

Evaluation of the Potentiality of Maniocresidues (*Manihot esculenta Crantz*) in animal feeding

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Abstract— Due to the successive increases in the prices of agricultural inputs is necessary to use alternative foods to ensure economic and environmental sustainability in animal production. In this paper, the nutritional composition of cassava and the various forms of its use in animal feed were studied in order to investigate the alternatives using these roots to reduce the production costs of the various animal species. Besides the nutritional characteristic, cassava has great economic and social importance, since it is cultivated in most of the Brazilian territory. Cassava residues can be used as substitutes for energy foods traditionally used in the diet of animals with similar performance to conventional energy concentrates and they can also reduce production costs. Cassava is cultivated in several regions of Brazil which is an important reason to become a biologically and economically viable alternative for animal feeding.

Keywords— *By-products, Alternative Feed, Monogastric, Ruminant, Biotechnology, Agroindustrial Residues.*

I. INTRODUCTION

Brazil is one of the largest producers of cassava in the world and according to the IBGE (Brazilian Institute of Geography and Statistics), in 2015, the national supply of cassava in Brazil increased by 7.5%, while the cassava's starch processing raised by 36%. The IBGE predicts a new production increase in 2016 to 24.2 million tons. 33.9% of this amount is used for human consumption, 50.2% for animal feed, 5.7% for other purposes, 0.2% were destined for export and 10% estimated as losses. In this case, one of the greatest challenges of contemporary society is the pursuit for an adequate management of solid waste, since population growth and modern patterns of consumption are becoming more common inducing agricultural and agroindustrial systems to increase their production. Agroindustry's income has been expanding in recent years due to the diversity of agricultural activities, technological advances, the development of new products and the improvement of quality in the various aspects of the sector. Due to the increase of productivity, large amounts of waste are generated and, when stored inadequately, can cause damage to the environment, creating problems of broad socioeconomic-environmental dimensions (Morales, 2012).

In the Brazilian's northeast, under normal climatic conditions, cassava production normally corresponds to 35% of national agroindustry production. This production is usually for human consumption, through flour and sour

sprinklesor gum that goes into the composition of several plates, such as cheese bread and tapioca. The main cassava producers in this region are three states, Bahia, Maranhão and Ceará, with production averaging 70% of the Northeastern Semi-arid Region (SEDAE, 2013).

The industrial units that process cassava produce high amounts of residues considered aggressive to the environment. Bagasse is the main solid waste produced in the cassava's production and, in general, is left in ditches that overflow with large organic load. However, the mass, or bagasse, of cassava is composed of the root fibrous material containing part of the starch which could not be extracted in the processing. The bagasse is generated in the stage of separation of the starch and is soaked in water and, under these conditions, presents a larger volume than the raw material itself, containing roughly 80% moisture (MIRANDA, 2014).

The literature review has the objective to investigate the food alternatives using cassava residues to add nutritional value and reduce the costs of feeding various species of animals.

II. PROCESSING FOR OBTAINING THE WASTE OF THE MANIOC

Population growth and modern patterns of consumption cause the increase of agricultural and agroindustrial systems' production. Agribusiness incomes have grown in recent years due to the diversity of

agricultural activities, technological advances, new product development and quality improvement in this sector. The productivity raise has increased the amount of waste generated that, when stored inadequately, can cause damages to the environment, creating social, economic and environmental problems (Morales et al., 2013).

According to the Ministry of Agriculture for Supply and Agrarian Reform (ORDINANCE No. 554, August 30, 1995), which defines the Identity, Quality, Conditioning, Storage and Transport Standard for cassava flour, the husk of cassava is the skin that surrounds the protective layer of the root. According to the same Ministry, the manioc rasp is defined as fragments of the central cylinder of the poorly ground cassava root. This poorly ground material is usable because it has some root pulp. The crust is a residue consisting of pieces of roots and bark, separated by sieves before the kiln, in the processing of cassava flour.

