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Consumption and conservation of cassava sticks in Libreville

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Abstract
In Gabon, a country more than 90% urbanized, cassava roots cover on average nearly 50% of the population's energy needs, and constitute more than 80% of energy supplies in rural areas. Cassava is consumed in several forms: cassava sticks, foufou flour, cooked tubers, cassadents and gari. The cassava stick is the product of a series of wet processing, the main steps of which are peeling, retting, defibration, rolling, pre-cooking, kneading, shaping, packing in wild natural leaves and terminal cooking.
The qualitative approach was carried out through a questionnaire survey to determine the consumption habits of the urban population of Libreville, its motivations and its representations. The experimental study of the conservation of cassava sticks focused on the observation of the cassava sticks consumed in Libreville according to the type of packaging.
It is a commonly consumed food in Gabon whose nutritional role is not well known to the populations. Cassava, like many other foodstuffs, is sensitive to heat, humidity, insects, rodents and molds.
The aim of our study is to determine the best conservation processes in order to obtain healthy products that retain all their organoleptic, nutritional and marketable qualities for greater access of populations to this commodity.

Keywords: Cassava tuber, cassava stick, processing products, nutritional intake, conservation, film paper

Introduction
Climatic vagaries are an important factor in the excessive variation in agricultural production. 2/3 of the African continent are subject to the risk of drought due to the instability of the rains and their poor distribution in space [1]. Based on this observation, the FAO has suggested a diversification of food production in the regions concerned by the development of the production of roots and tubers. And, because of its good profitability, low cost of production, resistance to drought and predators [2], cassava is a first-rate choice in this agricultural policy [3]. However, due to the climatic conditions and insufficient infrastructure for the conservation of cassava roots, the processing of cassava naturally imposed itself [4]. It allows, according to [5], to stabilize perishable roots by reducing their water content and extending their shelf life or consumption; reduce post-harvest losses, facilitate the transport of cassava products and improve their accessibility to consumers; to give finished products the desired health, nutritional and organoleptic characteristics; to diversify people's diets; add value to cassava roots, expand the commercial potential of local, regional or international markets and contribute to job creation, the growth of small agri-food businesses and the economic development of cassava value chains . With 200 million tons in 2010, cassava ranks fifth among food crops after corn, rice, wheat, and potatoes [6]. According to [7] world African production represents 55% of world production, Asia 31%, and Latin America 14%. In addition, cassava products find a place of choice in the African regional market. Regarding its consumption, 500 million people living in the tropics and below the Sahara feed on this foodstuff [8, 9] and 1 billion people in the world. Indeed, 57% of cassava tubers are used for human consumption, 32% for animal feed and for industrial purposes, 11% are waste [10]. The human diet is made up of a multitude of foods, ensuring security of coverage of the individual's nutritional needs. The judicious combination of these foods defines the nutritional balance of living beings. However, this variety may be limited to the frequent consumption of a few foods, the choice of which may be conditioned by the social situation, poor food information, psychological motivations or preconceived ideas [11]. These scenarios can lead to an imbalance in the diet, leading to health problems, among

other things. The transition from rural to urban areas has been accompanied in Gabon by a lack of knowledge of the origin of food by young people and the circulation of a certain number of preconceived ideas about local foods. Often in schools in the context of the study of food, school books present a variety of starchy foods that are not part of the daily life of the majority of students. Such practices, associated with the circulation of demeaning clichés, gradually lead to the abandonment of local starchy foods for imported products that are often less accessible. The cassava stick is variously appreciated local food. The objective of the study is to determine the best conservation processes in order to obtain healthy products that retain all their organoleptic, nutritional and marketable qualities for greater access of populations to this commodity.

Material and Methods

The qualitative approach was carried out through a questionnaire survey to determine the consumption habits of the urban population of Libreville, its motivations and its representations. This questionnaire is distributed to 100 people, 30 pupils of the second class S; 35 people who obtained the baccalaureate; 35 adults responsible for a household.

