Scientific Research Publishing

Food and Nutrition Sciences, 2023, 14, 843-863
https://www.scirp.org/journal/fns
ISSN Online: 2157-9458
ISSN Print: 2157-944X

Survey of Cereal Consumption Habits in the Community of Djougou, Benin

Mouhamed N. El-Hadji Alassane Moutawakilou[1,2], J. Kisito Chabi-Sika[3], Agossou D. P. Noumavo[1,4], Haziz Sina[4], Joseph Dossou[5], Lamine Baba-Moussa[4], Farid Baba-Moussa[1]

[1]Laboratoire de Microbiologie et des Technologies Alimentaires, Faculté des Sciences et Techniques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin
[2]Agro Sciences Laboratory (ASL), Abomey-Calavi, Bénin
[3]Agence Béninoise de Sécurité Sanitaire des Aliments, Ministère de l'Agriculture de l'Elevage et de la Pèche, Cotonou, Bénin
[4]Laboratoire de Biologie et de Typage Moléculaire en Microbiologie, Faculté des Sciences et Techniques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin
[5]Laboratoire de Bioingénierie des Procédés Alimentaires, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin
Email: fbmouss@yahoo.fr

How to cite this paper: Moutawakilou, M.N.E.-H.A., Chabi-Sika, J.K., Noumavo, A.D.P., Sina, H., Dossou, J., Baba-Moussa, L. and Baba-Moussa, F. (2023) Survey of Cereal Consumption Habits in the Community of Djougou, Benin. *Food and Nutrition Sciences*, **14**, 843-863.
https://doi.org/10.4236/fns.2023.149054

Received: July 11, 2023
Accepted: September 25, 2023
Published: September 28, 2023

Abstract

The cereal group occupies a prominent place in the dietary habits of people in northern Benin and there is little recent information on cereal consumption. This study aims to assess the consumption, acquisition and supply of cereals to households in the community of Djougou. A semi-directive survey with KoBoCollect was conducted among 369 households to collect individual cereal food consumption data. The survey data processed by statistical tools showed that the most consumed cereals are maize (95%, p = 0.887), millet (58%, p = 0.755), rice (55%, p = 0.753), sorghum (15%, p = 0.635), wheat (5%, p = 0.920) and fonio barely 5%. The most common mode of acquisition in Djougou is purchase (50%, p = 0.947) but donation is also observed (25%, p = 0.988) as well as production observed in 20.6% of households. Purchases are made from retailers in local markets (45%, p = 0.920) but also in streets and alleys (30%, p = 0.765). The most widely used preservation technique is drying at room temperature (70%, p = 0.995). Households most often dry in the areas provided in the field (50%, p = 0.783) and at home (40%, p = 0.643). The preferred storage location is the kitchen (60%, p = 0.790). The bedroom (20%, 0.669) and the store (15%, 0.522) are the alternative places for storing cereals. In addition, the supply costs of cereals increased between 2020 and 2021. This vertiginous rise in prices is due, among other things, to the covid19 pandemic. The various data generated not only make it possible 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 Safety, Benin

1. Introduction

The African continent, with its vast land covering an area of 3 billion hectares, has 1.3 billion hectares of agricultural land which allows it to be a major producer of various cereals such as maize, sorghum, millet and African rice. Wheat is widely grown in North Africa, Sudan and Ethiopia [1]. Furthermore, food supplies and diets have become increasingly similar in composition [2] [3]. Rice occupies a prominent place in the diet of Africans. It represents more than 25% of the total cereals consumed, ranking second behind maize. It is in West Africa that rice has experienced the greatest growth over the past 20 years [4]. Cereals (maize, millet, sorghum, rice) occupy a place of choice because of the wide range of foods they provide. These cereals are consumed in the form of porridge (koko, aklui, akluiyonou), dough (tö, owo, makumè, kafa, akassa), dumplings (yèkè-yèkè, ciéré, wassa-wassa, attiékè, arraw), drink (chapkalo, tchoukoutou or burkutu, dolo) or pancakes, which are the customary dishes of the populations [5]. For many developing countries, cereals represent the mainstay of the diet of generally low-income rural populations [6]. Annual food consumption in Burkina Faso comprises 62% of cereals. In Senegal, rice occupies nearly 50% of the volume of cereals consumed nationally and it is consumed, on average, more than one million tons of white rice per year [7]. Maize (*Zea mays L.*) is a cereal of great dietary importance for many populations in West Africa, mainly in Benin. This cereal is grown in seven out of eight of Benin's agro-ecological zones. It is therefore the subject of major national and regional transactions, thus occupying a place of choice in the diet of the population.

