Original Article

Alternative nutritional supplement for animal feed based on Chinese Potato (Colocasia esculenta) and banana (Musa x paradisiaca)

Medina-Villacis, Marlene[1], Espinoza-Guerra Italo[2], García-Gimeno, Rosa M[3], Posada-Izquierdo, Guiomar[4]
[1,2]Universidad Técnica Estatal de Quevedo. Av. Quito. Km 1 ½ vía a Santo Domingo. Quevedo, Los Ríos, Ecuador.
[3,4]Universidad de Córdoba, Campus de Excelencia Internacional Agroalimentario CeiA3. Campus Rabanales, Edificio Darwin 14071 Córdoba, España.
Email: mmedina@uteq.edu.ec

Abstract

The processing was done to obtain flour from Chinese potato (Colocasia esculenta) and rejection banana (Musa x paradisiaca). The objectives were to determine the best level of antioxidants for the mixture, determine the best drying parameter of times and temperatures, and carry out the economic analysis of the treatments under study. A multifactorial statistical design (2 *2*3) was used, with 12 treatments and two replicates totaling 24 experimental units. To establish the nutritional components of the banana and Chinese potato rejection flours and combination, through bromatological analysis, in addition to establish adequate ranges for drying, for conservation with the highest amount of nutrients. The factors under study: first-factor raw materials; counted with two Chinese potatoes and banana rejection; (Pch and Reb); the second factor with two ranges 0C Celsius (T0 at 60°C 4 hours and 65°C and 5 hours) and, third factor three percentages of antioxidants (Aci, Aas, Bs) citric acid, ascorbic acid and sodium metabisulfite, being its results the following, protein for the Chinese potato flour with 6.79; at a temperature of 5,870 C of the temperature range T65° and 5 hours; with the addition of the antioxidant ascorbic acid of 6.16%; representing an economically viable alternative. While for optimal antioxidants and conservation of nutritional elements, ascorbic acid at 0.05% contains more protein and crude fiber. About granulometry, the two raw materials meet the conditions established by NORMA INEN 2051:95 (1995), thus determining their use in flours for animal consumption.

Keywords: analysis, weight gain, processing, yields, agricultural by-products.

Introduction

The banana is a traditional crop widely cultivated in Ecuador; the ancients called it the "fruit of the wise men" (Musa sapiens), given its superior nutritional qualities. In the coastal region of Ecuador, this fruit is grown for export, bananas that do not meet the export parameters are transformed into waste and discarded (Banana Export , 2008).

In those areas determined as excellent banana producers, there is a high overproduction of bananas in rainy seasons, all of them are governed by a process of quality and biosafety standards for the product destined for export, with a large percentage of bananas that do not qualify, which also incurs a problem for the banana producing sector and the environment.

Access this article online

Quick Response Code:

Website: www.pnrjournal.com

DOI: 10.47750/pnr.2022.13.03.113

The Chinese potato is one of the first crops used by man; its history is more associated with the most primitive Neolithic cultures; it was already consumed as food. There are two genera Colocasia and Xantoma, of the Araceae1 family, cultivated under different names to identify the varieties that represent these genera.

Address for correspondence: Medina-Villacis, Marlene
Universidad Técnica Estatal de Quevedo. Av. Quito. Km 1 ½ vía a Santo Domingo. Quevedo, Los Ríos, Ecuador.
Email: mmedina@uteq.edu.ec

How to cite this article: Medina-Villacis, Marlene, Espinoza-Guerra Italo, García-Gimeno, Rosa M, Posada-Izquierdo, Guiomar, Alternative nutritional supplement for animal feed based on Chinese Potato (Colocasia esculenta) and banana (Musa x paradisiaca), J PHARM NEGATIVE RESULTS 2022;13: 757-760.

The name malanga comes from the Trinidad Islands, but its name is used in the islands of the Lesser Antilles, the Caribbean, and some southern states of the USA. It is also consumed in Asia and Africa. (Fernandez, 2005). It constitutes an alternative to contributing with solutions to human and animal feeding. Therefore, it is important to investigate the elaboration of flour combined with Chinese potato and banana to have a nutritional supplement used to diversify the contribution and reduce production costs. (Estrada & Galvis, 1990).

It is an essential energetic food since it is rich in carbohydrates. However, i protein content is low (Banana Export , 2008). For this reason, it generates much waste (rejection), which is destined for direct animal consumption, but even so, it is insufficient, leaving large amounts that are not used in the best way and can be processed, highlighting its nutritional qualities, rich in energy source and carbohydrates. It contains healthy carbohydrates, easy to digest and has zero fat content.