Biological material

Cassava, *Manihot esculenta Crantz* of the genus *Manihot*, belongs to the *Euphorbiaceae family* [12]. The different varieties [13] are divided into two groups according to their toxicity: bitter varieties rich in toxic cyanogenic carbohydrates. The lethal dose of hydrocyanic acid in humans is between 0.5 and 3.5 mg/kg body weight [14]. Sweet varieties that are devoid of hydrocyanic acid [15]. The processing of cassava results in the creation of several types of products such as cassava sticks.

Cassava sticks are bought on the markets of Libreville (Nkembo, La Peyrie, Mont - Bouet and Rio). These are obamba, fang, miéné, ndzébi and cameroonian (ebobolo) cassava sticks (Table 1).

Table 1: Distribution of samples

Batch	Type of packaging	Ethnicity	
1	Witness stick, original packaging	Ndzebi stick	NDZ
		Miene Staff	MN
2	Stick without packaging	Fang stick	FG
3	Stick with wrapper + film paper	Teke/ Obamba stick	TKOB
4	Stick without packaging and covered with film paper	Cameroon Stick	CAM

Depending on the ethnic groups, the shape, the flexibility and the varieties of the leaves differ, giving a particular flavor to the cassava sticks (Figure 1)

Fig 1: Presentations of the different types of cassava stick
A: Fang stick (Mboe); B: Myene stick (Iloti); C: Ndzébi stick (Pita); D: Téké/ Obamba stick (Okwo); E: Cameroon baton.

The time of each step in the transformation process is evaluated by each producer (Figure 2)

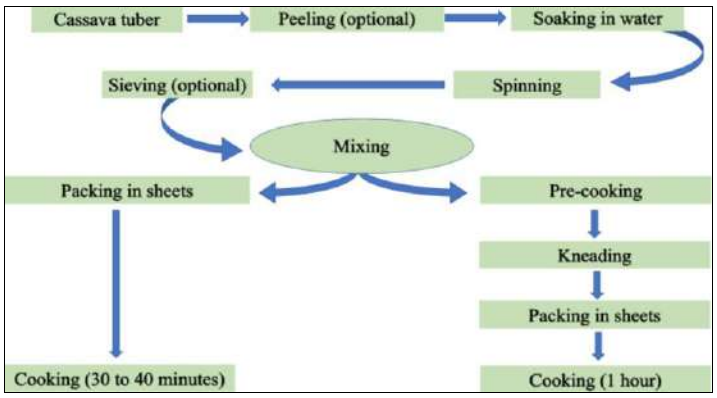

Fig 2: Diagram of transformation of tubers into cassava sticks

Consumption rating

The evaluation of consumption was made following a survey. The questions focused on: The forms in which cassava is preferably consumed, the tubers and starchy foods preferably consumed, the preferred supplement, the type of cassava most consumed, the preferred organoleptic characteristics.

Water content assessment

After knowing how to remove the packaging, the wet weight of each cassava stick is taken using an electronic scale that has been tared beforehand and then placed in an oven. Each week, come and take the dry weight of each cassava stick until the weight becomes invariable and take the mass of water by the formula: Water content, T= Mh / Ms x 100, with Mh: Mass wet, Ms: dry mass

pH determination

For pH determination, 100 g of each sample was dissolved in 100 ml of sterile physiological water. All homogenized and measured using a digital pH meter previously calibrated with phosphate buffer solutions pH=7 and acetate pH=4 at room temperature.

Determination of mineral salt content

In a previously tared crucible, 5g of each sample are weighed. The crucible containing the sample is then introduced into the Nabertherm furnace. The temperature increases gradually to reach 550 °C. Incineration takes place at 550 °C for 3 hours [16] After cooling, the crucible is again weighed on an electronic scale. The operation is repeated until a constant weight to within 0.5% is obtained. The ash content expressed as a percentage by mass is given by the following formula:

% Ash = M1/M2 x100, with M1: Mass of ash and M2: Mass of the test portion (5g)

Study of the conservation of cassava sticks

The observation focused on cassava sticks consumed in Libreville. The sticks are divided into four (4) (lots according to ethnic origin, ndzébi stick (NDZ), miene stick (MN, fang stick (FG), téké/ obamba stick (TKOB), (Cameroon stick (CAM). stick with original packaging (control stick), (lot 1); stick without packaging (lot 2); stick with packaging covered with cling film (lot 3); stick without packaging and covered with cling film (lot 4 In a second step, the sticks are kept in the open air on the palliasse at an ambient temperature of 30 °C.