Grains, especially cereals and legumes, account for more than two-thirds of calorie intake in sub-Saharan Africa. Rice, maize, millet or sorghum, sometimes combined with beans, cowpeas or groundnuts, generally constitute the basis of the diet of populations in both urban and rural areas. However, these products are not consumed raw, but dishes made from processed products. From the product harvested to the dish consumed, the grains must undergo a succession of post-harvest and primary processing operations (shelling, grinding, etc.) to be incorporated into culinary preparations. It often happens that foods intended to be a source of nutritional intake and well-being become sources of various dangers, in particular food poisoning.

In most African countries, nearly half of cereal production has an aflatoxin content above international standards. Estimation of the amount of aflatoxin in maize in 2022 gave ranges of [0.064 and 0.509 µg/kg] in Senegal [7], [8.0; 1081 ppm] in Tanzania, with a rate of samples exceeding the maximum limit which varies between 2% - 85% [8].

From May 2007 to July 2008, 105 cases including 9 deaths from food poison-

ing due to endosulfan in the health zone of Tchaourou in Benin; "the toubani" (dough made from bean flour) including around 60 victims in August 2010 in Parakou; in August 2011 in Djougou another food poisoning due to the consumption of paste made from yam chips where 08 out of 10 people died [7]. It thus appears that staple foods in general and the cereal group in particular will be the most consumed and could present a risk for the many populations who consume them in Benin and elsewhere. This state of affairs cannot be ignored and must be the subject of scientific research. A fundamental step in this process is the collection of data.

Indeed, consumption data on cereals are rare in sub-Saharan Africa [9]. In these countries, with the exception of a few export products, local consumption products such as cereals are neglected. According to [10], the diet in Benin is based on roots, tubers and cereals. Significant variations are observed between the north and the south [10]. The objective of our study is to collect food consumption data on cereals in the North of Benin, more precisely in the community of Djougou, through a survey of the dietary habits of households in this commune. To assess cereal consumption data in northern Benin, the community of Djougou was drawn by lot to be the subject of this study. The community of Djougou is one of the densest in population in northern Benin.

2. Material and Methods

2.1. Methods

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 [11]. The interviewer goes to each household, asks questions to the Head of Household and writes down the answers using a smartphone equipped with the KoBoCollect application [12].

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.

The survey took place in the community of Djougou in northern Benin (**Figure 1**) four (04) districts were drawn by lot. By district, four (04) districts were again drawn, which leads to a total of 16 districts namely: Petoni Poho, Zongo, Taïfa, Kilir, Zountori, Batoulou, Formagazi, Baparape, Partago, Tepredjissi, vanhoui , Momongou, Bougou 1, Bougou 2, Kpandouga and Kpaouya.

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 [13].

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

N: Total number of households in the study area

n: Total number of households in selected neighborhoods or villages

i: 5% = 0.05

$Z_\alpha = 1.96$

Considering the demographic data from the general population and housing census (RGPH4) carried out by INSAE in 2013, it comes out that the commune of Djougou has 12 arrondissements and a total of 34,039 households. Out of these 12 arrondissements, 4 have been chosen at random for the survey. These are the arrondissements of **Djougou 1** with 5230 households, **Djougou 3** with 3488 households, **Partago** with 3723 households and **Bougou** with 1330 households. These households add up to: **13,771**. Hence, we have:

- Total number of households in Djougou: $N = 34{,}039$
- Total number of households in the selected area: $n = 13{,}771$

Therefore, p = n/N and we get: p = 0.4

At this step, we apply the sampling method (Schwartz, 1995) to obtain the number of households to survey. Let X be that number. We get:

$$X = \left((Z_\alpha)^2 \cdot p \cdot (1-p)\right) \Big/ (i)^2$$
$$= 1.96 \times 1.96 \times 0.4 \times 0.6 \Big/ (0.05 \times 0.05)$$
$$= 368.7936$$

We have to round up and we obtain $X = 369$ households to survey.

