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Food safety in cassava “flour houses” of Copioba Valley, Bahia, Brazil: Diagnosis and contribution to geographical indication[☆]

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ABSTRACT

Cassava is one of most important foods in tropical countries, and in Brazil, it is largely processed as cassava flour, which constitutes a staple food. Although cassava flour presents unique sensory characteristics, the majority is produced in artisanal units, which do not adhere to food safety guidelines. Thus, this study aimed to evaluate the hygienic-sanitary profiles of the cassava flour houses of Copioba Valley, Bahia, Brazil. This was a quantitative, exploratory study involving 72 flour houses in the abovementioned region. To evaluate the flour houses, the checklist proposed by the National Service of Industrial Learning was used. This list comprises five dimensions: building conditions; equipment and utensils; workers in the production area, food handling, and sales; raw material and products displayed for sale; and production flow, food handling, sale and quality control. The results showed that none of units met more than 60% of the requirements, which is below the recommended cutoff and indicates poor hygienicsanitary conditions. Equipment and utensils made up the group with the lowest performance (4.54%), whereas the highest performance was observed in raw material and products displayed for sale (45.42%). All blocks were evaluated, and in all flour houses investigated, the results presented a major public health concern due to the abovementioned poor conditions. The study highlighted the problems of food safety in a traditional supply chain in the region. However, simple changes are possible, and these changes would not only have positive effects on the hygienic-sanitary profiles of flour houses but would also have an important social impact.

1. Introduction

Cassava represents one of the main food sources of the tropical regions; its production is estimated to fall just behind that of rice and corn (FAO, 2015). Africa, the Caribbean and Latin America stand out as continents with higher production of cassava for human consumption (UNCTAD, 2012).

From a historical perspective, the growth and use of cassava for human consumption in Brazil is associated with the country's indigenous culture and dates back to its discovery. Thus, over time, products such as cooked root, cassava flour and tapioca[1] were gradually incorporated into the eating habits of Portuguese people

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[1] Tapioca is the starch that is extracted from cassava roots.

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and slaves, ultimately becoming one of the identifiable features of Brazilian food culture (Cascudo, 2004; Piperno, 2011).

Currently, most cassava root in Northeast Brazil is processed as flour, and the production chain for this flour is characterized by the use of family labor forces in hundreds of small units called cassava flour houses ("casas de farinha"). The majority of cassava flour houses follow traditional, artisanal methods and operate in very simple structures that frequently lack adequate conditions for the appropriate and safe processing of foods and other products (Cardoso, Müller, Santos, Homma, & Alves, 2001).

Although cassava flour processing uses simple technology, precautions are required. These include the proper selection of raw materials and the use of proper hygiene practices and correct handling procedures during production to guarantee the quality of the final product. Nonetheless, with regard to the family-run flour production facilities of the Northeast, studies have raised concerns about product safety (Cardoso et al., 2001; Raspor, 2008).

Good manufacturing practices (GMPs) are considered among the most useful tools for the improvement of hygienic conditions in food processing and are highly beneficial instruments to achieve safety in the final product. In addition to mitigating hazards, GMPs also provide a more efficient and organized environment for work, optimizing the entire production process (Baş, Yüksel, &, Çavuşoğlu, 2007).

In the state of Bahia, the tradition of cassava flour production and trade has been preserved. The production of a flour called Copioba is particularly high; this flour is famous and renowned for its fine granulation and crispy texture, which is superior to that of other cassava flours (Castellucci Júnior, 2008). Given the historical and geographical importance of the production of this flour, which involves local knowledge, quality characteristics, identity and popularity, Copioba cassava flour meets most of the requirements for geographical indication[2] (GI).

Products that are eligible for GI must comply with legislation aimed at the producers' organization, the processing methods, the quality criteria for production standardization, and the establishment of regional and local marketing, as well as a sales network (Branco et al., 2013).

Thus, given the popularity of Copioba cassava flour, its eligibility for GI and the scarcity of studies on the hygiene practices associated with its production, this work aimed to evaluate the hygienic-sanitary conditions of cassava flour houses in Copioba Valley, Bahia, and to promote food safety in this production chain and the GI candidacy of cassava flour.

