

LOCAL CEREAL FLOURS REPARTITION ON MARKETS AND SELLERS APPROACH ON PRODUCTION AND CONDITIONING IN THE DISTRICTS OF ABIDJAN COTE D'IVOIRE

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Abstract

In Côte d'Ivoire, cereals are traditionally grown in northern areas. After production, they are generally transformed into flours and consumed mainly as staple foods in form of thin and thick porridges or alcoholic or non-alcoholic beverages. However, constraints to traditional processing of local cereals have led to a shift towards adoption of quality, easy to cook imported cereal products. Mechanization of the hulling and milling steps for flours production has become a way to valorize local cereals. This survey help assert that millet and maize flours were the main local cereal flours produced and sold on the markets. No significant difference was found between the numbers of women processors of millet, white and yellow maize flours identified ($P<0.05$). Preference between the local cereal flours showed that on a 1 to 3 scale comparison ($P<0.05$), millet flour ranked as being the most prized followed by white maize and then yellow maize. The yellow maize owes its popularity to addition of alkaline ash. In terms of volumes of production and sale, maize flours were the most important ($P<0.05$). As far as quality was concerned, the wet processing and the ignorance of hygiene practices observed are limiting factors.

Keywords: Cereal processing; Abidjan; Côte d'Ivoire; local cereal flour; producer survey

Introduction

Côte d'Ivoire, since the fifties, has been characterized by an important population growth and a rapid urbanization (Dubresson, 1989). This development has led to an increase in demand for cereals (AFD, 2011; Broutin, 2011). The consumption of cereals is about 2.3 Mt for a local production of 1.5Mt (BECEAO, 2013) indicating that Côte d'Ivoire has a sizeable cereal deficit. The increased demand in cereals mainly concern rice, maize and wheat. The calorific contribution in the period of 2004-2008 was about 19.1%, 6.5%, and 0.8% for rice, maize and millet/sorghum, respectively; that of wheat was reported to be 4.8% (ReSKASS, 2011). So, the country has to resort to a massive importation of rice, wheat and maize to meet demand however the agricultural policy to reach self-sufficiency in cereals has mainly been focused on rice production (BUPED, 2010). Maize cultivation has also made progress but to a lower level (PRESAO, 2011). The major interest in rice, maize and wheat has led to the marginalization of traditional cereals such as millet, sorghum and fonio (Cruz *et al.*, 2012; ReSKASS, 2011 and Basset, 2002). The imported cereals have an actual advantage on local cereals with regard to price, quality and convenience. Indeed, local cereal flours production was time consuming and arduous. They were traditionally produced by hand pounding, using wooden pestle and mortar or by grinding with stones (Aboua *et al.*, 1989). These inconveniences have also contributed to the adoption of imported easy to cook foods such as refined rice and wheat flours, and abandoning local cereal productions (IPGRI, 2003). Urbanization has brought in changes in lifestyle, diversity in food consumption patterns as a result of increased food choice on markets (FAO, 1994). However, it has been reported that, despite the shift towards imported goods consequent to changes in lifestyles in the urban settings, the ethnic background of Ivoirians remain determinant for their overall eating habit (Dubresson, 1989, N'zi and Sylla, 1980).

Local cereals are mainly grown in savannah zones (northern areas) and traditionally consumed, after processing into flour, as staple foods by the native population (Kouakou *et al.*, 2010). Urban consumers, mainly women, because of time constraints due to employment, do not have much time to spare for long traditional meal preparation (Delisle, 1990). So, they would look for processed and pre-prepared foods (Drenowski and Popkin, 1997). Hence, this indicates that there are potential value-generating opportunities for local foods production if only adequate processing is provided (Elbehriet *et al.*, 2013).