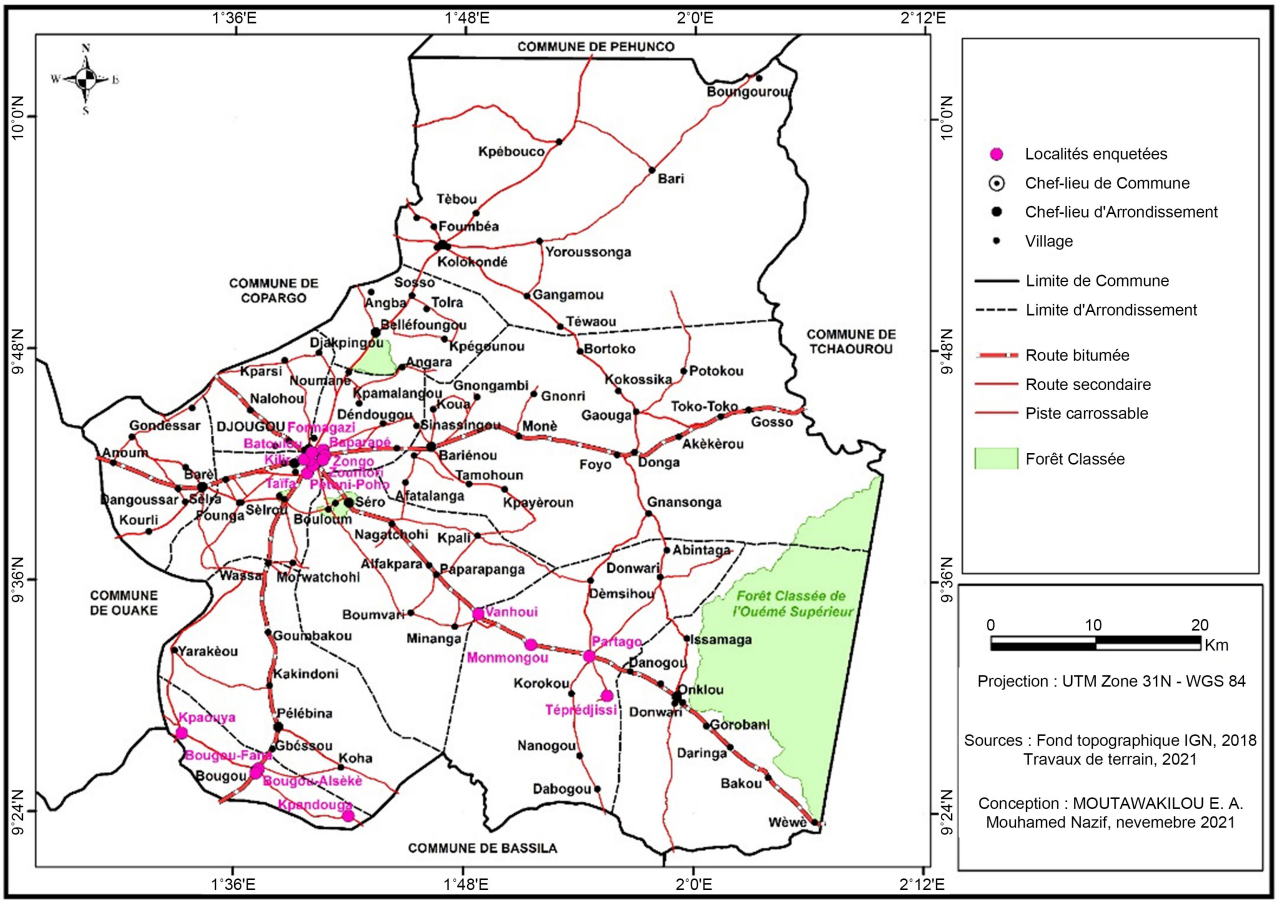

Figure 1. Map of the study area.

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

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 in the form of 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 Dendi, Yom, Lokpa, Ditamari language and in French.