Banana. It is a herbaceous plant belonging to the genus musa and family Musaceae. The edible banana originated through a series of mutations and genetic changes from inedible wild species Musa acuminata, Musa balbisiana, of small fruit with numerous seeds. To arrive at the mutations, changes in the hereditary characteristics of the chromosomes gave rise to the commercial edible banana. It is native to Southeast Asia and the Pacific islands. Taxonomic evidence shows that the edible banana originated in the Malay Peninsula. However, today commercial varieties are grown in all tropical regions of the world, and it is the most widely cultivated tropical fruit. Bananas are not developed from seeds, as their reproduction is vegetative, so in many cases, scientists speak of clones instead of varieties (Simmonds & Shepherd, 2012).

The production of bananas for export (Musa x paradisiaca) unleashed an environmental problem, given the quality control requirements that led to fruit rejections between 20% and 25% v/v (Hincapié, 2004). These rejects have been subject to uncontrolled manipulation, such as the custom of disposing of them in the open air and unauthorized dumps (BANATURA, p. 38, 2003). Their natural degradation generates toxic and greenhouse gases, attracts vectors and produces leachates that affect surface and groundwater quality and soil quality. This problem has been studied by many researchers, who propose the use of fruit in animal feed, composting and the production of starch and ethanol (IIT, 1980); (Morales & Uribe , 1985); (Fuentes & Bayona , 1994); (Afanador , 2005).

Banana rejection is a by-product from banana plantations that do not undergo rigid quality control. In general, banana waste is a source of energy in proteins, carbohydrates, vitamins and minerals in the feeding circle of poultry. Because banana rejects possess qualities, small and medium-sized feed mills are in charge of processing them, with the objective of integrating them into the diet of poultry. Using this process given to banana rejects, by-products such as feed, supplements, and alcohol, among others, are obtained.

Chinese potato (Colocasia esculenta L) The Chinese potato is of purely Andean origin. Because of its excessive consumption and cultivation, it is said that it may be of Peruvian origin, as are some of the surrounding countries where this delicious tuber is found in abundance (Anonymous, 1998). The Chinese potato belongs to the Araceae family, which also includes several roots or tubers known as the white carrot, beet etc. It is a traditional food in many tropical areas of the world. The plant is indigestible if eaten raw due to ergot substances in the plant cells. Severe gastrointestinal problems can occur unless it is processed first (Urbina, 2001).

The cultivation of this tuber is beneficial from the economic and commercial point of view because there is a great demand from international markets such as the USA, Russia and Europe, among others since they have become aware of the nutritional and medicinal properties that this tuberous root contains, which makes the Chinese potato an indispensable food for their daily diet (Urbina, 2001).

They are sources of calories, mainly from carbohydrates. They are cooked in water as with other tubers; they can also be consumed baked or fried in oil. Flour can be obtained after cooking and dehydration. The root is also used as a source of energy in animal feed. Secondary use of Araceae is the use of the leaves that are consumed tender and cooked. This use is every day in several species and one of them, the belembé, is cultivated exclusively for its leaves (Leon, 1968).

It can be used in the production of flour, which is a fine white product obtained from drying and milling the Chinese potato. This product contains in addition to starch, fiber ash with it makes it a good substitute for animal feed in combined form as banana meal, which is part of a product as nutritional supplements (Simmonds & Shepherd, 2012). Therefore, this research aims to elaborate flour based on banana (Musa x Paradisiaca) and Chinese potato (Colocasia esculenta) rejection as a nutritional supplement for animal production.

Materials and methods

The trial was conducted at the Laboratory of Ruminology and Nutritional Metabolism of the State Technical University of Quevedo. Campus La María located at 7 / ½ Km via El Empalme - Los Ríos. For the elaboration of this flour, the following norms were used: NTE INEN 2051, which corresponds to the elaboration of flour of vegetable origin, to determine the size of the particle prior to the process. The study factors involved:

Factor A: raw materials

Factor B: Drying

Factor C: Antioxidants

For the experimental design, an A*B*C factorial arrangement design was used with the levels of A= 2; B=2; and C=3. Where A= Raw material (banana flour and Chinese potato), B=Raw material drying (time and temperature) and C=Best antioxidant (citric acid, ascorbic acid and sodium bisulfite). A total of 12 treatments; 2 replicates and 24 experimental units. Data processing was performed with the help of INFOSTAT statistical software, for analysis of variance (ANOVA) and Tukey's significance tests ($p \leq 0.05$).

Results

Table 1 shows the effects between factors and variables in the study for the "Elaboration of flour from Chinese potato (Colocasia esculenta) and banana (Musa x Paradisiaca) as a nutritional supplement for an animal fee." Factor A; moisture, ash and fat percentage. The analysis of variance carried out for the effect of the raw material factor showed high statistical significance among the treatments, showing that the Chinese potato obtained the highest values for the percentages of moisture, ash and fat, with averages of 14.69, 4.19 and 0.50, respectively.