Presently, milling by mechanical means commonly using abrasive decorticators and disk mills has become popular (FAO, 1985; Seck, 1989). To meet financial constraints imposed by mills, some women, very early, have turned into local cereal flour producers and sellers (Ki, 2000). In

neighboring countries, Sahelian and Coastal, lot is being done with regard to local cereal valorization (CIRAD, 1995; Thuillier, 1991). At present, a wide range of local cereal flours derived products with suitable qualities and easy to cook are put in the markets in countries like Mali (Kaminski *et al.*, 2013), Senegal (Ndiakhere, 2005), Niger (AF, 2008), Benin (Devautour, 1992; Nago and Hounhouigan, 1990; Nago, 1989) and Burkina Faso (AF, 2006). In Côte d'Ivoire, no formal reports on local cereal flours production are available. This study aims at getting an overview on the primary transformation of local cereals into flours production in the Districts of Abidjan. The flour producers survey was undertaken whilst observing environment and the ways of handling raw and end products.

Materials and Methods

Study area and selection of respondents

The survey was carried out in nine (9) areas of Districts of Abidjan namely Abobo, Adjamé, Attécoubé, Cocody, Marcory, Koumassi, Port-Bouet, Treichville, Yopougon. A total of 307 cereals flour sellers were identified in the course of the study. Structured questions were administered to identify their socio-demographic status that is gender, nationality, ethnic origin, marital status, and educational background. The importance of the type of cereal flours was evaluated by questions on eventual consumers' preference and the daily amount of flour sold. General information were asked to identify critical areas that may have potential influence on overall product quality. Information on processing steps, flours handling at selling hours and after selling times were thus taken into account. Spoiling signs were provided by respondents.

Data analysis and calculation tools

Data were collected under complete disjunctive matrix. Multivariate Statistical Analysis (MSA) by classification with Tree diagram, Euclidean distance metrics and single linkage distance methods were jointly used to analyse these data. Pearson Chi square (Chi²) test was used to see correlation between frequencies at 5% level. ANOVA (Analysis of Variance) was done and Fisher's Least Significant Difference was used for means comparison at 5% level. SPSS 17.0 software was used for Chi square (Chi²) test while Statistica 7.1 software was used for MSA classification and ANOVA.

Results and Discussion

Socio demographic characteristics of the sellers

The respondents were women (100%), originating from Côte d'Ivoire (59%) and neighboring countries (41%), mainly Sahelian. The main ethnic group among the Ivoirians was northerners (91% of respondents). For the

marital status, the majority, (70%) of the respondents was married and 24% were single. As for their education level, 83% of them had no formal education (illiterate) and 13% with primary level. The prevailing number of northerners as local cereal processors would be due to the fact that they originate from areas where cereals are grown and represent the main staple foods. These women processors surveyed have obviously no formal training; their professional experience result from years of traditional family education. They would perceive their activities as a continuation of household tasks for income generation. They could be ignorant of existing standards for good manufacturing and hygiene practice of commercial production. An African regional standards project has been drawn up by the Codex Alimentarius (FAO/WHO, 1985) where conditions of hygiene and packing have been fixed. Moisture content, granularity and ash content are crucial factors for quality attributes of cereal flours. These standards aim at helping both processor and user to better characterize and position the product. Considering the low education level of the protagonists, campaign to raise their awareness on existing standards to ensure competitiveness to their products would be advisable.

Local cereal flours sale in the District of Abidjan.

The sale of local cereal flours in the markets of the District of Abidjan is illustrated in Table 1. Among the cereal grains identified with retailers, meaning, white and yellow maize, white and red sorghum, millet, rice and fonio, only, three (3) are processed into flours and sold on the market places. The rates of white maize, yellow maize and millet flours selling were 99.35%, 94.13% and 71.01%, respectively (Table 1). The test of Fisher showed no significant differences ($P < 0.05$) between the means of the 3 types of flour sellers surveyed per area. There is indication that the level of involvement for the 3 types of flours production is equally shared by the women surveyed. Most of the time, they would produce and sell the 3 types of flours at the same time. Rice, sorghum and fonio flours are nonexistent on market places.

Table 1: Local cereal flours selling in the District of Abidjan

Types of cereal	Means values per area	Rate of flour sales (%)
White maize	33.88 ^a ± 5.82	99.35
Yellow maize	32.11 ^a ± 5.67	94.14
Millet	24.22 ^a ± 4.92	71.01
Rice	0.00 ^b	0.00
Red sorghum	0.00 ^b	0.00
White sorghum	0.00 ^b	0.00
Fonio	0.00 ^b	0.00

Means values having a common letter are not significantly different according to Fisher’s LSD test at the 5% level.

