methods for Malavolta et al. (1997).

RESULTS AND DISCUSSION

Samples of residues from the banana candy industry required 22 hours of dehydration at 60°C to present ideal texture for the formation of pellets, with the participation of 81.16% DM. The dry matter is the representation of nutritional constituents present in products, such as crude protein, carbohydrate, ether extract, neutral detergent fiber, acid detergent fiber, minerals, important for balancing the animal diet (MEDEIROS and MARINO, 2015).

It was verified with the use of the regression equation, that the material with 81.16% of DM allowed the best aggregation of the studied material, but even with the great reduction of water, there is still the need to reduce the share of water to 12%, to prevent nutrient degradation, which can occur by the action of fungi, bacteria, oxidations, Mailard reaction, and other undesirable aspects that can cause food poisoning and impair the performance of animals, and may even cause death.

The use of pellet should be evaluated in different ways, including the issue of cost-benefit and nutritional. As for the economic issue, it is important to highlight the need for dehydration and palletization practices, which involve, but improve food conservation by reducing the proliferation of pests in foods with a lot of water participation in their composition, and also the issue of regional availability, such as banana peel.

It is important to note that the formation of banana peel in pellets aims to improve the conservation of the product, which can be stored by longer period in enhancement the banana peel. Banana peel "*in natura*" presents a high degree of deterioration when in contact with air, causing the rejection of animals and food waste.

On the nutritional issue it is important to compare the composition of pellets from banana co-products with maize for being the main energy food used in animal feed, and widely used in supplementation of field or confined cattle.

The bromatological constituents will be discussed with reference to maize, taking databases made available by NRC (2000); Garcia Neto (2010); Valadares Filho et al. (2016) and FEDNA (2019). Table 1 includes descriptive analyses of the evaluated bromatological parameters.

Table 1 – Descriptive analysis of the percentage participation based dry matter of crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), total carbohydrate (TC), not structural carbohydrate (NSC), total digestible nutrients (TDN), mineral matter (MM) e organic matter (OM) of banana peel pellet sample

	CP	EE	NDF	ADF	TC	NSC	TDN	MM	OM
%									
Min	8.1	0.6	67.1	52.3	76.5	2.7	24.6	13.0	86.2
Max	9.6	1.0	73.8	58.3	78.0	10.9	28.2	13.8	87.0
Means	8.5	0.8	71.5	54.6	77.2	5.7	26.8	13.5	86.5
SE	0.2	0.1	2.2	1.9	0.5	2.6	1.1	0.2	0.2
Var	0.3	0.05	14.6	10.9	0.6	21.0	3.8	0.2	0.2
DP	0.5	0.22	3.8	3.2	0.8	4.6	2.0	0.4	0.4
CV	6.8	27.9	5.4	5.9	1.0	80.9	7.3	3.2	0.5

Min – minimum value observed; Max – maximum value observed; SE – standard error; Var - Variance; SP – standard deviation; CV – Coefficient of variation

The share of crude protein was on average 8.6% in banana peel pellet, and this value was above the critical level of 7% minimum requirement for ruminants develop ruminal fermentation (LAZARINI et al., 2009). In banana residues Dormond et al. (1998) observed a value of 10.45% in ripe banana peel, while Emaga et al. (2007) observed values de CP de 6.3 a 11.2% in the peel at different stages of banana maturation, demonstrating that the more mature the banana the peel has the higher protein value.

Values of CP in 10.8% (NRC, 2000), 8.0% (GARCIA NETO, 2010), 9.0% (VALADARES FILHO et al., 2016) and 7.3% (FEDNA, 2019) are reported in corn grains, and banana peel pellet may be a corn substitute food in the crude protein factor.

The ether extract verified in the banana peel pellets was 0.8% (Table 1), value lower than that of maize than in the databases consulted, which presented values of 4.1, 3.3, 4,0 and 3.3%, NRC (2000), Garcia Neto (2010), Valadares Filho (2016) and FEDNA (2019), respectively. As the fat present in food may be a performance limiter of ruminants, the contents in the feed should be in the range of 3 the 5% (LANA, 2005), already Medeiros et al. (2015) mention that the level of ether extract in the ruminant diet should be between 3 the 6%, being values above 6% limiting by causing negative effects on ruminal degradation, decreasing feed efficiency, negatively affecting animal performance.

The participation of neutral detergent fiber (NDF) observed in the pellet of the observed banana peel was 71.5% (Table 1), while Dormond et al. (1998) observed value of 50,1% NDF in peels banana. The value observed in 71,5% NDF is considered as a limiting factor in food intake, however, because it is a pellet with shorter fiber structures or as mentioned by Medeiros et al. (2015) foods that have thin cells, the influence of NDF may be less and may not cause reduced consumption that may affect animal performance.

