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Characterization of cereal consumption in Cotonou, Benin

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ABSTRACT: The cereal group occupies a prominent place in the dietary habits of the populations of southern Benin and there are few recent consumption data on cereals. This study aims to assess the consumption, acquisition and supply of cereals to households in Cotonou. A semi-directive survey with KoBoCollect was conducted with 345 households to collect individual cereal food consumption data. The survey data studied by inferential statistics showed that the most consumed cereals are corn (99%, p=1), rice (85%, p=0.936), wheat (35%, p=0.999), sorghum (15%, p=0.659), millet (10%, p=0.971) and fonio at less than 5%. The most common mode of acquisition is buying from secondary market (95%, p=0.987) and street (85%, p=0.999) retailers. The most used preservation techniques are: drying at room temperature (70%, p=0.619) and keeping the product away from light (30%, p=0.806). Households most often dry in areas laid out at home (70%, p=0.984) or at the edge of the road (30%, p=0.939). Storage places are very diverse: the kitchen (45%, p=0.871), the bedroom (40%, 0.998), the living room (25%, p=0.900) and the store (20, 0.931). In addition, the supply costs of cereals increased from 0.009 USD to 0.056 USD between 2020 and 2021. This vertiginous rise in prices is due to the covid19 pandemic. The various data emitted make it possible not only to have fresh data but also to invest them in the assessment of health risks for the achievement of a high level of protection of the health and life of consumers.

KEYWORDS: cereals, survey, consumption data, food security, Benin.

1 INTRODUCTION

Africa is one of the largest producers of several cereals including maize, sorghum, millet, etc [1]. Globally, food supplies and diets have become more similar in composition [2], [3]. Most of the world's agricultural area (82%) is used to grow 20 major crop products [2] and four staple crops (rice, wheat, maize and potato) which provide the majority of the world's energy needs [4], [5].

Consumption data on cereals are rare in sub-Saharan Africa [6]. In these countries, with the exception of a few export products, local consumption products such as cereals are neglected. According to Amiot-Carlin [7], the diet in Benin is based

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on roots, tubers and cereals. Significant variations are observed between the north and the south [7]. To assess cereal consumption data in the southern part of Benin, the city of Cotonou was drawn by lot. This city is one of the most concentrated in population in Benin.

It was a concrete question of knowing the cereals which are the subject of a large consumption, but also of having knowledge of the modes of supply, the suppliers, the places of acquisition, the use or not of preservatives chemicals, preservation techniques, places of exchange and places of storage of cereals.

2 MATERIALS AND METHODS

2.1 MATERIAL

The materials used in this survey are essentially composed of maps of the counting areas of the 13 districts of Cotonou; GPS; desktop computers, laptops, tablets; android mobile phones; servers; network equipment; printers; peripherals and accessories; software.

2.2 METHOD

The methodological approach revolves around the collection of data, their processing and the analysis of the results. The collection method used for the survey is the semi-structured door-to-door interview [8]. The interviewer goes to each household, asks questions to the Head of Household and notes the answers using a smartphone equipped with the KoBoCollect application [9].

A pre-survey was carried out and served as a basis for the formulation of certain hypotheses. These hypotheses were verified at the end of the actual survey by inferential statistics.

STUDY AREAS AND STUDY POPULATION

The survey took place in the commune of Cotonou in southern Benin. Of the thirteen (13) districts in the commune of Cotonou, four (04) districts were drawn by lot. By district, four (04) districts were again drawn, which leads to a total of 16 districts namely: Agla Center, Zongo Ehuzu, Gbeto, Jonquet, Missebo, Gbediga, Houeyiho, Gbegamey 2, Vodje Center, Cajehoun1, Cadjehoun 2, Fidjrosse Centre, Aibatin 1, Aibatin 2, Gbedegbe and Missité.

The survey took into account socio-demographic characteristics in relation to household cereal consumption habits.