2.2. 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 [14] 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 people interviewed

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 Discussion

3.1. Analysis of the Basic Information of the Households

3.1.1. Gender Consideration

Figure 2 shows that 56% of the heads of households who responded to the survey were women, while 44% were men.

3.1.2. Age Range of Heads of the Households

Figure 3 shows that the heads of household surveyed are young, with over 57% aged between 18 and 35. 39% of heads of household are between 35 and 55. Female heads of household are also young, aged between 18 and 35. The graph above illustrates the situation.

3.1.3. Distribution of the Size of Households

Looking at Figure 4, we can see that the households studied are relatively large, with an average of around 6 people and an almost normal distribution. The distribution shows good diversity and a central tendency fairly close to the average of 6 people per household.

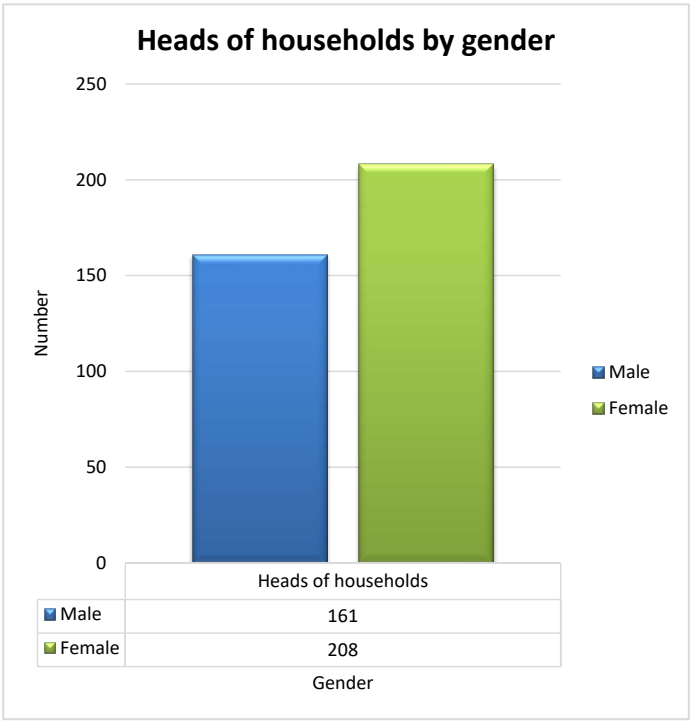

Figure 2. Heads of households by gender.

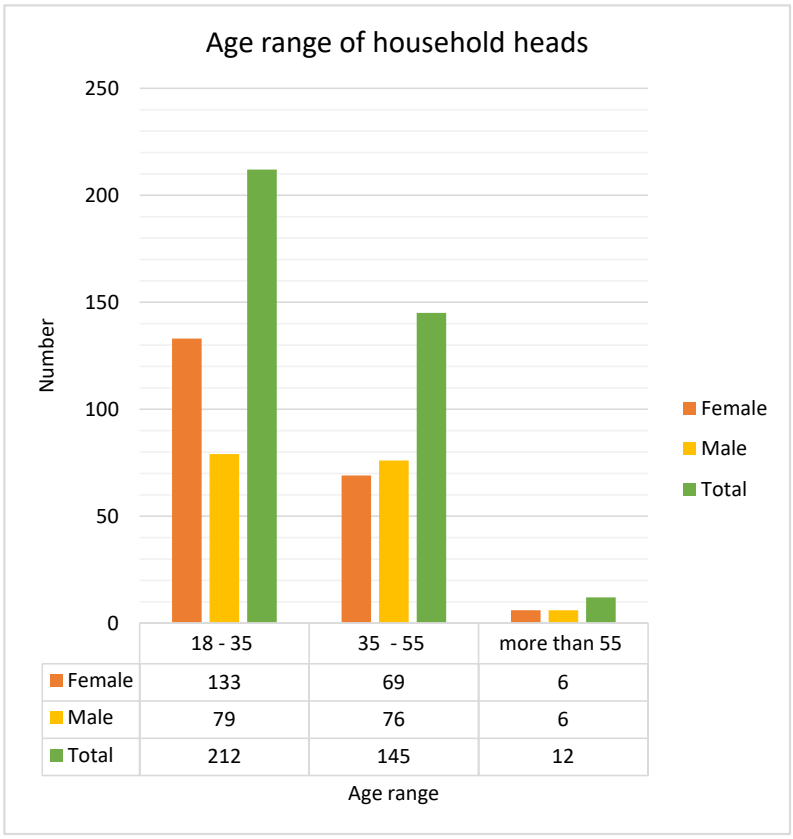

Figure 3. Age range of household heads.