Results

The population, potential customer, demands not only that it is a question of producing the best product or service, but that it is necessary on the one hand to obtain the durability of the agreed level of quality and, on the other hand, to guarantee it to its clients. Any customer requires two important things; the quality of the product, which he expects to be satisfied with and the quality assurance of the company in which he expects to have confidence and that it makes sure of obtaining the quality of the product [17]

Table 2: Forms, frequency of cassava consumption, preferred starch

Shape	%	Frequency	%	Favorite starch	%
Stick	36	Every day	6	Potato	14
Gary	20	More than 4 times/week	14	Potato	12
Believed	3	1 to 3 times / week	34	Taro	6
Cassadent	18	Rarely	42	Yam	8
Boiled	23	Never	4	Banana	16
				Bread	16

Among the products resulting from the transformation of the cassava tuber (Table 2), it appears that it is the cassava stick that is preferentially consumed. Consumption these days is becoming less frequent. The cassava stick has become a luxury product and is no longer enough for large families. Rice and bread are nowadays the most consumed at the expense of cassava stick, because they are more economical and can be stored longer.

Table 3: Nutritional perception, preferred type of cassava

Bring	%	Complement	%	stick type	%
Carbohydrates	30	Cassava	42	fang	45
Energy	12	Rice	20	Obamba / teke	35
Lipids	4	Bread	16	Miene	14
Proteins	8	Banana	18	Ndzebi	14
Nothing	6	Taro, yam, couscous	4	Punu and others	6
Without opinion	40	Without opinion	1		

However, given the demography of the Fang population, the Fang cassava stick is the most consumed; it is not only less expensive but it is also sold in all Libreville markets (Table 3).

Table 4: Classification of elements determining the choice of cassava sticks.

Criteria	Elements
1	Sheet quality
2	Packaging
3	Color
4	Texture
5	less fiber
6	Less acid
7	Better taste
8	Vendor's hygiene
9	Less smell
10	Neither too soft nor too stiff

The set of items in Table 4 shows which elements guide consumer choice. To make it food of choice in our nutrition. The characteristics cited by respondents must be taken into account pore improves the quality of cassava sticks need to be improved

The water content of the different varieties of cassava sticks varies between 51.30% to 58.33%. It depends on the transformation process of the producers. The pH of the

different varieties of cassava sticks varies between 4.84 and 5.04 and depends on the concentration of acidifying microorganisms (Table 6).

Table 5: pH, water content and mineral salts of the different varieties of cassava stick

	Obamba / Teke	fang	Myene	Ndzebi	Cameroon
Weight	28,937	28,937	28,937	28,937	28,937
Number	5	5	5	5	5
M3	0.15	0.16	0.261	0.14	0.343
Rate of mineral salts %	0.03	0.032	0.052	0.028	0.068
fresh mass	342.12	263.86	433.40	974.70	268.45
Dry mass	142.53	117.35	191.12	474.67	119.34
mass of water	199.59	146.51	242.28	500.03	149.11
Water content %	58.33	55.52	55.90	51.30	55.54
pH	4.91	4.94	5.21	4.84	5.04

Batch 1 sticks (NDZ 1, MN 1, FG 1, TKOB1, CAM1) were still soft but had a lot of mold. The same applies to the sticks of the 3-stick batch with the two types of packaging (NDZ 3, MN 3, FG 3, TKOB3, CAM3). On the other hand, the sticks of batch 4 (NDZ 4, MN 4) wrapped only in film paper remained soft and showed no mold (Table 7).

