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CASSAVA AND TAPIOCA FLOUR QUALITY IN THE STATE OF PARÁ, BRAZIL

QUALIDADE DE FARINHAS DE MANDIOCA E TAPIOCA NO ESTADO DO PARÁ, BRASIL

CALIDAD DE LAS HARINAS DE YUCA Y TAPIOCA EN EL ESTADO DE PARÁ, BRASIL

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ABSTRACT
Flour is one of the main products derived from cassava, mainly consumed in the North and Northeast of Brazil. It is obtained by hand, in rudimentary processing units called "Flour Houses", which allows this product to be exposed to several types of contamination during the manufacturing and storage process. The objective of this study was to evaluate the quality of cassava and tapioca flour produced in the municipality of Castanhal and Santa Izabel of Pará, both in the Stat Samples of cassava and tapioca flour were obtained and submitted to coliforms, molds and yeasts counts, and determination of strange matter at the macro and microscopic levels. In the analyzes for coliforms, the samples presented values ranging from <3.0 to 9.2 MPN / g. The values obtained on the molds and yeasts counts ranged from <1.0 x 101 to 1.3 x 106 CFU / g. The samples showed dirt, stones, wood fragments and unidentified strange matter. The Tapioca and Cassava Flour samples analyzed are out of the standards for human consumption, which shows a lack of production, processing, and manipulation, therefore compromising consumer health.

KEYWORDS: *Manihot Esculenta.* Cassava Flour. Tapioca Flour. Physical Contamination

RESUMO
A farinha constitui um dos principais produtos derivados da mandioca, muito consumida em todo o país e principalmente na região Norte e Nordeste, obtida de modo artesanal, em unidades de processamento rudimentares chamadas “Casas de Farinha” o que possibilita a esse produto uma exposição a diversos tipos de contaminações durante o processo de fabricação e armazenamento. O objetivo deste estudo foi avaliar a qualidade de farinhas de mandioca produzidas no município de Castanhal e Santa Izabel do Pará, os dois no Estado do Pará, Brasil. Amostras de farinha de mandioca e tapioca foram obtidas e submetidas a contagem de coliformes, bolores e leveduras e determinação de matérias estranhas a nível macro e microscópicos. Nas análises para coliformes, as amostras apresentaram valores variando de <3,0 a 93 NMP/g. Os valores obtidos na contagem de bolores e leveduras variaram de <1,0 x 10^1 UFC/g. As amostras apresentaram sujidades, pedras, fragmentos de madeira e matérias estranhas não identificadas. As amostras de farinha de mandioca

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e tapioca analisadas encontram-se fora dos padrões de consumo humano, o que mostra uma falta de cuidado na produção, processamento e manipulação, comprometendo assim a saúde do consumidor.

PALAVRAS-CHAVE: *Manihot Esculenta.* Farinha de Mandioca. Farinha de Tapioca. Matérias Estranhas.

RESUMEN
La harina es uno de los principales productos derivados de la yuca, de amplio consumo en todo el país y principalmente en la región Norte y Noreste, obtenida de manera artesanal, en rudimentarias unidades de procesamiento denominadas “Casas de Harina”, lo que permite exponer este producto a diversos tipos de contaminación durante el proceso de fabricación y almacenamiento. El objetivo de este estudio fue evaluar la calidad de la harina de yuca producida en los municipios de Castanhal y Santa Izabel do Pará, ambos en el Estado de Pará, Brasil. Se obtuvieron muestras de harina de yuca y tapioca que se sometieron a recuentos de coliformes, mohos y levaduras y determinación de materias extrañas a niveles macro y microscópicos. En los análisis de coliformes las muestras arrojaron valores que oscilaron entre <3,0 y 93 NMP/g. Los valores obtenidos en el conteo de mohos y levaduras oscilaron entre <1,0 x 101 UFC/g. Las muestras mostraron tierra, piedras, fragmentos de madera y materias extrañas no identificadas. Las muestras de harina de yuca y tapioca analizadas se encuentran fuera de los estándares de consumo humano, lo que demuestra una falta de cuidado en la producción, procesamiento y manipulación, comprometiendo así la salud del consumidor.