The sample size in each survey area is calculated by the method of [10].

$$X = Z_{\alpha}^{2} * \frac{p(1-p)}{i^{2}} \; avec \; p = \frac{n}{N} \quad (1)$$

N: Total number of households in the study area

n: Total number of households in selected neighborhoods or villages

i: 5% = 0.05

Z_{α} = 1.96

The demographic data from the general population and housing census (RGPH4) carried out by INSAE in 2013 provide us with the values of n and N above for each of the districts selected. For this purpose, we have:

N = 166433 (Number of households in Cotonou)

n = 56020 (Number of households in the selected neighborhoods)

Applying formula (1), we get:

X1=345 households to interview

CONDUCT OF THE INVESTIGATION

As a prelude to the actual survey, a pre-survey was carried out on a sample of 100 randomly selected households in the city of Cotonou. The data and results of the pre-survey made it possible to formulate a certain number of hypotheses which were subsequently subjected to a binomial test.

With regard to the investigation itself, three (03) major stages have marked its progress.

The first step consisted in the practical training of the investigators. During this training, they received useful knowledge for the smooth running of activities, among other things, the recognition of the geographical limits of the different city districts thanks to counting maps, knowledge and use of the KoBoCollect mobile application. Interviewers also learned how to effectively use the survey questionnaire, which is integrated into the mobile application as an electronic form.

The second stage is a full-scale test phase. Each pair of interviewers was asked to interview five (05) households in their survey areas. This test enabled the management team to assess the average interview time, the level of assimilation of the knowledge acquired and to find solutions to the difficulties reported by the interviewers, in particular the resistance of certain heads of households to answer to the questions. This trial phase made it possible to set the average number of daily interviews at 10 households. In addition, the interviewers all demonstrated a good understanding of the use of the collection tool (KoBoCollect). In view of the results obtained, the test phase was validated, and the third phase was opened.

The third step consisted in collecting the actual data in accordance with the electronic form registered in the application. An average of 10 households per day was set per pair of interviewers. In the event of insufficient Collection, the geographical proximity method has been recommended to compensate for the collection. In each concession, only one head of household was interviewed. In the case of a building, each apartment is considered a house. These conditions were respected to ensure consistent representativeness. The interviews were conducted in the Fongbé, Mina, Goun, Yoruba, Dendi and in French languages.

2.3 DATA PROCESSING AND ANALYSIS

At the end of the survey, the various data collected were pre-processed by the KoBoCollect application. Further processing was performed with hypothesis testing. The Spyder development environment was used to perform all the necessary calculations, particularly the p-value calculation. The steps for calculating the p-value [11] are as follows:

STEP 1: Calculate the probability of success (p) given the data.

$$p = \frac{n}{N}$$

n: number of positive responses obtained

N: number of respondents

STEP 2: Calculate the minimum number of successes to expect under the Null Hypothesis.

$k = N * H_0$

H_0: decimal value of the null hypothesis

(0.9 For H_0 = 90 %)

N: number of people interviewed

STEP 3: Calculate the p-value

$$p_{value} = \sum_{i=k}^{N} C_N^i p^i (1-p)^{N-i}$$

3 RESULTS AND DISCUSSIONS

3.1 MOST CONSUMED CEREALS IN COTONOU

All the households surveyed consume maize and its derivatives (100%) (Table 1). Our null hypothesis (H_0=99% or more) is validated (p=1.00). Maize is therefore the first most consumed cereal in Cotonou. Similar results have been found by many other researchers [6], [12], [13], who have jointly drawn the conclusion that maize (*Zea mays L.*) is a cereal of great dietary importance for many populations in West Africa, mainly in Benin where it constitutes the basis of the diet of the populations of the South and the Center of the Country.