The sellers reported that there was no demand concerning sorghum and fonio flours in the different markets of the District of Abidjan; they would be homemade. Actually sorghum and fonio are not generally named in the dietary habitsof Ivoirians (ReSAKSS, 2011). These two cereals, just,like millet are staple foods in typical areas, where they are traditionally grown and mainly auto consumed (Kouakouet *al.*, 2010). Maize is a nontraditional cereal which has been widely disseminated in savannah zones because of its high productivity and precocity (PRESAO, 2011).The agricultural performances of maize as well as its successful commercializationmight explain the popularity of its flours. Millet is described as being tastier and more digestible than sorghum (FAO, 1995).The availability of millet in the form of flours on market places would be justified by consumer’s preference. The selling arguments for millet and maize flours were the taste, availability and price (Figure1). Observations from the tree diagram showed that the main argument for the popularity of millet and maize flours was the taste (highest linkage distance 8). At distance 5, the tree diagram split up in two subgroups: price for yellow and white maize. Availability criterion for millet and maize and price was met in the minor category.

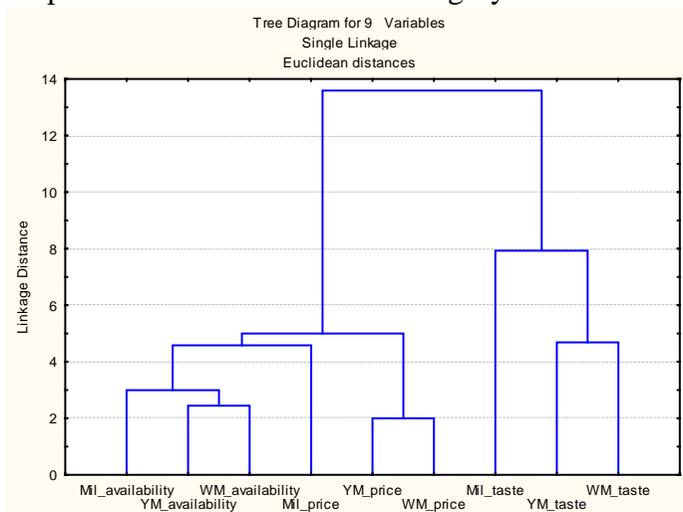


Figure 1: Selling arguments about maize and millet flours on the markets of the District of Abidjan. Legend: Mil: millet, YM: yellow maize, WM:white maize

Daily outputs and preference of cereal flours

Cereal flour producers would not give formal information on their daily outputs that could be attributed to their low education level. Thus, information on the amount of flours sold was illustrative.They were expressed as portions of sacks (100kg) of raw cereals processed. In Table 2,

is summarized the results of the different quantities of local cereal flours sold. Analysis of the tiniest quantities, less $\frac{1}{4}$ a sack, shows that millet flour was the least sold ($p < 0.05$). Millet flours were consistently characterized by their low quantity produced in all the markets surveyed. For the $\frac{1}{4}$ sack volume, the selling level was significantly similar for all the flours: $p < 0.05$. At the maximum daily output identified, $\frac{1}{2}$ sack, yellow and white maize flours are dominant ($p < 0.05$). It is not clear if local flours production is a good income generating activity; roughly speaking, transforming 100 kg can bring in 4000francs CFA (9\$ US) according to the respondents. The new trend among local cereal flour producers is the selling of ready to cook products; indeed, some millet flour sellers have tremendously increased their daily output by proposing easy to cook dried rolled flours for porridges.

Table 2: Daily selling of local cereal flours

Portion of Sacks	Types offlour	Means \pm SD
< $\frac{1}{4}$	White maize	4.11 ^a \pm 5.48
	Yellowmaize	4.88 ^a \pm 5.60
	Millet	14.33 ^b \pm 13.72
$\frac{1}{4}$	White maize	11.11 ^a \pm 4.85
	Yellowmaize	11.11 ^a \pm 5.64
	Millet	7.33 ^a \pm 10.24
$\frac{1}{2}$	White maize	19.66 ^a \pm 11.42
	Yellowmaize	17.11 ^a \pm 12.32
	Millet	5.11 ^b \pm 2.31

Mean values having a common letter are not significantly different according to Fisher's LSD test at the 5% level.