The sticks OA1, OB1, OC1, OD1, OE1 are the control sticks and only in the original packaging. OA2, OB2, OC2, OD2, OE2 sticks without wrapping were very stiff inedible and also had mold. Sticks OA3, OB3, OC3, OD3, OE3 (sticks with both types of packaging) had excess multi-colored mold (orange, green and white) and were in a very advanced state of degradation (no longer edible). On the other hand, the OA4, OB4, OC4, OD4, OE4 sticks, wrapped only in cling film, were still soft and showed only a few small, insignificant white spots of mould.

Table 6: Visual appearance of cassava sticks after one month of storage

Identification	Existence of mold	cassava state
OA1	++	Less tender
OA2	+	Dry
OA3	++	Less tender
OA4	−	Tender
OB1	++	Less tender
OB2	++	Dry
OB3	++	Less tender
OB4	−	Tender moist
OC1	+	Less tender
OC2	++	Dry
OC3	+	Less tender
OC4	−	Tender moist
OD1	+	Less tender
OD2	++	Dry
OD3	++	Less tender
OD4	−	Tender moist
OE1	+	Less tender
EO2	+	Dry
OE3	+	Less tender
EO4	−	Tender moist

Discussion

The survey results show that cassava is a commonly consumed food. It is usually eaten in stick form, steamed or as gari. The frequency of consumption is very variable. However, among the various tubers and starches consumed, the cassava stick is still the preferred food, followed by rice, bread and bananas. Moreover, the most consumed stick is that of the Fang, ahead of that of the Téké/ Obamba. These results could be explained by the fact that the latter (Fang) are the largest population in the Estuary and Woleu-Ntem.

In addition, according to respondents, products from cassava processing are consumed in a variety of ways to diversify. Moreover, it appears that the majority of consumers are unaware of the nutritional value of cassava sticks and believe that they are not beneficial for the metabolism and the proper functioning of the body. However, [13], show that there is not always total leaching of carbohydrates during the transformation of tubers into cassava paste.

It is important from a nutritional point of view that consumers know that cassava is made up of a storage molecule starch of a carbohydrate nature, composed of molecular chains of glucose [17]. This molecule, from the group of starchy foods, plays an important role in the production of energy necessary for survival. It provides almost all the energy consumed by the brain, so that its availability influences the psyche: in the event of a drop in the level of glucose available to the brain, the cerebral functions which require an effort, such as self-control or taking of a difficult decision, are altered [18]. The results show that consumers would like a better quality of cassava stick, namely: better taste, absence of fibres, less acid, more hygiene, better selection of wrapping leaves, less odor and more tender, in the aim of making this foodstuff a starch of excellence. But the lack of ethical rules in the manufacture of sticks leads consumers to turn away from the product. They also want a better quality of cassava stick, which should have: a better taste, a presence of fibers, less acid, more hygiene, better selection of packaging leaves, less odorous, more tender, in the aim of making this foodstuff a food of excellence.

The water content of the cassava stick samples (Table 6) analyzed varies between 51.30% (Ndzébi stick) and 58.33% (Obamba stick) with an average value of 55.31%. The rate of dry matter between 41. 67% to 48.70%. These differences in humidity could be explained by several factors: the storage time of the unprocessed dough, the pressing or not. Indeed, the longer the storage time and in poor condition, the more the dough becomes dry and floury. Another aspect is how cassava is processed according to ethnic culture. Note that the moisture content is the source of the texture and taste of the different types of cassava stick. The quantity of the packaging sheets of the sticks, their sterilization, before use is at the origin of the duration of the shelf life of the sticks. The high humidity also promotes the development of microbial flora. This flora can come from the quality of the water used but also from the natural product packaging sheets which are not always subject to specific treatment by the producers. This set of data makes cassava sticks a very quickly perishable product [19]. In all processors, there is a variation in humidity from one production to another. Three operations influence the moisture content of sticks: pressing, drying and cooking. The conditioning temperature can also have an influence on the humidity level.