Households surveyed in Cotonou consume 87.54% of rice and its derivatives (Table 1). Our null hypothesis is validated (H_0= 85%, p=0.936). Rice is then the second most consumed cereal by the populations in Cotonou. Other researchers have gone in the same direction as us. Indeed, it is reported that strong urbanization, access to the labor market and growing incomes lead city dwellers to consume more imported foods, rice in particular [12]. According to the estimates of [7], in Senegal in urban areas rice consumption is 77% while in rural areas it represents 59% of cereal consumption. Senegal consumes, on average, more than one million tons of white rice per year [7].

This study revealed that maize is consumed in a high proportion compared to rice and this could be justified by the fact that maize is the most cultivated cereal in Benin due to several favorable conditions, including climate, soil and the short production cycle which allows it to be grown at least two (02) times a year. As far as rice is concerned, it is essentially an imported product whose average price per kilogram is higher than that of corn.

Tableau 1. Level of cereal consumption in Cotonou

Cereals and derivatives	Cereal consumption, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	Yes	No		
Corn and derivatives	345 (100%)	0 (0%)	**99%** or more	*1.000*
Rice and derivatives	302 (87.54%)	43 (12.46 %)	**85%** or more	*0.936*
Mil and derivatives	45 (13.04%)	300 (86.96 %)	**10%** or more	*0.971*
Sorghum and derivatives	54 (15.65%)	291 (84.35 %)	**15%** or more	*0.639*
Wheat and derivatives	147 (42.61%)	198 (57.39 %)	**35%** or more	*0.999*
Fonio and derivatives	4 (1.16%)	341 (98.84 %)	**5%** or more	*0.000*

n = total households surveyed

Table 1 showed that 42.61% of households surveyed consume wheat and its derivatives. Our null hypothesis (H_0=35%, p=0.999) is validated. Wheat is thus the third most consumed cereal in Cotonou, because more than 35% of the population of Cotonou consumes wheat and its derivatives (0.999). In the South of Benin, the populations have a more Western habit so that wheat-based foods such as bread, cake, croissant, pizza, chawama and others are widely consumed on a daily basis.

Table 1 showed that 15.65% of households surveyed consume sorghum and its derivatives. Our null hypothesis (H_0=15%, p=0.639) is therefore validated. Sorghum is the fourth most consumed cereal in Cotonou, more than 15% of the population in Cotonou consumes Sorghum (0.635). Sorghum is used in the manufacture of certain local drinks and porridges. In addition, sorghum is better consumed in other countries in the West African sub-region. In Burkina-Faso, for example, sorghum is consumed even more and it represents 40 to 50% of Burkinabe national production [14].

The results in Table 1 also reveal that 13.04% of households surveyed consume millet and its derivatives. Our null hypothesis (H_0=10%, p=0.971) is validated. Millet is then the fifth most consumed cereal in Cotonou. [15] reports that the consumption of millet is higher in the northern region of Benin and that this could be explained by the abundance of cereals such as maize, rice and wheat in southern Benin. Less than 5% of the population in Cotonou consumes Fonio. This is a lesser known cereal in southern Benin.

3.2 CEREAL SUPPLY MODES IN COTONOU

Table 2 showed that 97.10% of households surveyed get their supplies by purchasing, thus validating our hypothesis (H_0=65%, p=0.987). Purchasing is the characteristic method of acquisition for all households in Cotonou. It represents 50.7% of

supply methods [15]. Self-consumption, which accounts for 13.6%, and donations, which account for 86.4%, constitute other forms of supply [15]. These results differ significantly from ours. This could be explained by the difference between the methods used. Purchasing is the essential method of acquiring cereals and represents 51% of expenditure [16]. About 16% of households surveyed received cereals by donation, thereby validating our hypothesis (H_0=20%, p=0.068). The gift is the second mode of grain supply. [16] in his survey found lower rates namely: 10% of cereal donations in Cotonou and 9.3% of donations in Ouagadougou. This same author estimates that the same phenomenon is observed in Dakar.