2. Materials and methods

An exploratory and quantitative study was performed with cassava flour producers from Copioba Valley, Bahia, Brazil. Fieldwork was conducted from November 2012 to February 2014 as part of the project entitled "Quality, identity and notoriety of cassava flour of Nazaré das Farinhas, Bahia: a contribution to Geographical Indication".

After identifying producers, we established communication with the individuals responsible for the flour production units, which resulted in the participation of 72 flour houses.

To evaluate the hygienic conditions of these flour processing facilities, the Checklist for the Establishment of the Food Manufacturing Area (CEFM) was used; this checklist is recommended by the Safe Food Program of the National Service of Industrial Learning ("Serviço Nacional de Aprendizagem Industrial" – SENAI, 2000). The CEFM involves most of the items necessary to ensure safety in food processing and classifies the flour house units in terms the percentages of requirements they meet.

The CEFM contains 60 questions that are organized in four parts as follows: A – Identification, B – Evaluation, C – Score of the establishment and D – Registers of observations. Part A, in addition to identifying the production establishment, includes complementary research information and records.

Part B, Evaluation, is designed to record information related to the evaluation itself and is structured in five blocks:

Block 1, referring to building conditions, comprises nine dimensions involving 22 questions (indicators): 1. Floors (2); 2. Linings and Roof (2); 3. Walls and partitions (2); 4. Doors and windows (4); 5. Sanitary facilities (2); 6. Changing rooms (2); 7. Wash basins in the food handling area (3); 8. Water tanks and water installations (2); and 9. Waste disposal (3).

Block 2, related to equipment and utensils, comprises five dimensions involving 10 questions: 1. Equipment and machines (2); 2. Utensils (2); 3. Furniture (2); 4. Equipment for refrigeration (2); and 5. Cleaning and disinfection (2).

Block 3 evaluates workers in the production area, as well as food handling and sales. This block comprises two dimensions involving six questions: 1. Clothing/garments (4); and 2. Worker health (2).

Block 4 concerns the raw material and products displayed for sale and comprises only one dimension involving four indicators. Block 5 comprises four dimensions, which are associated with production flow, food handling, sales and quality control. These dimensions encompass 14 questions, which are distributed as follows: Proper flow (2); Protection against contamination (2); Proper storage (4); and Packing and labelling of the final product/product displayed for sale (6).

Each block was scored with a specific weight to obtain a global grade, as shown in Table 1.

To calculate the score for each block, a particular constant (K) was used. This procedure was applied to avoid penalizing establishments in cases in which some of the evaluated items were considered not applicable/available (NA). The values of the constants are described below:

Constants for each block:

1. Building conditions: $K1 = 60$;
2. Equipment and utensils: $K2 = 50$;
3. Workers in production area, food handling, and sales: $K3 = 32$;
4. Raw material and products displayed for sale: $K4 = 24$;
5. Production flow, food handling, sale and quality control: $K = 53$.

Part C, the score for each block, was calculated according to the following mathematical formula:

$$WB = \sum S \times W/K - \sum NA$$

in which:

WB = score of the block
$\sum S$ = sum of items of the block that received appropriate classification
$\sum NA$ = sum of items of the block that were considered not applicable
K = block constant
W = specific weight of the block

[2] In Brazil, GI represents a way to qualify products and services that are assigned intrinsic and unique characteristics. These characteristics bind them to their production region of origin, with specific qualities related to the environment (geography, climate, soil) or to the traditional knowledge passed from one generation to another in a given culture (BRASIL, 1996; Giovannucci, Barham, & Pirog, 2010; Branco et al., 2013).

Table 1
Evaluation from CEFM – Part B: Specific weights by evaluation block.

Block	Specific weights
1 – Building conditions	W1 = 10
2 – Equipment and utensils	W2 = 15
3 – Workers in production area, food handling, and sales	W3 = 25
4 – Raw material and products displayed for sale	W4 = 20
5 – Production flow, food handling, sale and quality control	W5 = 30

Source: SENAI, 2000.

Table 2
Classification criteria of the units of food processing according to the total score.

Scores	Classification
91–100	Excellent (E)
81–90	Good (G)
61–80	Regular (R)
Under 60	Poor (P)

Source SENAI, 2000.