About local cereal preference, the level of appreciation by sellers was rated as followed: highly, moderately and weakly prized (Table3). On the highly prized scale, millet flours ranked first ($P < 0.05$). On the moderate basis, white maize was predominant ($P < 0.05$). On a 1 to 3 scale, that is, weakly prized, yellow maize flour prevailed ($P < 0.05$). In summary, millet flour was the most appreciated among the three cereals flours. Production of yellow maize flour with addition of ashes is the most common form sold in all the markets surveyed. When comparing yellow and white maize, it appears that the preference of the population goes to the latter for direct human food in West Africa (FAO, 1997). The popularity of white maize is that it is more suited to a broader range of recipes adapted from traditional cereals like millet and sorghum (Abouaet *al.*, 1989). Yellow maize is reportedly preferred for animal feed in many regions as it gives a yellow color to poultry, egg yolks and animal fat (IITA, 2013).

Table 3: The preference of local cereal flours from most prized to least prized

Rating scale	Types of cereal	Means±SD
Highlyprized	White maize	13.44 ^a ±1.02
	Yellowmaize	07.88 ^b ±5.32
	Millet	18.33 ^c ±6.34
Moderatlyprized	White maize	17.66 ^a ±1.02
	Yellowmaize	09.44 ^b ±5.64
	Millet	07.11 ^b ±5.94
Weaklyprized	White maize	03.77 ^b ±2.77
	Yellowmaize	12,22 ^a ±7.41
	Millet	0,77 ^b ±1.30

Mean values having a common superscript letter within the same column are not significantly different according to Fisher's LSD test at 5% level.

General information on the production and conditioning of local cereal grains and flours

Some of the criteria that are determinant to quality products are the choice of cereals varieties and adequate storage conditions of grains (Lebeurier, 2009). The respondents would get their supply in raw cereals from regular markets, with wholesale dealers or retailers; they have no control on the selection of cereal varieties to guaranty stable products. The market value of 100kg of maize or millet grains cost 20.000 francs CFA (45\$ US) or 30.000 francs CFA (67\$ US), respectively. The sacks of raw and decorticated cereals grains are stacked in dusty premises, infested with roaches and rodents. Good hygiene practices requires that grains storage facilities be kept clean, aerated, disinfected with appropriate pesticides (DILA, 2011) to preserve grains from mold, insects and rodents attack. Poor quality grain cannot be made into acceptable products. The two criteria, choice of selected varieties and adequate storage conditions for raw grains are not met for stable safe quality product.

Concerning flours production, four (4) main steps of transformation were identified by the women processors, meaning: cleaning of raw grains, hulling, tempering and milling (Figure2).

Women producers engage local millers' services to decorticate and grind their cereal grains for a fee. Local mills provide minimal services; their equipment park consists of decorticators and disk mills (suitable for wet and dry materials). No specific precautions are taken to clean up the equipment's before milling even though decorticators and mills have been reported to be major sources of food contaminations (Lana *et al.*, 2003; Weidenbörner *et al.*,

2000). Raw grains and the flours produced are not separately handled. The mills are located inside or around markets areas; they would offer conveniences such as running water and space that allow the women to conduct the main stages in the process at the same place. For the tempering process, utensils are left outside in open air overnight.

About cleaning of grains, the respondents were aware that cleanliness is a criterion of quality which has direct influence on the acceptability of the end product. Before processing, the grains (maize or millet) are cleaned out of foreign matter (small stones, damaged kernels, straw, insects, and metallic debris). Maize grains are manually sorted to remove impurities while millet grains are washed (wet cleaned) to eliminate undesirable matters.

As for hulling, the main object of this step is to remove the hulls and a part of the germ rich in lipids in order to get flours that can be well kept (CIRAD, 1995). Hulling is 100% mechanized according to the women processors surveyed. Only maize grains are submitted to this process. The maize grains are slightly moisten (about 50g of water per kg of grains) to soften the surface of the grain and ease detachment of external envelopes (pericarp). The separated bran is used for animals feed. The hulling yield is about 70 to 80%. Millet grains are not decorticated because of unsuited technologies on the markets that would lead to very low yields of 55 to 60%, beside, millet is an expensive good.