Tableau 2. Supply methods in Cotonou

Modes of grain supply	Adoption, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
Purchase	335 (97.10%)	10 (2.90%)	**95%** or more	*0.987*
Production	55 (15.94%)	290 (84.06%)	**20%** or more	*0.026*
Donations	58 (16.81%)	287 (83.19%)	**20%** or more	*0.068*

Table 2 showed that 15.94% of households surveyed produce their own cereals. Our null hypothesis H0=20% is rejected.

In Cotonou, less than 20% of the population engages in the production of cereals for self-consumption. [6] reports in his communication on the supply and distribution of food in French-speaking African cities that: "self-consumption still remains one of the methods of supply in certain cities such as Ouagadougou and Cotonou we meet populations who have an agricultural production activity". In addition, in Ouagadougou, the survey of [16] estimates at 5.4% the rate of households that produce their own cereals.

3.3 Cereal Suppliers And Places Of Acquisition

In the cereal distribution chain in Cotonou, the main suppliers identified are: retailers, wholesalers, producers and supermarkets. The results of our survey reveal that 90.43% of the households surveyed get their supplies from retailers. This result validates our hypothesis (H_0=85%, p=0.999). Retailers are therefore the main suppliers of cereals in Cotonou (Table 3). This result can be explained by the fact that retailers are closer to consumers and make their products more accessible. In addition, consumers only need small quantities of cereals to meet their daily needs. In addition, the high proportion of supply from retailers could be explained by the high urbanization and population density in Cotonou.

Tableau 3. The different types of grain suppliers in Cotonou

Grain supply	Adoption, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
Retailers	312 (90.43%)	33 (9.57%)	**85%** or more	*0.999*
Wholesalers	80 (23.19%)	265 (76.81%)	**25%** or more	*0.24*
Supermarkets	23 (6.67%)	322 (93.33%)	**10%** or more	*0.015*
Producers	10 (2.90%)	335 (97.10%)	**5%** or more	*0.025*

The results of our survey also reveal that 23.19% of surveyed households get their supplies from wholesalers. This result validates our hypothesis (H_0=25%, p=0.24). Wholesalers are the second cereal suppliers in Cotonou (Table 3). This result is explained by the fact that wholesalers essentially distribute cereals to retailers.

About 6% of households surveyed get their supplies from supermarkets. Our hypothesis (H_0=10%, p=0.015) is not validated. Similarly, 2.9% of households surveyed get their supplies from producers. Our hypothesis (H_0=5%, p=0.025) is not validated. These results are justified by the fact that the sale prices of cereals at the level of supermarkets are not within the reach of the average Cotonois. Moreover, there are very few cereal producers in Cotonou due to the unavailability of cultivable land in the Coastal Department.

Table 4 shows that 47.25% of households surveyed get their supplies from local markets, thus validating our hypothesis (H_0=40%, p=0.997). This observation is explained by the fact that local markets are made up of retailers for the most part and that they are closer to consumers. [18] in his communication for the benefit of the FAO went in the same direction as us by finding that the purchase is the first mode of supply in cereals and that the rural markets are the first places of purchase. He goes on to say that 17% of households in Cotonou get their supplies from rural markets. This result is much lower than ours.

Some households surveyed (29.57%) get their supplies in the streets and alleys, thus validating our hypothesis (H_0=25%, p=0.976). The lack of market infrastructure in Benin was the cause of the high rate of grain acquisitions in streets and alleys.

Tableau 4. Cereal procurement locations in Cotonou

Places of grain acquisition	Adoption, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
Major Markets	96 (27.83%)	249 (72.17%)	**20%** or more	*0.999*
Local Markets	163 (47.25%)	182 (52.75%)	**40%** or more	*0.997*
Supermarkets	14 (4.06%)	331 (95.94%)	**10%** or more	*0.000*
Streets and Alleys	102 (29.57%)	243 (70.43%)	**25%** or more	*0.976*

Reading Table 4 revealed that 27.83% of the households surveyed get their supplies from the Large Markets, thus validating our hypothesis (H_0=20%, p=0.999). The large markets come in third place among the places of acquisition of cereals in Cotonou. These results are explained by the fact that the major markets are the headquarters of the wholesalers.