PALABRAS CLAVE: Manihot Esculenta. Harina De Yuca. Harina De Tapioca. Materiais Estrañas.

INTRODUCTION

Flour is one of the main products derived from manioc (*Manihot esculenta* Crantz), being part of the daily meal of most Brazilians, especially in the North and Northeast regions (Dias & Leonel, 2006). It can be described as the product obtained by the slight roasting of the grated roots of cassava previously peeled, washed, and free of the cyanide radical. The product submitted to the new roasting is called "roasted manioc flour" (Brazil, 1978).

The flour production has a considered simple and rudimentary technology (Silva, 2014), exposing the product to several risks (Dósea et al., 2009). According to Cohen et al. (2005), such risks are mainly due to the precariousness of the establishments, which operate under improper conditions of infrastructure and hygienic-sanitary conditions.

For Bert & Santos (2016), during the production process the concept of Food Safety must be respected in order to prevent contaminants of physical origin (stones, glass pieces, bones), biological (bacteria, fungi, viruses, parasites) and chemical (waste cleaning products).

Among the parameters that define the quality standards of a food, the microbiological characteristics stand out (Brandão, 2007). The microbiological analysis of a food can be carried out to investigate the presence of microorganisms, quantify and identify them and ascertain the hygienic sanitary conditions of the process (Lima et al., 2007).

Another way of evaluating quality is through the investigation of strange matter in food, which has the objective of evidencing fraud, checking the quality of the raw material and the hygienic-

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sanitary conditions of food processes and storage (Lima et al., 2016). Dirt is included in the group of strange matter, such as the presence of insects, fungi, hair, sand, glass, metal fragments and other strange matters impurities to the food composition (Villela, 2004).

The objective of this work was to evaluate the biological and physical contamination of cassava and tapioca flour, produced in the municipality of Castanhal and Santa Izabel of Pará, both in the State of Pará, Brazil.

MATERIALS AND METHOD

The study area comprised the rural area of the municipality of Castanhal and Santa Izabel of Pará, in the State of Pará, Brazil, where the presence of Cassava flour producing units called "flour houses" are common. To determine the sampling sites, a preliminary study was carried out together with the Technical Assistance and Rural Extension Company of the State of Pará, the Castanhal Unit, which contributed to the provision of locations and field visits.

The collection sites were geo-referenced, and the location points are shown in Table 1. Twelve samples were obtained: 6 of cassava flour (FM) and 6 of tapioca flour (FT), in their original coded packaging. They were conditioned in environmental temperature and sent to the Laboratory of Microbiology and Food Analysis of the Pará State University for analyzes.

Table 1. Location of collection points of samples of cassava flour and tapioca of the municipality of Castanhal and Santa Izabel of Pará, State of Pará, Brazil. S = South latitude; W = West longitude

Flour Houses	S	W
F1	1º07'23.740	47º52'55.278
F2	1º14'13.050	47º52'23.417
F3	1º07'23.740	47º52'55.278
F4	1º08'42.209	47º57'07.710
F5	1º21'04.589	47º49'08.958
F6	1º20'38.339	47º49'19.427
F7	1º22'36.209	47º50'41.909
F8	1º17'23.0	48º03'27.0
F9	1º17'04.0	48º03'27.0
F10	1º17'53.0	48º56'19.0
F11	1º15'18.0	48º3'38.0
F12	1º14'21.0	48º3'38.0

Microbiological analysis of coliforms was performed using the Most Likely Number (NMP) technique, according to Kornacki & Johnson (2001), and the presumptive test was carried out in three different tube series of Lauryl Sulfate Triptose (LST) of double concentration test and six tubes in

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single concentration, performing three successive dilutions (100, 10^{-1} and 10^{-2}) incubated in an oven. The confirmatory test was performed in *Escherichia coli* (EC) broth for coliforms at 45 ºC.

The counting of molds and yeasts was carried out according to the methodology described by Normative Instruction No. 62 of August 26, 2003, where 25 g of each sample was weighed and diluted in 225 mL of homogenized 0.1% peptone saline solution, resulting in dilution 10^{-1}, where the remaining dilutions were carried out. Subsequently, 0.1 mL of each dilution was inoculated on the surface of the plates containing 10% tartaric acid acidified Potato Dextrose Agar in duplicate. With the aid of the Drigaslki loop the inoculum was spread over the surface of the medium until complete absorption. The plates were incubated, without inverter, at 25 ± 1 °C for seven days in a B.O.D incubator and the results obtained were expressed in CFU / g.