The total score (TS) of each cassava flour house was calculated as the sum of the grades for each block, i.e., TS = WB1 + WB2 + WB3 + WB4 + WB5. Based on this score, Part C (Classification) was completed in accordance with the procedures presented in Table 2, which were established by SENAI (2000).

Finally, in part D (Registers of observations), the variation in flour roasting temperature was recorded using an infra-red thermometer (ScamTemp, Incoterm, Porto Alegre, Rio Grande do Sul, Brazil). An imaginary point was established for the measurement, which was located in the middle of the ray of the circumference of the ovens. Based on a 15-min monitoring period, with records of minimum and maximum temperatures, the average temperature was calculated.

3. Results and discussion

Evaluation of the processing units.

The results of the evaluation of the cassava flour houses are presented in Table 3, and specific topics will be discussed.

Table 3. Evaluation of cassava flour houses in terms of the maximum possible score, the average of the obtained grades, the amplitude and the achievement rate (%) of the requirements. Copioba Valley, Bahia, 2012–2013.

3.1. Building conditions

Regarding block 1, a low compliance with building requirements was observed in the units, suggesting unsatisfactory facility conditions in the investigated set of cassava flour houses. One justification for this outcome pertains to the fact that most of the units operated in adapted buildings whose structures were not originally designed for the activity or in buildings that had been refurbished improperly.

The following items were identified as critical: the lack of a complete physical structure, including the absence of walls or partitions, doors, windows, or toilets, and insufficient facilities for ceilings and liners (Fig. 1). The achievement rate of this block did not reach one – third of the maximum possible rating, indicating the need for structural improvements in processing units.

Based on visits to the flour houses, it became clear that many had a precarious infrastructure. In most cases (70%), the floors were pure earthen soil; in other cases, the floors were composed of a mixture of cement and compacted earthen soil (20%) or cement alone (10%). The ceilings (roofs) of the flour houses were also in

Table 3
Evaluation of cassava flour houses in terms of the maximum possible score, the average of the obtained grades, the amplitude and the achievement rate (%) of the requirements. Copioba Valley, Bahia, 2012–2014.

Blocks	Maximum possible score	Average (standard deviation)	Lowest grade	Highest grade	Achievement rate (%)
1 – Building conditions	10	2.97 (0.56)	2.10	4.90	29,72
2 – Equipment and utensils	15	0.68 (0.44)	0	2.40	4.54
3 – Workers in production area, food handling, and sales	25	3.78 (3.49)	0	8.33	15.14
4 – Raw material and products displayed for sale	20	9.08 (1.49)	6.66	10.0	45.42
5 – Production flow, food handling, sale and quality control	30	9.10 (2.89)	4.52	12.30	30.34

Fig. 1. Facilities of cassava flour houses in Copioba Valley, Bahia, 2012–2013.

poor condition because the covers were made with clay tiles supported by wood rafters and laths that were unlined. These structures, while affording some product protection, did not favor cleaning, leaving food products susceptible to contamination.

Given that most of the cassava flour houses did not have walls or any physical barriers to protect them, animals such as dogs, cats, poultry, swine and insects were frequently present in their internal and external areas. This finding was also reported by Bonfim, Dias, and Kurozawa (2013), who observed animals in 100% of the cassava flour houses examined in their study.

Among the flour houses of Copioba Valley, only one (1.4%) had drinking water, revealing a significant failure to meet the recommendations for food production (Brasil, 2002; Obadina, Oyewole, Sanni, Tomlins, & Westby, 2008; Thomas & Philips, 2015). In the majority of units (98.6%), the water used for food processing was stored in closed barrels; in 87.8% of units, the water came from springs located within their property. Moreover, there were no sanitation facilities in any of the units.

In their consideration of the problems associated with the artisanal processing of Gari, a typical food from Africa, James et al. (2012) established guidelines for the proper processing of this product and emphasized the relevance of hygienic-sanitary conditions.