Regarding the pH, we see that all the varieties of cassava stick are acidic, with pH varying between 4.84 (Ndzébi stick) and 5.21 (Myéné stick) (Table 6). This would be due to the fermentative microorganisms that develop in this food, the fermentation conditions and the transport and storage conditions [19]. These bacteria are responsible for the

increase in acidity. The difference in pH observed between the varieties of cassava sticks would then be explained by a variation in microbial concentrations in these cassava sticks. It should also be noted that the stages relating to the cassava transformation process, namely the fermentation methods, the pressing time, the filtration, the transport and storage conditions, the quality and/or the quantity of ferment used, the duration fermentation and/or conservation vary according to ethnic groups and producers. All these factors are responsible for the acidity and organoleptic characteristics of cassava sticks [20].

We observe a low ash content, a negligible content of mineral elements, ranging from 0.28% for the Ndzébi stick and 0.68% for Cameroon cassava. Research conducted by [14] on the cassava tuber shows the latter to be low in mineral elements, with an ash content of 0.7%. Indeed, the action of water, in all the processes of transformation of cassava sticks, is at the origin of significant losses in mineral elements and other nutritive molecules [21]. Cassava sticks, also called Chikwangue or Miondo in Central African countries, is a moist product that must be consumed quickly (3 to 4 days maximum) after production [4]. In the case of this study, the preservation of cassava sticks in film paper was better than traditional packaging. It extended to one month in ambient air after purchase, unlike the other samples, which after one week already showed mold [22]. After two weeks, A2, B2, C2, D2, E2 sticks without packaging were dry and had mold. Sticks A1, B1, C1, D1, E1 were still soft and had more mold. Same for A3, B3, C3, D3, E3 (sticks with both types of packaging). On the other hand, the A4, B4, C4, D4, E4 sticks, wrapped only in film paper, were always soft and showed no mold. The A2, B2, C2, D2, E2 sticks without packaging were so rigid that they could not be edible as they were, and they showed mold. The sticks A1, B1, C1, D1, E1 are the control sticks kept only in the original packaging. Sticks A3, B3, C3, D3, E3, that is to say sticks with both types of packaging, show an excess of multicolored mold (orange, green and white). These sticks are in a very advanced state of degradation. It is important to note that often these sticks are simply washed and reheated for consumption. However, in cassava, toxigenic molds have been reported by [23].

Sticks A4, B4, C4, D4, E4, on the other hand, wrapped only in film paper are hardly rigid (hard) and but show a little more white spots of mold. Water and air permeability is the factor playing an important role in the deterioration of packaged products. The use of film paper as packaging is better because it is impermeable to humidity and air, unlike *Megaphrinium sheets. Macrostashum* bio-packaging traditionally used when making cassava sticks. Although bio-packaging improves the organoleptic qualities of cassava, it is not impervious to humidity and is a factor of rapid perishability. It should also be noted that film paper is a non-living material that is difficult to degrade. *Megaphrinium* wrapper leaves *Macrostashum* are living materials that deteriorate after a week to two weeks showing their imperfection in long-term conservation but with a definite advantage during waste management.

In particular, we observed that the Téke / Obamba cassava deteriorated more quickly. This degradation is due to its high water content (58.33%), unlike the other sticks which perish later. This degradation leads to the proliferation of microorganisms such as bacteria, yeasts and molds, some of which produce toxins that are toxic and carcinogenic to humans [23].

Conclusion

The cassava tuber, following many transformation processes, is the source of several food products in Gabon. The best known of these is the cassava stick. This name actually includes a variety of products obtained by similar transformation processes, but with different physical and organoleptic properties.

The cassava stick is essentially energetic thanks to its high rate of carbohydrates and a low content of mineral salts and other nutrients. The very long manufacturing process leads to making it a production chain. The quality of the product is a fundamental criterion of sale. The packaging and the storage time are decisive in the sales process. The plastic film prolongs the preservation of the cassava stick, unlike traditional wrapping sheets. The plastic film slows down the appearance of microorganisms (bacteria, yeast and moulds), some of which produce harmful and carcinogenic toxins for humans. Aflatoxins are known to be the most potent natural carcinogens and according to the WHO, these mycotoxins are the cause of 49% of liver cancers diagnosed across the continent. In addition, they cause an economic loss.

To deepen the results of this study and contribute to the valorization of cassava sticks, it would be desirable to characterize the flora of the packaging leaves and to measure the levels of contamination in food products made from cassava.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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