The macroscopic dirt survey was performed according to the methodology described by Brazil (2011), where 25 g of each sample, in triplicate, were transferred to Petri dishes and analyzed with the naked eye and with the help of a magnifying countertop glass with lighting and increase. For the acquisition of images of the strange matter found, a stereo integrated LED lighting microscope with a 4.4: 1 zoom was used.

Meanwhile, dirt microscopic research was carried out according to the methodology described by Fontes & Fontes (2012). 25 g of each sample was dissolved in 50 mL of chloroform. The mixture was then homogenized, standing quietly for 10 minutes to allow the dirt sedimentation to settle. These were removed and placed on filter paper to eliminate chloroform with the aid of a vacuum pump. Strange matter was analyzed under an optical microscope (Medluz, E100 binocular led).

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RESULTS

Table 2 shows the results of the microbiological analyzes.

Table 2. Results of the Most Probable Number (NMP) analyzes of coliforms at 45 ºC and counting of Yeasts and Molds in Colony Forming Units per gram (CFU / g), in the samples collected from cassava and tapioca flour. FM = cassava flour; FT = tapioca flour, of the municipality of Castanhal and Santa Izabel of Pará, State of Pará, Brazil

City	Sample	Coliforms a 45 ºC (NMP/g)	Yeasts and Molds (UFC/g)
Castanhal	FM1	9, 2	$< 1, 0 \times 10^1$
	FT2	< 3, 0	$2, 0 \times 10^1$
	FM3	< 3, 0	$< 1, 0 \times 10^1$
	FM4	< 3, 0	$< 1, 0 \times 10^1$
	FM5	< 3, 0	$< 1, 0 \times 10^1$
	FM6	< 3, 0	$< 1, 0 \times 10^1$
	FM7	< 3, 0	$< 1, 0 \times 10^1$
Santa Izabel do Pará	FT8	< 3, 0	$1,3 \times 10^6$
	FT9	< 3, 0	$2, 0 \times 10^1$
	FT10	< 3, 0	$3, 0 \times 10^1$
	FT11	< 3, 0	$1,4 \times 10^2$
	FT12	< 3, 0	$1, 5 \times 10^1$

It is observed that in Table 2, all samples are within the limits established by current legislation (Resolution RDC Nº. 12 of 02.01.01 of the National Health Surveillance Agency), which is 10^2 NMP / g for Coliforms at 45 ºC. This fact can be attributed due to the characteristic of the products studies, taking into account that during the processing of cassava and tapioca flour, high temperature ovens are used for roasting (cassava flour) and in the spice stage (tapioca flour), thus reducing the water content of these products.

Studies carried out corroborate the results found in the present study. Chisté & Cohen (2006) reported that at the beginning of flour processing, the samples presented high coliform load (> 1.1 x 10^3), which was reduced in the pressing stage and in the final product after roasting (< 3). According to Silva et al. (2012), the low microbial activity observed in flours can be attributed to the characteristic of the dehydrated food, in which such reduction is accentuated by the low humidity available. As well as Negreiros (2014) emphasizes that the roasting stage, which uses high temperatures, can contribute with the low values of contamination and reduction of the number of microorganisms.

The microorganisms of the coliforms group are indicators of processing failures, even if the processing does not present satisfactory hygienic conditions, the low humidity of the flours makes them an inhospitable environment for several bacteria. According to Chisté et al. (2007), the presence of coliform microorganisms may be an indicator that the conditions of production and / or handling to which the food is submitted is not satisfactory. For Macêdo (2015), this may indicate there was

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contamination during the manufacturing process or even post-processing, also providing information on the likely presence of pathogens or on deterioration of food.

Low levels of coliform contamination were also found by Luna et al. (2013), where samples analyzed for coliforms at 45 ºC presented values lower than 3.0 MPN / g, as well as in the results presented by Silva et al. (2012), which also reported mean values of thermotolerant coliform in cassava flour below < 0.3 NMP / g.