Also noteworthy was the manner in which wastewater from the pressing of cassava mass ("manipueira") was disposed; the water was released directly into the ground without any treatment. Santos (2009) evaluated the environmental contamination caused by the direct disposal of cassava wastewater and noted that in the area where this liquid was dumped, virtually all the plants died or did not develop, revealing that the hydrocyanic acid content of this residue is a major environmental contaminant. Therefore, this material should be used for other purposes and not be dumped directly onto the soil.

Montagnac, Davis, and Tanumihardjo (2009) called attention to the risks this waste carries, not only for the environment but also for the inhabitants of the polluted area. The author reported several serious symptoms related to cassava wastewater exposure, such as muscle atrophy, epithelial damage and vision loss.

The solid waste from the processing of cassava roots (bark and peelings) was crammed into piles within the units and would subsequently be allocated for one of two uses: plantations (44.4%) or animal feed (46.6%). Producers reported that this waste can be present in units for up to 48 h until its final use, encouraging the proliferation of insects and other pests, a condition that shows similitude to those reported by Thomas and Philips (2015) in Oyo State, Nigeria.

In block 1, the only variable that achieved greater compliance was access: 94.5% of the flour houses had adequate access, which was not common in other units (housing). Given the set of identified structural inadequacies, the producers claimed that there were no specific programs that would encourage them to undertake structural improvements. This necessitates action by public authorities to mitigate the situation.

3.2. Equipment and utensils

Block 2, equipment and utensils, yielded the lowest score. This result highlights some specific issues, including the fact that the equipment and utensils were located in areas common to all manufacturing processes, which did not meet the current standards. In addition, the maintenance and handling of these items were precarious.

Establishments were characterized by rustic equipment and utensils because most were manufactured with wood, a material that makes cleaning difficult (Fig. 2). Following rural traditions, wood was also used to manufacture troughs, bowls, shovels for the mechanized system and/or for the manual system, and squeegees for turning flour, among other items. Freitas, Farias and Vilpoux (2011) notes that this practice risks food contamination once utensils are exposed to dirt and also attracts pests that favor physical and biological contamination. Evaluating the production safety of "Fufu", Obadina, Oyewole, Sanni, Tomlins, and Westby (2010) observed similar rustic characteristics in flour production units.

However, the repurposing of household utensils has been a common practice in the flour houses of Copioba Valley; these findings were also reported in flour houses surveyed by Bonfim et al. (2013) and Maranhão (Fig. 2). In the Valley, for example, it was possible to identify household goods such as bathtubs or internal refrigerator boxes, which were used for storing ground cassava mass and/or prepared flour.

With regard to equipment hygiene requirements, the above results emphasized the need for appropriate cleaning procedures in the pre- and post-use steps. These procedures were not routine and therefore resulted in the formation of scaling on equipment, constituting a source of contamination.

In 75% of the surveyed flour houses, craft presses made of wood, with a rotating screw system and hydraulic jack (Fig. 3), were used; for 25% of producers, the process was performed in hydraulic presses. For pressing, both in modern and ancient systems, the cassava mass was placed in raffia bags and could remain there for 2–24 h Sant'anna and Miranda (2004) noted that this is one of several unsafe steps in terms of food quality because the food is subject to various forms of contamination because the raffia bags are recycled and often do not undergo cleaning.

In the production of flour, the furnace is one of the primary

Fig. 2. Hardiness and conservation status of equipment used in the production of Copioba flour (A) and the reuse of domestic installations for flour production (B). Copioba Valley, Bahia Brazil, 2013.

machines used. In most cases (77.8%), the furnaces were characterized by a brick structure with mud and/or cement and had an iron plate on which the flour was blended by a set of blades in planetary motion. These blades operated through a combustion engine or electric motor that comprised a mechanical system; alternatively, squeegees or wooden paddles were used in a manual system (22.2%). However, in the flour mills visited, regardless of the adopted roasting system, no cleaning schemes or preventative maintenance practices were used to ensure the operation of the furnaces.

According to Brandão, Santiago, Normande, Araujo, and Duarte (2011), equipment can serve as an incubator for the growth of microorganisms when employed at inappropriate temperatures; however, if the materials work at the correct temperature, growth can be prevented. In the surveyed flour houses, the temperature of the furnace ranged from 89 to 290 °C, with an average of 100.5 °C, a significant finding with regard to determining the load of microorganisms present in cassava flour.