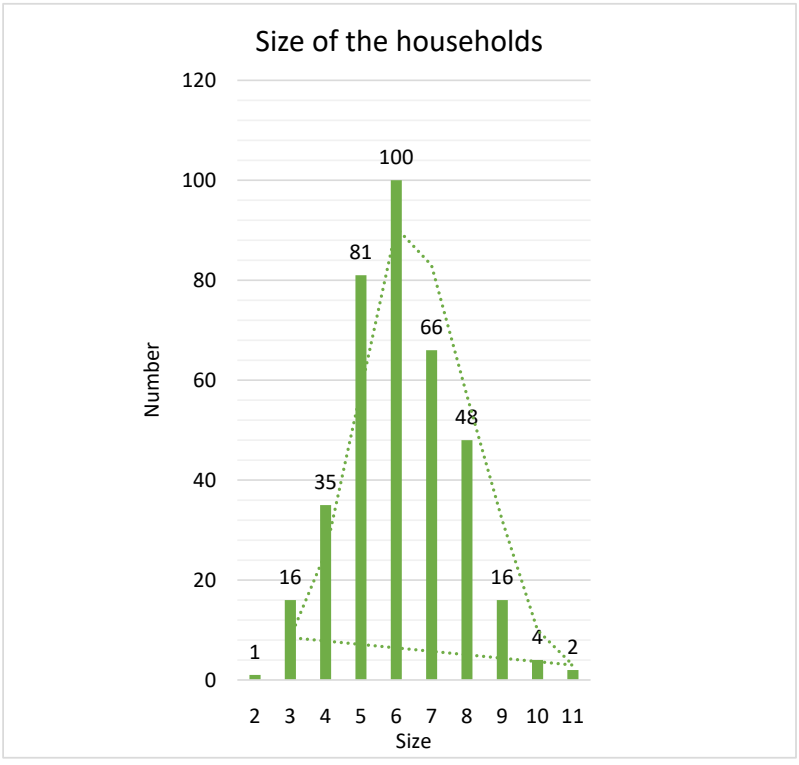

Figure 4. Size of the households.

3.1.4. Distribution of Heads of Households by Area

Figure 5 shows that 52.85% of households surveyed are in rural areas, and that 57.44% of them are women. In urban areas, 55.17% of household heads are also women.

The analysis we are making here further supports the one we made previously about gender as it shows that most heads of the households are female.

3.1.5. Occupations of the Heads of Households

Figure 6 shows that the main occupations of heads of household vary in the commune of Djougou. Housekeepers top the list, followed by farmers and merchants. Next come tailors and cattle-breeders. Finally, there are several other trades that are not the most important.

3.2. Consumption Rates of Different Cereals in Djougou

The households surveyed consume maize and its derivatives at 96.21% (Figure 7). Our null hypothesis (H_0 = 95% or more) is validated (p = 0.887) and makes maize the first most consumed cereal in Djougou. Similar results have been found by many other researchers [6] [15] [16], 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.