Some households surveyed (4.06%) get their supplies from supermarkets. Our hypothesis (H_0=10%, p=0.000) is not validated. Our analysis show that supermarkets are more frequented by privileged people with the financial means and a high standard of living. Also, the availability of cereals in supermarkets is limited. [18] identified the places where cereals are purchased, which are: rural markets, importers, urban wholesale and large markets, secondary markets, small neighborhood markets, neighborhood shops and finally, neighborhood supermarkets.

3.4 Conservation Techniques, Drying And Storage Areas

Table 5 reveals that 70.43% of Cotonou households dry cereals at room temperature, thus validating our hypothesis (H_0=70%, p=0.619). Drying at ambient temperature is the primary technique for preserving cereals in Cotonou. Cereal storage in Benin has not undergone significant modernization. In addition, the abundant availability of solar energy is favorable to the technique of preserving cereals by drying. Some households (32.17%) surveyed store cereals by protecting them from light, thus validating our hypothesis (H_0=30%, p=0.806). The technique of preserving cereals by shielding the product from light is the second preservation technique used (Table 5). Very few households (8.41%) in Cotonou preserve cereals by drying them in a controlled enclosure, thus validating our hypothesis (H_0=5%, p=0.995).

Tableau 5. The different cereal preservation techniques in Cotonou

Cereal preservation techniques	Adoption, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
Dry at room temperature	243 (70.43%)	102 (29.57%)	**70%** or more	*0.619*
Drying in a controlled enclosure	29 (8.41%)	316 (91.59%)	**5%** or more	*0.995*
Protect the product from light	111 (32.17%)	234 (67.83%)	**30%** or more	*0.806*
Use of chemical preservatives	6 (1.74%)	339 (98.26%)	**5%** or more	*0.000*

About 1.74% of households surveyed preserve cereals with chemical preservatives. Our hypothesis (H_0=5%, p=0.000) is not validated. Very few households in Cotonou use chemical preservatives. This result could be explained by the fact that chemical preservatives are less known to the populations of Cotonou on the one hand and on the other hand, the user of chemical preservatives could constitute an additional cost for the household. In addition, households often purchase sufficient quantities for their short-term needs.

Reading Table 6 revealed that 74.78% of the households surveyed dry cereals in the areas fitted out at home, which validates our hypothesis (H_0=70%, p=0.984). Due to the strong urbanization in the South of Benin and particularly in Cotonou, the populations have only the alternative of their residence for the drying of cereals. The areas around the tracks are the second place for drying cereals in Cotonou. A no less negligible portion of households dries (33.91%) cereals by the roadside, which validates our hypothesis (H_0=30%, p=0.939).

Tableau 6. Drying places

Drying places	Cereals drying, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
On site in the field	19 (5.51%)	326 (94.49%)	**5%** or more	*0.715*
Areas set up at home	258 (74.78%)	87 (25.22%)	**70%** or more	*0.984*
Along the way	117 (33.91%)	228 (66.09%)	**30%** or more	*0.939*

Only 5.51% of Cotonou households dry cereals on site in the field, which validates our hypothesis (H_0=5%, p=0.715). This result can be explained by the fact that Cotonou is not a place of high agricultural production in Benin.

About 47% of Cotonou households store cereals in the kitchen (Table 7), validating our hypothesis (H_0=45%, p=0.871). The same proportion of households (47.54%) store cereals in the bedroom, thus validating our hypothesis (H_0=40%, p=0.998). The results also showed that 30.43% of households store cereals in the living room, validating our hypothesis (H_0=25%, p=0.900). The strong urbanization of the city of Cotonou and the space constraints do not favor the establishment of storage infrastructures adapted to the conservation of cereals. This is why the populations of Cotonou, failing to keep cereals in attics as is the case in the northern part of Benin [19], store their cereals in bedrooms, living rooms and kitchens.