Banana peel by comparting the protective part of the fruit, the high participation of NDF in banana peel pellet, resembles other co-products from the fruit peel, such as passion fruit and acerola, values of 66.1 and 72.6% NDF as reported of Valadares Filho et al. (2016), or in apple pulp, beet root pulp and grape pomace value of 50.1, 44.3 and 48.6% NDF, respectively (FEDNA, 2019). In corn grain values of NDF are lower than those found in the banana peel pellet, presenting values of 10.8, 8.0,13.06 and 9.0%, NRC (2000), Garcia Neto (2010), Valadares Filho (2016) e FEDNA (2019), respectively.

The cellulose and lignin fraction of a food that makes up acid detergent fiber (ADF) was verified in the banana peel pellet with the participation of 54.6% (Table 1), to superiors 42.8% observed from Dormond et al. (1998) in peels banana. In apple pulp, beet root pulp and grape pomace value of ADF related in FEDNA (2019) they are 36.2, 22.8 and 46.7% NDF, respectively. Value above the 3.3, 3.2 and 2.8% related in NRC (2000), Garcia Neto (2010) e FEDNA (2019), respectively, from corn.

For good rumination to occur, it is necessary to balance the rate and extent of structural carbohydrate degradation (TC) (slow fermentation carbohydrates) and non-structural carbohydrates (NSC) by rumen microorganisms (MACEDO JUNIOR et al. 2007). The verified values of TC and NSC in pellet was from 77.2 and 5.7%, respectively (Table 1), which characterizes the product as a rumination stimulator and that would not cause excessive rapid fermentation which is responsible for the production of fatty acids ruminal pH, by exceeding the buffering capacity of the salivary bicarbonate system, c as what occurs when diets have in their composition high participation of grains such as corn grain, which has an inverse relationship to that observed in the peels banana pellet, corn grain, the share of non-structural carbohydrates is 72.3% (VALADARES FILHO, 2016). Whereas in as apple pulp, beet root pulp and grape pomace the participation of non-structural carbohydrates are intermediate with values of the 36.8, 40.2 and 22.1%.

The high observed participation of NDF, ADF, structural carbohydrates and the low participation non-structural carbohydrates of banana peel pellets may explain the low energy calculated in this food. The participation of total digestible nutrients (TDN) of the peel and banana pellets observed was 26.8% (Table 1), providing approximately 1.0 Mcal. of DE.kg^{-1} DM, energy value below the energy values of other products such as apple pulp, beet root pulp and grape pomace, that providing 2.2; 2.4 e 2.2 Mcal. of DE.kg^{-1} DM (FEDNA, 2019). Low energy can lead to reduced food consumption due to lack of energy. In practice, bulky foods have lower levels of TND (MEDEIROS et al., 2015).

Minerals not representing all inorganic substances, as some salts can volatize (Salman et al., 2010). The average contents of MM and OM verified in the peels banana pellets were of 13.4and 86.5%, respectively (Table 1). In the forage offered to cattle the phosphorus usually presents deficit, mainly because the soils where they are implanted are poor in this mineral, which consequently decreases its bioavailability, failing to meet the nutritional needs of the animal (TOKARNIA et al. 2000; LANA, 2005). However potassium is found in adequate amounts and at times can negatively interfere with the physiology of the animal (PEDREIRA and BERCHIELLI, 2011), mainly in cows in the period preceding parition, which makes it important to determine this two mineral in the supplements to be used for feeding ruminants (ARBOITTE et al., 2019). According to Medeiros and Marino (2015) and Medeiros et al. (2015) phosphorus and potassium deficiency can reduce the intake and consequently the decrease in animal performance of cattle.

In table 2 the participation of phosphorus and potassium present in banana peel pellets are represented, with values of 0.22 and 0.07%. In green banana flour with peel, Vargas and Lobo (1992) verified levels de P total of 0.13%, while whereas Dormont et al. (1998) observed in ripe banana peel value of 0.19% of P and 9% of K.

Table 2- Percentage contents phosphorus and potassium present in banana peels pellets

	Phosphorus, %	Potassium, %
Minimum	0,20	0,07
Maximum	0,25	0,07
Means	0,22	0,07
Standard error	0,01	0,001
Variance	0,06	0,002
Standard deviation	0,02	0,015
Coefficient of variation	0,11	0,22

How foods are classified according to energy levels, fiber and protein (LANA, 2005) banana peel pellets would be classified as bulky food of low fibro-rich energy value. Can be instilled in the diet of ruminates in the form of a dietary supplement when forage deficit occurs, as well as being used in the production of rabbit feed, due to the content of ADF, meeting the needs of this animal species that present requirements between 15 and 18.5% of the DM of the diet (KLINGER and TOLEDO, 2018) instead of the use of shells of very low nutritional quality such as rice, intestinal disturbances in animals due to the abrasiveness of the material.

CONCLUSIONS

The exact percentage of moisture for the formation of the pellets of the residues of the manufacture of banana candies was 18,84% moisture, presenting bromatological characteristics low energy feature in front of corn grain food. Evaluations in animal models should be carried out in place of corn to determine the replacement levels in the diets and the performance of the animals.

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