In the tempering step, the decorticated maize grains (grits) are washed to remove remaining bran and soaked overnight (12 to 15h). Wetting aims to ensure brittleness of grains for fine milling (McKevith, 2004). However, prolonged wetting have been shown to be impoverishing because of draining of nutriment (Favier, 1989). This traditional practice has also been proven to be unnecessary because 1 to 3 hours tempering is reported to insure optimum brittleness (Ndjouenkeuet *al.*, 1989). Crystal ashes are added at about 5g to 50g for 1kg of hulled grains, there is no standard. Quantities are left to one's skills. The crystals of ashes or "potash" used are highly alkaline. Addition of ashes aims at softening grains hulls to facilitate milling during industrial process; it is intended to be a rapid step at the time of washing decorticated grains in industrial processing (Abouaet *al.*, 1989).

Milling was the last step for the transformation of the cereal grains into flours. It is 100% mechanized. Maize grits and millet grains are milled to give flours with high moisture content which leads to a rapid fermentation and does not permit conservation beyond one or two days. The flours are sieved into fine flours with standard sieves available on the markets.

Four (4) types of maize flours are available on the markets of the District of Abidjan. White and yellow maize flours with or without ashes. The ash-containing yellow and white maize flours are characterized by a strong flavor imparted by the ashes (potash). The natural yellow color of the

maize turns into an intense color while the white maize treated with potash displays a light yellow shade. The respondents declared the maize flours produced to be 100% pure. Pure white and potash-containing yellow maize are the most common forms of maize flours produced and sold on the markets surveyed.

With cereals such as maize, it is possible to remove the bran by a simple milling followed by sieving the flour. In the case of millet such a process is not enough. The pericarp of a millet grains has the characteristic of disintegrating into fine particles when the grain is crushed during milling (FAO, 1995; Perten, 1983).The type of millet product obtained in the commercial processing is thus dark grey wholemeal flour rich in bran and germ. The wholemeal millet flour is very nutritious but has poor keeping quality for it becomes rapidly rancid.Three percent (3%) of the women surveyed admitted mixing the millet flour with white maize or rice flour to make profit.

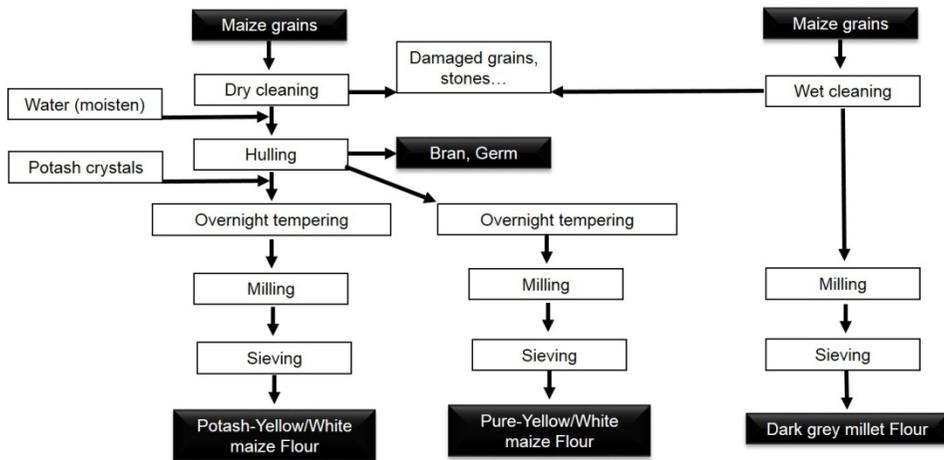


Figure 2: Maize and millet flours processing schemes

The sellers surveyed are most of the time sheltered from the sun with their good. They can be found grouped inside the central building of big markets, or under hangars, away from garbage cans. Flours are sold in bulk, exposed to ambient air, insects, dust and density of persons. The recipients containing flours are placed on tables or laid on the ground. Flours are handled by the very hands in contact with money.