Almeida, Costa, Nunior, Lima, and Nascimento (2005) conducted a study with 26 flour samples collected from traditional units in Alcântara, Maranhão, and found that the incidence of yeasts and molds ranged from non-detection up to 87 CFU g^{-1}, indicating that the temperature used in the roasting process acts as a product safety measure. Moreover, the final product itself has a low potential as subtract for microorganism development. Thus, these findings highlight the importance of well-functioning furnaces and of monitoring the roasting temperature to ensure the safety of processed flour.

However, a study conducted by Sant'anna and Miranda (2004), in which 35 cassava flour samples sold on the open market were collected, reported that 45% of the samples featured *Bacillus cereus* counts above the legal standard. This raised issues regarding the roasting process, in which temperatures may have been insufficient to destroy the spores of this microorganism.

In Copioba Valley, most flour houses (87.8%) had a single oven and were largely (94.5%) powered by motors, whereas the remaining (5.5%) operated with manual work. However, there were some flour houses that performed roasting via ancient methods, using three furnaces (Fig. 4). The three furnaces had different temperatures with different functions: the first, with an average temperature of 75 °C, induced the process of partial dehydration, popularly known as "zanzar"; the second, at a slightly higher temperature (average of 95 °C), caused complete dehydration, a process known as "grolhar"; and the third and final oven, with a temperature of 125 °C, performed the final roasting of the flour, a function known simply as "toasting" (Lody, 2013).

All units used manual processes for the sieving step. The sieves were constructed by the producers and were made of a wooden structure and nylon screen, whose mesh corresponded with the desired particle size, a practice also described by Santos, Carvalho, Silva, Rezende, and Miyaji (2009). During this phase, the remaining fraction in the sieves - larger particles and fibers - could be recrushed and homogenized with a prepared flour. This practice was adopted in 60.6% of the flour houses in Copioba Valley; 39.4% of the units did not adopt the practice because the addition of this fraction negatively affects the particle size and the quality of the final product.

In contrast to cassava flour processing, in the production of Gari flour, the product remaining in the sieves is usually added because the particles coming from the sieve pass through a frying process and thus become drier and are more easily incorporated into the flour obtained thereafter (James et al., 2012).

Generally, the flour houses did not have a cleaning schedule. Cleaning and disinfection of containers, mainly after use, was not observed at the visited sites.

It was common to find residue from previous processing, although 100% of the producers reported daily cleaning before starting production. Equipment were cleaned occasionally with brooms and cleaning cloths; however, the remains of prior production were often noted. These findings are similar to those of a study conducted by Brandão et al. (2011), who investigated 51 flour houses in Northeast Brazil and noted no major concerns on the part of producers in terms of worker, environment or equipment hygiene.

In addition to the rustic conditions, non-compliance with hygiene requirements was observed with regard to equipment, utensils and environments. There was considerable accumulation of waste, as well as exposure to contaminants and animals, among other forms of dirt, which creates opportunities for flour contamination in the units and must be corrected. Thus, considering the hygienic and sanitary aspects of this block, the evaluated flour houses generally failed to meet any of the legal requirements (Brasil, 2002).

When evaluating cassava processing units in Ghana, Johnson, Johnson, Tomlins, Oduro-Yeboah and Quayson. (2008) observed results similar to those of this study; the entire production system of cassava products did not meet the recommended quality requirements.

As a counterpoint to this description, in a study to support small producers of cassava flour, the National Support Service for Micro and Small Enterprises (SEBRAE) prepared a manual with guidelines on the structure, equipment and utensils of flour houses entitled "Reference Manual for Flour Houses" (SEBRAE, 2006).

This publication contains guidelines concerning sanitation requirements for equipment, including the ease of cleaning surfaces, to prevent the accumulation of waste and the development of microorganisms. It also includes recommendations for the adoption of preventive maintenance practices to minimize the problem

Fig. 3. Models of artisanal presses used in Copioba Valley, Bahia, Brazil, 2013.

Fig. 4. Roasting systems with a manual furnace (A) and with a motor (B) in Copioba Valley, Bahia, Brazil, 2013.

of parts wearing down. The manual is beneficial for both consultation and educational activities with producers.