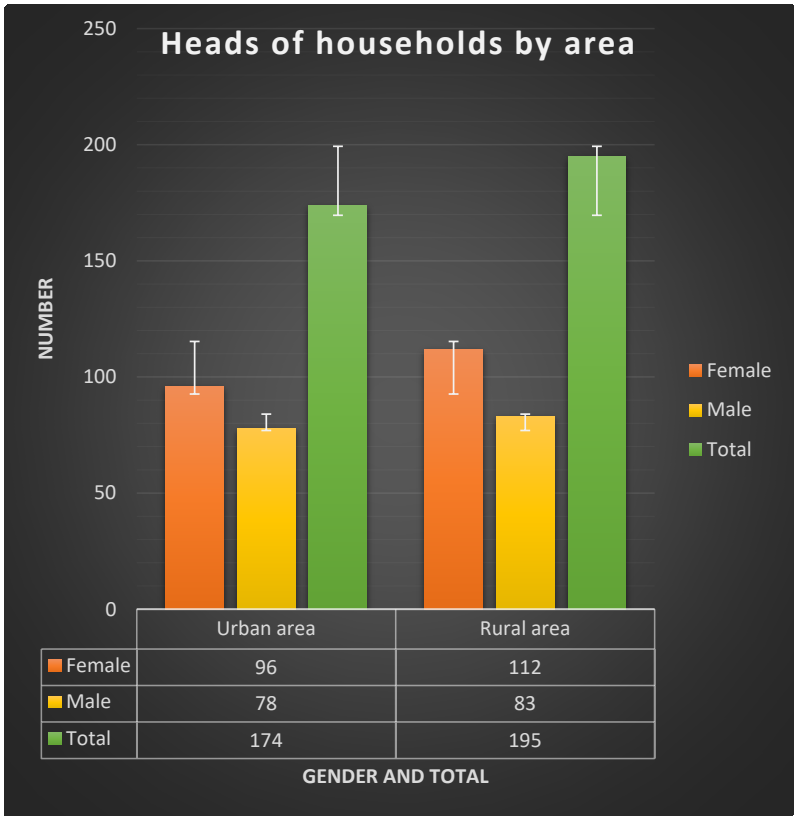

Figure 5. Heads of households by area.

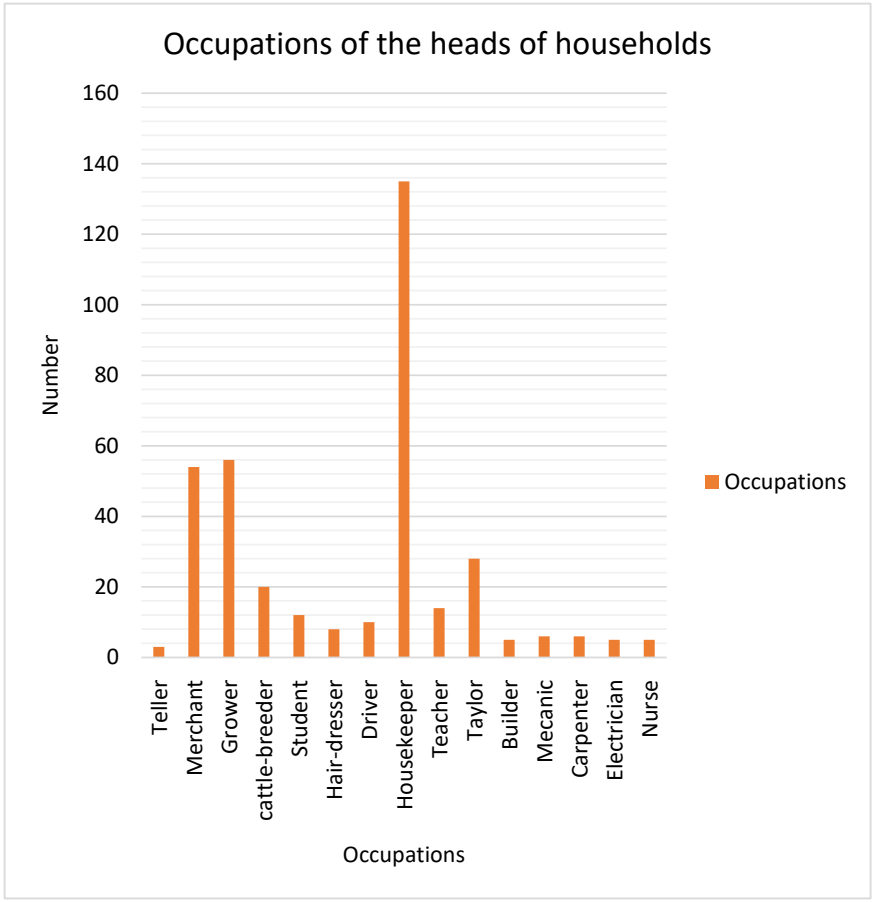

Figure 6. Occupations of the heads of households.