According to Araújo et al., (2014), one ton of manioc generates 15.4 kg of crustacea. This amount may vary with collection time, type of crop and process adjustments. In agribusiness, it is important to find some use for production residues and to develop processes that represent an alternative for a transformation of materials into products of higher added value. Therefore, the use of waste is essential as it contributes to a reduction of the accumulation of organic waste, reducing its environmental impact.

Silva et al., (2014) studied the process of protein enrichment of the manioc flour residues with *Saccharomyces cerevisiae* yeast. This process occurred in semi-solid fermentation, in the absence and presence of a non-nitrogenous protein source (urea) to speed up the growth of the microorganism. The article demonstrated that there was a high bioconversion efficiency of the processes, transforming the cassava residue (*crueira*) into bioproducts (pellets) with high added value similar to or greater than conventional concentrates, and could be used as a food alternative for ruminants in the time of scarcity in Brazil's Northeast which is a semi-arid region.

III. NUTRITIVE VALUE OF MANIOC RESIDUES

Silva et al., (2014), studied the nutritional capacity of manioc bagasse meal, table flour meal and bran meal, where crude protein contents were 1.6%, 3.7% and 3.0%, respectively. These results demonstrate the need to develop and adapt technologies to increase protein levels in cassava residues.

The same paper demonstrates that the greater capacity of cassava starch expansion in relation to cereal starch, especially corn, may be related to the lower amount of amylose. Moreover, the constitution of the cassava

starch differs from the grains because it does not present pericarp and endosperm, which are physical barriers to the digestion process. These characteristics of cassava starch facilitate digestion in comparison to maize starch and sorghum.

The results of the physico-chemical characterization of *crueira* present variations between different studies reported in the literature. However, these differences are due to the use of different varieties of cassava, climatic and soil conditions of the producing region, as well as the difference in methodology used to analyze the parameters used by each author. However, it is possible to verify that the *crueira* works as a residue with high content of starch and low content of ashes. This makes the *crueira* a high potential residue for use in bioconversion processes using microbial cultures (ROCHA, 2016).

According to Miranda (2014), the biotransformation process by the fungus *R. oligosporus* significantly decreases the content of hydrocyanic acid. This process can also be applied as a pre-treatment of cassava leaf meal before it is added to the MM to increase the allowed amount of the cassava leaf flour to be added in order to increase the amount and improve the quality of the protein available in this supplement.

The energy bioconversion of the leaf and cassava bagasse by the fungus *rhizopus oligosporus* to obtain functional food through solid state fermentation, promoted the protein enrichment of up to 8% in the substrate. It had higher digestibility obtaining values of up to 79.5%. This value is similar to animal proteins, it also increase the lipid, ash and crude fiber contents, and decrease the moisture content. The biotransformation process also indicated a decrease of up to 60.2% in substrate toxicity, due to the presence of hydrocyanic acid, promoting greater food safety (MIRANDA, 2014).

IV. USE OF MANIOC RESIDUES IN ANIMAL FEEDING

The dehydrated cassava starch residue (RDFM) promoted a decrease in the pigmentation of the skins and the meat of the birds without interfering in the other parameters of quality. There was a reduction in serum triglyceride and VLDL cholesterol at 79 days of age. The use of up to 2% of the cassava residue kept the productive indicators of the birds. However, the results showed that it is not economically feasible to include RDFM in the animals' diet (PICOLI, 2013).

Santos et al. (2013) evaluated the use of a mixture of cassava leaves and dehydrated roots as food for Japanese quails. They concluded that it is possible to add

up to 50% of the animal food to the diet in the breeding phase (8 to 21 days) without affecting the birds' diet.

Viana et al., (2012) studied shoot silage and cassava scrap and concluded that fractionation studies of carbohydrates in fraction B (potentially digestible carbohydrate) and fraction C (indigestible carbohydrate not degraded in the rumen) are important to promote better understanding of them. These studies are also important because they contribute for the balancing of diets according to the requirements of each animal category.

The cassava leaves silage with cassava scrap presents ideal pH and temperature values for better silage quality, good chemical composition, with high CP content, reduction of ADF, increase of crude protein fractions A and B, besides reduction of carbohydrate fractions and high in vitro digestibility. Therefore, it is recommended that cassava leaves for the manufacture of silage with addition of shavings at the 30% level, with potential for use in ruminant feeding (LIMA, 2013).