3.3. Workers in production area, food handling, and sales

In block 3, the poor rating of the units was linked to the unsatisfactory performance of the handlers regarding correct handling of the product, both in processing and in post-processing, as well as the lack of qualifications to adopt good manufacturing practices in the production process. It was frequently observed in the surveyed units that hygienic procedures were practically nonexistent among handlers.

The use of items of clothing and personal protective equipment, including gloves and caps, was not observed, even in the production area. Issues related to personal hygiene demanded attention, given the high frequency of food handlers with long and dirty nails, beards, and skin lesions. Furthermore, inappropriate habits were observed, such as spitting and smoking in the production area.

In their microbiological and hygienic-sanitary assessment of cassava processing units in 13 municipalities of southwest Bahia, Rebouças, Santos, Benjamin, Figueiredo, and Oliveira (2011) found that the workers did not meet the minimum level of personal hygiene (nails, arms, hands, and hair). The authors also reported that food handlers smoked and consumed food and drinks in the processing area, which was often dirty with food debris and waste from flour production.

In their study in Maranhão state, Bonfim et al. (2013) observed that the most problematic issues in terms of personnel in the area of production, manipulation and sale included the absence of uniforms, gloves and caps and the presence of ornaments and handlers with dirty or long nails and no experience conducting medical examinations.

According to Silva Junior (2005), the fulfilment of control measures concerning the personal hygiene of food handlers during the handling and processing of foods is important to avoid cross-contamination of the environment, utensils and equipment, thereby contributing to the reduction of contamination of the final product and to the provision of safe food.

Because there were no piped water systems in the flour houses, there were no hand washing basins or cleaning products for the workers' hands. These results are corroborated by Bonfim et al. (2013) and Denardin et al. (2009), who reported a large percentage (100 and 67%, respectively) of flour houses without sinks for hand washing.

With regard to occupational health requirements, in the Copioba Valley, it was observed that periodic examinations were not performed by all the respondents. This finding agrees with the work of Bonfim et al. (2013), in which 100% of producers did not perform periodic examinations, and with Denardin et al. (2009), who reported a prevalence of 89% for this indicator.

As described by Chaves, Assis, Pinto, and Sabaini (2006), handlers are a significant source or cause of food contamination occasioned by hand and body contact, as well as production practices; therefore, handlers should be aware of their role throughout the preparation and distribution of food. Nevertheless, and despite the popularity of Copioba flour, there were no training programs on food safety - whether occasional or through continuing education – for workers in the surveyed flour houses.

These results highlight two issues: first, a paucity of information among producers, who rely on empirical knowledge acquired over time for the flour production process, and second, either neglect or limited action on the part of agencies responsible for overseeing the sector.

3.4. Raw material and products displayed for sale

In block 4, one concern pertained to the care of raw materials; in most units, the cassava roots destined for flour production were not washed, and after peeling (scraping), they were laid on tarpaulin or in plastic barrels that rarely passed through cleaning processes. Thus, these operations significantly contributed to contamination of the raw material to be processed. Similarly, in Nigeria, Oyo State, Thomas & Philips found results that corroborate these findings.

Another important aspect was the storage of the final product, which is usually packaged in 50 Kg nylon bags with an inner plastic coating; this reduces the chance of the product being exposed to external contamination. However, these bags were arranged directly on the ground, without any protection, or were placed on plastics unsuitable for this purpose. Notably, these practices reduce both the safety and the shelf life of the product and may also pose health risks to consumers (Akingbala, Oyewole, Uzo-Peters, Karim & Baccus-Taylor, 2005; Carvalho, 2006). Therefore, to achieve safer conditions, flours must be prepared with good manufacturing practices and good storage conditions (N'Guessan, Bedikou, ZOUE, Goualie, & Niamke, 2014).

For the majority of producers (94.5%), packed flour was traded in bulk and without any identification at fairs in the city itself or in nearby towns or at small businesses in the region. According to Brazilian legislation (Brasil, 2011), foods should be identified, and descriptions must be prominent and visible, containing at least the company information and the type of product. However, none of the studied flour houses complied with this recommendation.