Resolution RDC No. 12 of January 2, 2001, used as a standard for food analysis, does not establish a limit for the counting of molds and yeasts in flours, but Ordinance No. 451, dated September 19, 1997, establishes the limit value of 10^4 CFU / g of these microorganisms in starches, flours and meal. The findings in the present study for the determination of molds and yeasts proved to be superior to the standard only in the FT8 sample. The others the values obtained are considered acceptable for consumption, since values are lower than 10^4 CFU / g.

When analyzing samples of cassava flour collected at fairs in the city of Macapá – AP, Brazil, Mesquita et al. (2017) observed 80% of the samples indicated the presence of mold, since these are common in the storage of the product. Rodrigues et al. (2015), also evaluated the presence of molds and yeasts in cassava flour, in a study conducted at fairs in the city of Ji-Paraná-RO, Brazil, observing that 8.3% of the samples had mold contamination above the established standard.

The low values for yeast and mold counts found in the present study may be associated with the storage conditions of the flour, the packaging used as well as the storage conditions. The presence of molds and yeasts in foods, according to Silva et al. (2009) can indicate poor conditions of equipment sanitation, mold and yeast multiplication in the product due to failures in processing and / or storage and raw material with excessive contamination. For Mundim (2014), factors such as temperature, humidity, water activity and substrate are the most important for the development of fungi and production of mycotoxins.

Regarding the dirt survey, all 12 samples of flours analyzed showed physical contamination, of unidentifiable strange matter or not. From the analysis, it was possible to carry out the quantification of the identified materials, according to Table 3.

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Table 3. Quantification of the material found in samples of cassava flour and tapioca. FM = cassava flour; FT = tapioca flour of the municipality of Castanhal and Santa Izabel do Pará, State of Pará, Brazil

City	Sample	Stone	Bark Remains	Wood Fragments	Unidentified Strange Matter	Hair	Insect Fragments
Castanhal	FM1	0	2	3	3	0	2
	FT2	0	0	4	4	0	0
	FM3	0	3	1	6	0	0
	FM4	1	0	1	3	0	0
	FM5	2	1	1	1	0	0
	FM6	0	1	2	4	0	0
	FM7	0	2	1	2	0	0
Santa Izabel of Pará	FT8	1	1	0	0	4	0
	FT9	0	0	0	1	0	1
	FT10	0	0	0	1	1	0
	FT11	0	1	1	0	2	0
	FT12	1	0	0	1	0	0

In relation to dirt surveys, there were presences of stones (5), bark remains (11), wood fragments (13), insect fragments (3) hair (7) and unidentified strange matter (24) which, according to CNNPA Resolution No. 12 of 1978, makes food inappropriate for human consumption, since it establishes the absence of dirt, parasites, and larvae in flour (Brazil, 1978).

In the literature, there are few studies showing results of physical contamination in food, although for many foods, the detection of dirt is a mandatory item to determine quality standards. In the present study, in 100% of the samples evaluated, it was possible to detect wood remains, probably coming from the materials used in the processing of the product or its transport. In a similar study, Lima et al. (2007), observed the presence of wood in all its samples, besides the presence of insects, proposing that such contamination occurred during the production of food, transportation or even during handling at the place of sale.

Bark remains were found in 71% of samples and insect fragments, such as wings, as well as stones and other unidentified materials represents 14%, and were in disagreement with Resolution RDC No. 175 of 08.01.2003 of the National Surveillance Agency, which establishes - foodstuffs must not present harmful substances to human health, such as: insects at any stage of development, alive or dead, whole or in parts; other live or dead animals, whole or in parts; parasites; excrement of insects and / or other animals; and rigid, sharp and / or sharp objects.

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The physical contamination can be easily detected with the naked eye, however in some cases, only with the aid of magnifying glasses. Micro-dirt may pose a health hazard to the consumer, so a microscopic analysis is necessary to identify the type of dirt and then the risk this contamination can cause. In the present study, it was possible to identify some dirt only after microscopic analysis, which some can be observed in Figure 1.