Ferreira (2013) states that the material composed of bark, peeled and manioc rasp presents high energetic value, but offers insignificant protein value. However, the results of the analyzes with vinasse showed that the residue has considerable values of protein and minerals. In this context, the enrichment of residues from cassava industrialization, with vinasse, resulting from the manufacture of alcohol, increases the protein and mineral content of the mixture. The bromatological results show that the feed can be considered as an energetic food, but it is considered as a protein and can be used in the treatment of ruminant animals.

Among the ingredients used in animal feed formulations, the bovine blood added to cassava meal presented as an excellent agglutinant of the pellets. When adding the blood to the cassava meal for pelletizing, there was an increase in the protein content of the control experiment (37.56%) to 44.14% in dry basis (SENA E NUNES, 2016).

Shinya (2017) cultivated four yeast strains in fermenter with sugarcane bagasse and manioc hydrolysed with amylases or not, in single or fed batch. A strain of *Saccharomyces cerevisiae* M26 was used as a comparative for the fermenter tests. Pre-treatment of sugarcane bagasse was not beneficial for cell growth. According to the highest cellular concentrations, four species were selected and identified as *Sporobolomyces japonicus* *Sia 70a*, *Sporidiobolus pararoseus* *Sia 33.1*, *Wickerhamomyces onychis* *LABI2* and *Rhodotorula mucilaginosa* *LABI1*. All of them produced xylanase in culture with cane bagasse in fermenter (0.25 U / ml for *S. pararoseus* *Sia 33.1*, 0.31 U / ml of *LABI1* *R. mucilaginosa*, 0.34 U / ml of *W. onychis* *LABI2* *Sia 70a*, 0.52 U / ml *S. japonicus* *Sia 70a*), the

amylases were produced by *S. japonicus* *Sia 70a* (0.2 U / ml), *S. pararoseus* *Sia 33.1* (0.26 U / ml) and *R. mucilaginosa* *LABI1* (0.33 U / ml) in cassava bagasse culture. The highest concentrations of biomass were reached with cassava bagasse as substrate. The hydrolysed cassava bagasse resulted in the production of 5.2 g / L of *S. pararoseus* *Sia 33.1*, 8.5 g / L of *R. mucilaginosa* *LABI1* and 10.9 g / L of *W. onychis* *LABI2*. This result is much higher than that obtained by *S. cerevisiae* *M26* in the same medium (3.1 g / L). *S. japonicus* *Sia 70a* reached 8.1 g / L using untreated cassava, twice the value of *S. cerevisiae* *M26* under the same conditions.

Araújo et al. (2017) analyzed the protein enrichment with microorganism in semi-solid fermentation. The study demonstrated the gradual increase of protein contents in the fermentations of the substrates (manioc peel) in the in natura form and processed with 2% of yeast and / or added to the different levels (0, 1, 2 and 3%) of urea a variation of this nutrient from 1.59% to 10.19%, respectively. They also observed that the protein content was inversely proportional to the non-fibrous carbohydrate contents, as well as the levels of neutral detergent fiber (NDF) and acid detergent fiber (FDA), because when the glucose metabolism decreases, sporulation is favored. It is worth mentioning that the spores present different biochemical constitution of the vegetative forms from which they are derived.

V. CONCLUSIONS

The success of livestock farming depends on adequate food planning, and it is necessary to use alternative food adapted to local conditions and agroindustrial co-products that can be used for animal feed, avoiding or mitigating the negative effects of lack of food at certain times of the year. In this context, cassava industry residues that have considerable nutritional value, presenting high carbohydrate fractions, consequently presenting a high energy value desirable for a better use in the animal feed, being necessary more studies on better forms of use of this residues in all the Brazilian regions. It is also concluded with this review that the residues of the cassava industry are products of wide versatility as to their possibilities of use as feed for both ruminant and monogastric animals and identify themselves as alternative sources that allow reducing the cost of animal feed and dependence on ingredients conventionally used for feed formulation.

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