Furthermore, this block had the highest percentage of adequacy in relation to the maximum score group (45.42%), which is the result of two indicators that showed compliance with the recommended measures. The first concerned the sensory characteristics expected for the product – when the flour is a product free from odors or unpalatable flavors and has particular attributes that favor the quality of the final product, and the second was product packaging in post-production.

3.5. Production flow, food handling, sale and quality control

In block 5, despite the low level of performance recorded, there was an orderly flow to the production process in a "U" form that reduced the possibility of cross-contamination, given the linear direction of production. The reception areas, as well as the root peeling and washing space (dirty area), were not physically isolated from the processing area (grating, pressing, sieving, roasting and packaging). However, workers and utensils did not cross between these two areas, thus limiting food contamination during processing.

Among the indicators that presented inadequacies, the handling of the final product occurred without protection, exposing the flour to the handler and the environment. The use of packaging without product identification was also observed. There was no control with respect to the post-processing of the product, and there were also no laboratory tests that could verify its final characteristics.

Regarding storage of the finished product, the level of inappropriateness of the surveyed units reached 94.5%. The maximum time of product storage in flour houses was three days, and for the most part, there was no specific area designated for this purpose. Thus, flour tended to be stored in the homes of farmers, directly on the floor.

Vehicles used for distribution of the product included private transport (40.54%), lorries and pickup trucks (both 25%) and cars (9.5%). RDC Resolution No. 275/2002 (Brazil, 2002) states that the vehicles used to transport food must be consistent in their purposes of use and must also meet certain requirements, such as having coverage for load protection; applying measures to ensure the absence of urban pests or any evidence of them, such as feces, nests, etc.; and being cleaned regularly. These requirements were not met by any of the flour houses of Copioba Valley.

3.6. Classification results of CEFM

None of the evaluated units reached an adequacy rate higher than 60%; ratings below this index indicate poor hygienic-sanitary conditions. This finding agrees with those of other studies.

When assessing the hygienic-sanitary profile of flour houses in southwestern Bahia, Rebouças et al. (2011) observed that 100% of the units were classified as substandard. The authors explained that flour house workers do not observe the operating technical specifications established by government and non-government agencies. According to the researchers, the hygienic-sanitary problems identified in the flour houses included non-use or misuse of equipment and utensils, incorrect disposal of waste, non-delimitation of the production area, non-compliance with several steps of the process (preparation of the roots, peeling, washing and storage of ground roots) and poor infrastructure.

Cassava flour is consumed in large quantities in Brazilian culture, but the results obtained for flour houses surveyed in the Copioba Valley reveal a critical situation in terms of the safety of food production in the region and the broader context of family farming. These results also significantly shape whether cassava flour production will meet the requirements to apply for geographical indication (BRASIL, 1996).

Based on the data, food safety in cassava flour production is one of the issues of greatest concern when applying for geographical indication. Therefore, it is imperative to adopt corrective measures in the short and medium term that aim to implement good manufacturing practices, to promote the principle of health protection and to boost both food supply and local development, a guideline that is also established in other countries (Ababio & Lovatt, 2015). For example, in Nigeria, some studies report initiatives that have supported producers in achieving better and safer conditions for cassava processing (Dziedzoave et al., 2010; Obadina et al., 2010). According Thomas and Philips (2015), in addition to safety aspects, cassava proper processing contributes to minimizing post-harvest losses and environmental pollution, extending shelf life, and improving trade.

4. Conclusion

In the five different blocks evaluated - building conditions, equipment and utensils, food handlers, handling, and storage and distribution - the results showed several areas of non-compliance with the hygiene requirements for cassava flour production in the Copioba Valley region. This is a great concern from the perspective of public health, given the poor classifications for all units.

The findings of this study reinforce the need for the adoption of good manufacturing practices, with their various dimensions and components, given the reality of artisanal production. This study confirmed the urgency of establishing adequate physical structures in flour houses, as well as developing educational activities for producers.

Given the aforementioned findings, even simple changes would be immediately possible and would contribute positively to the hygienic-sanitary profiles of the units. In turn, these changes would benefit society and would also support the eligibility of Copioba's cassava flour for geographical indication.

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