For factor B, temperature and drying time at 60 degrees Celsius and 4 hours showed high statistical significance, with values for moisture, ash and fat percentages averaging 12.13, 3.60 and 0.52, respectively.

In factor C, composed of antioxidants, the sodium metabisulfite 0.03% showed high statistical significance and obtained the highest values for the percentages of moisture and ash averages of 13.97 and 3.61 respectively. In the antioxidants composed of citric acid 0.04%, it was statistically superior to the other antioxidants in the percentage of fat with 0.49%.

Table 1. Effects between factors and variables in the study for the "Elaboration of flour from Chinese potato (Colocasia esculenta) and banana (Musa x Paradisiaca) as nutritional supplement for animal feed".
Chinese potato (Colocasia esculenta) and banana (Musa x Paradisiaca) as a nutritional supplement for animal feed".

Factors	Variables		
Raw Materials	**Hummidity (%)**	**Ashes (%)**	**Grease (%)**
Potato China	14.69 a	4.19 a	0.50 a
Banana rejection	7.99 b	2.78 b	0.42 b
Drying			
T 60° 4 hours	12.13 a	3.60 a	0.52 a
T 65° 5 hours	11.55 b	3.37 b	0.40 b
Antioxidants			
Sodium Meta Bisulfite 0.03%.	13.97 a	3.61 a	0.44 c
Ascorbic acid 0,05%.	10.11 b	3.50 ab	0.46 b
Citric acid 0.04% Citric acid 0.04	9.93 b	3.35 b	0.49 a

Font: Medina, M. 2019.

According to Larrañaga & et al. (1999). The presence of a higher or lower percentage of humidity favors the presence or absence of microorganisms or can also act as a catalyst and cause food spoilage.

The ash results in this study reached values higher than those indicated by the Ecuadorian Technical Standard INEN 2051:95 (1995) for flours, indicating a maximum level of 1% (Roquel, 2008). Their studies on raw flour production report reaching ash percentages between 2.90 and 2.92% at the laboratory level. Therefore, it was determined that T1 (Chinese potato + T60ºcx 4 citric acid 0.04%), T2 (Chinese potato + T60ºcx 4h + ascorbic acid 0.05%), T10 (banana rejection + T65ºcx 5 hours + citric acid 0.04%) and optimal results of Fat, Fiber, Protein, Ashes, Energy and Humidity are demonstrated, which is fundamental for the combination of two flours under study for the elaboration of a nutritional supplement. In order to expose the homogenizer, it will be combined with a ratio of 40% banana rejection flour and 60% Chinese potato flour due to the nutritional contribution of these two by-products. It is packed in hermetic bags of 1 kg and the respective sealing.

According to the standards for the elaboration of flour for use in animal feed, the best results in all variables were in treatments T1, T2, T10, which established acceptable results with standards for the elaboration of flour.

Likewise; the economic analysis of the treatments, we see that in all of them there is equality in the final costs of the research. Therefore, it is established in this variable the total costs that resulted in $61.97 for each treatment, PVP $5.00, sales=pxq 150.00, net profit $56.97, cost-benefit -0.919315798, the profitability of -92%.

Discussion

About the protein percentage, all treatments did not reach a value lower than that established by the Ecuadorian Technical Standard (INEN 2 051:95, 1995), which establishes a minimum protein value of 8%. Roquel (2008) also carried out studies on potatoes and obtained crude protein values higher than those established by the standard (11.50%); however, the results obtained in this study are similar to those mentioned by For Sánchez & Basurto (2007); and Espínola et al. (1998), of all the treatments studied, the percentage of fiber exceeds the value admitted by the Ecuadorian Technical Standard for flour, which is situated at 11.50% (INEN 2 051:95, 1995) for flours, which is around 1%. Espínola et al. (1998) and Roquel (2008) also reported that their research reached percentages higher than the permissible limit of the standard, which was in the range of 1.80 and 5.23% at laboratory level.

Conclusions

The percentage content of moisture, fat, crude protein and crude energy differed significantly in all factors and interactions without affecting their quality. Therefore, it was determined that the optimum temperature to conserve the nutritional elements was T60° and 4 hours since they contain more protein and crude fiber.

Regarding the antioxidants to preserve the nutritional elements, ascorbic acid at 0.05% was used. Regarding the granulometry, the two raw materials meet the conditions established by the INEN 2051 NORM that determines their intended use; a flour for animal use requires a coarser granulometry. Therefore, the best cost-benefit ratio was obtained with banana flour production.

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