Tableau 7. Storage locations

Storage locations	Cereals storage, n=345 (number/percentage)		*Null hypothesis (H_0)*	p-value
	YES	NO		
Kitchen	165 (47.83%)	180 (52.17%)	**45%** or more	*0.871*
Bedroom	164 (47.54%)	181 (52.46%)	**40%** or more	*0.998*
Living room	105 (30.43%)	240 (69.57%)	**25%** or more	*0.900*
Store	80 (23.19%)	265 (76.81%)	**20%** or more	*0.931*
Attic	45 (13.04%)	300 (86.97%)	**20%** or more	*0.000*

The storage of cereals in stores is observed in 23.19% of the households questioned, validating our hypothesis (H_0=20%, p=0.931). The fact is that the quantities often purchased are not so important to require storage in large infrastructures. Living rooms and kitchens are sufficient for the conservation of these foodstuffs. The use of attics as conservation infrastructure is observed in Cotonou at 13.04% and therefore our hypothesis (H_0=20%, p=0.000) is not validated. Granaries are used very little in Cotonou due to strong modernization, space constraints and the small quantity of cereals to be stored for household needs.

3.5 AVERAGE CEREAL SUPPLY COSTS BETWEEN 2020 AND 2021

Tableau 8. Average grain supply costs in Cotonou

Average cost per Kg	Maize	Rice	Millet	Wheat	Sorghum	Fonio
Average cost in 2020 (USD/Kg)	0.374	0.801	0.547	0.804	0.381	0.512
Average cost in 2021 (USD/Kg)	0.383	0.878	0.576	0.849	0.465	0.568
Average price variation (USD/Kg)	+0.009	+0.077	+0.029	+0.045	+0.084	+0.056

Between 2020 and 2021, there was a significant increase in the average cost of all the cereals considered by our study. Other Institutions have also observed these increases. This is the case of the National Institute of Statistics and Demography (INStaD) which in its May 2021 publication reveals a 3.3% increase in the producer price index for food products in the 1st quarter of the year 2021 [20]. By comparing to the same period of the year 2020, the INStAD specified that the producer price index increased by 25.2% and that this evolution is linked to the increase in the cereal indices. (+47.3%) [20]. The price increases thus observed are partly explained by supply and distribution difficulties due to the COVID-19 pandemic, which paralyzed the general merchandise transport network. In addition, the difficulties of access to fertilizers specific to cereal production also explain this price increase. Finally, generalized inflation has contributed to the increase in the prices of basic necessities, including cereals. In addition, INSAE reports in August 2021 that cereal prices have increased in Benin during the last week. She argues that maize prices have increased in the cities of Porto Novo (South-East), Parakou (North-East), Natitingou (North-West) and Lokossa (South-West), while in Cotonou and in Bohicon, prices fell, explaining this price variation by the market supply.

The data collected during this survey increase the possibility of making a health risk assessment on the cereals concerned by this study in Benin.

4 CONCLUSION

This study revealed that the most consumed cereals in Cotonou are, in order of importance, maize, rice, wheat, sorghum and millet. In addition, these cereals are all produced in Benin with the exception of wheat. The main preservation technique is air drying at room temperature. The main places for drying are the areas set up at home or in the fields. Storage is preferably done in kitchens, bedrooms and stores. Purchasing is the main method of acquiring cereals, followed by donation and production. Retailers supply the majority of cereals in local markets and they are followed by wholesalers in this distribution. A variation of +0.009 USD to + 0.056 USD is observed on the average price of all the cereals covered by our study. These important data generated by this study on cereal consumption in the city of Cotonou constitute an important source of food information and open the door to other aspects of research, in particular the evaluation of the exposure of the populations of Cotonou to the dangers microbiological and chemical content in cereals.

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