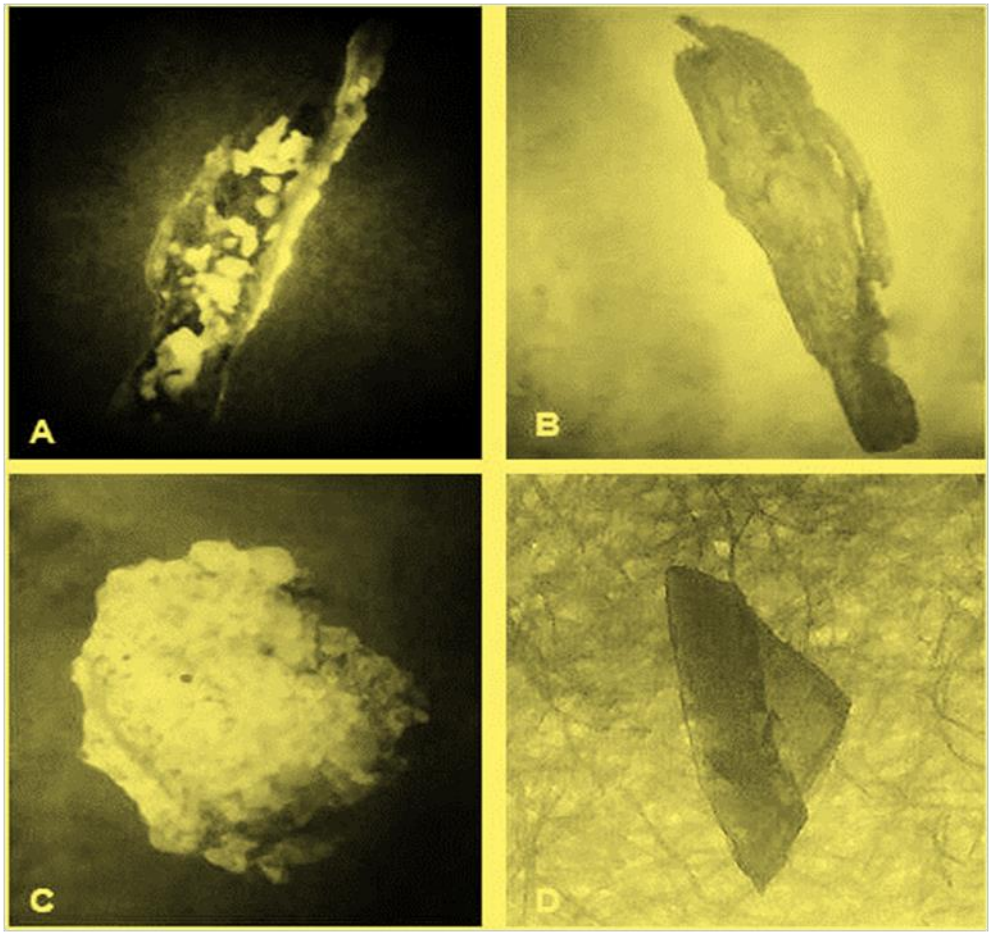

Figure 1**.** Materials identified in cassava and tapioca flour samples at macro and microscopic levels of the municipality of Castanhal and Santa Izabel do Pará, State of Pará, Brazil. A. Piece of bark, B. Piece of wood, C. Stone fragment, D. Wing fragment

The presence of dirt in samples of tapioca and cassava flour may be related to the lack of structures of the producing units, called "Flour Houses". These sites have inadequate infrastructure for food processing, with little or no supervision, which directly reflects the quality of these products. It is noteworthy that most of the processing units are in rural communities, of family subsistence and most are unaware of the standards and techniques of Good Manufacturing Practices. Similar results were obtained by Chisté et al. (2007), where they observed that most of the flours are produced in precarious establishments, without adequate infrastructure and minimum hygienic-sanitary conditions. It is also possible to find the presence of animals transiting in the processing area, allowing access also to insects and rodents.

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CONCLUSION

The analyzed samples of the municipality of Castanhal and Santa Izabel of Pará, State of Pará, Brazil presented satisfactory results regarding the microbiological quality, however the physical contamination presents a potential risk to the health of the consumer, thus making the analyzed samples unfit for consumption.

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