The wet process used for local cereal flours production makes it hard to keep over 24 hours because of high water content favorable to microbial growth. In an attempt to minimize deterioration, the unsold flours are readily spread, over plastic sheets to be dried in open air. 53% of the respondents would leave the flours on the selling sites, 17% keep the flours in improvised

warehouses and 30% take their products home. In any case, they will ensure that the goods remain uncovered or not hermetically covered to limit spoilage. These practices expose flours to rodents, insects and dust. Concerning the unsold flours, the respondents reported three types of behaviors; indeed 83% said they would discard rotten products when 13% would feed animals. The 3% remaining admit using again by mixing with fresh flours. All the behaviors observed during the whole process of transformation of raw grains into flours are revealing of practices that might be hazardous for consumer’s health. Microbiological and physicochemical analysis is imperatively needed to assess quality of the cereal flours.

Seller’s criteria on rotting signs were: aspect (color), odor, texture, taste and bugs. In Figure3, the tree diagram illustrates the classification of the rotting signs of millet and maize flours as cited by the sellers surveyed. Analysis of the diagram allows the following observations: the ascendancy of aspect (color) and odor over the other signs. The two criteria displayed the highest linkage distances, 9 and 8. The most obvious sign of rotting is aspect, meaning discoloration, with linkage distance 9. The original colors of the maize and millet flours tend to fade away with apparition of dark spots (dark molds). At linkage distance 8, the flour odor is the second rotting sign described by respondents. Taste, occurrence of bugs, and texture are minor characteristics with linkage distances at 4.5, 2 and 1, respectively (Figure 3).

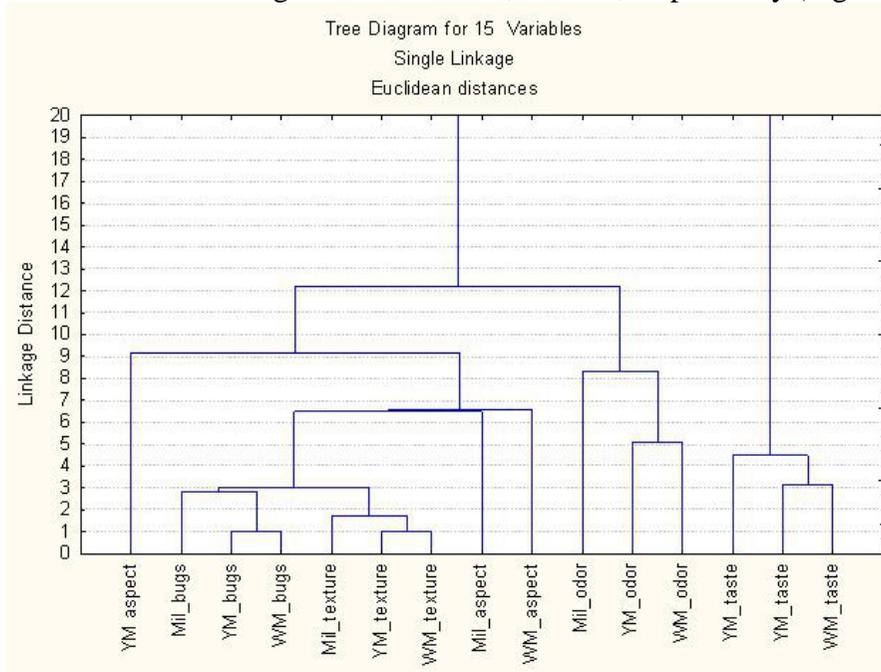


Figure 3: Flours rotting signs description by respondents.

Figure 3: Flours rotting signs description by respondents.

Conclusion

The local cereal flours production in the District of Abidjan concerns mainly white and yellow maize and millet. Taste, availability and price would justify their popularity. As far as preference is concerned, millet ranks first followed by white maize then yellow maize, however white and yellow maize flours are the most sold on the markets. The actors of local cereal flours production are women originating from traditional growth areas. Their main skill is the educational background and they are ignorant of existing manufacturing and hygiene standards for commercial flours production and marketing. Critical areas that can affect the overall quality and nutritive value of the local cereal flours have been identified: the storage facilities of grains, cleanliness of the mills materials as well as the whole transformation process (including the unnecessary tempering) and handling of the flours. These observations can serve as useful basis to develop competitive quality products in order to conquer a wider urban market.

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