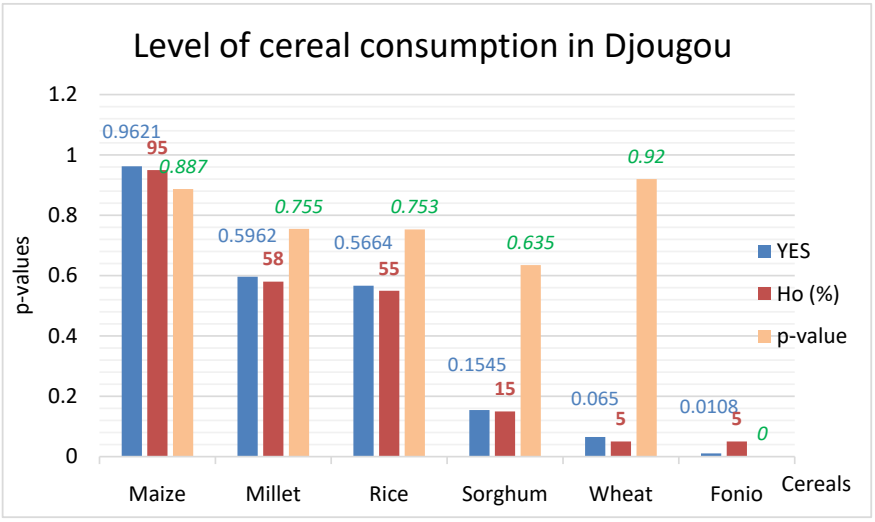

Figure 7. Proportion of consumption of different cereals and results of hypothesis tests.

Households surveyed in Djougou consume 59.62% of millet and its derivatives (**Figure 7**). Our null hypothesis is validated (H_0 = 58%, p = 0.755). Millet is then the second most consumed cereal by the populations in Djougou. [16] Found concordant results by reporting that in the departments of Atacora, Donga and

Borgou, millet consumption is in the range of 11 - 18 kg per adult-equivalent/year and that in the 8 other departments of Benin as well as in large cities, millet consumption is insignificant or non-existent. A study carried out by the CePED in 2010 [17] also found results similar to ours. The populations in the North of Benin have less Western food habits so that certain foods based on millet ("Foura" commonly called "Dèguè" and other millet derivatives are very popular). Outside Benin, millet is also considered a noble cereal because it is often served during traditional ceremonies [18]. This is the case in Burkina Faso, for example, where the majority of food processors (70%) use millet in proportions of 1 and 5 kg to produce the zoom-koom drink [19].

Figure 7 also reveals that rice is the third most consumed cereal by the populations of the community of Djougou. Indeed, 56.64% of surveyed households consume rice and its derivatives, validating our hypothesis (H_0 = 55%, p = 0.753). Regarding the consump

tion rates of rice and its derivatives, many other researchers have also found similar proportions in Benin and Africa. 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 [15] [17]. According to the estimates of [10], 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 [10].

Sorghum is the fourth most consumed cereal in Djougou, because more than 15.45% of the population of Djougou consumes Sorghum and its derivatives, validating our hypothesis (H_0 = 15%, p = 0.635). Outside Benin, sorghum is just as well consumed in the West African sub-region as it is used in the manufacture of certain local drinks and porridges. In Burkina-Faso, for example, sorghum is consumed even more and it represents 40% to 50% of Burkinabe national production [20].

In the South of Benin, the populations have a more Western habit so that wheat-based foods such as bread, cake, croissant, pizza, sharwama and others are widely consumed on a daily basis but this is not the case in northern Benin and it is even quite the opposite. Indeed, only 6.5% of surveyed households consume wheat and its derivatives in Djougou with H_0 = 5% and p = 0.920 (**Figure 7**).

"Digitaria exilis" fonio is a cereal grown in some Sudanian areas of West Africa. Less than 5% of the population in Djougou consumes Fonio and its derivatives. It is a cereal hardly consumed in Djougou and in Benin in general. According to [21], the very difficult and painful culinary preparation of fonio has made it a marginal cereal in consumption, particularly in towns, and has raised fears of its disappearance. In Guinea, the traditional nature of fonio and the attachment to domestic know-how in its processing explain the limited use of this type of product. In Mali and Burkina, fonio is considered more as an African product of diversification and is less the support of the rural identity of city dwellers [21].

3.3. Cereal Supply Modes in Djougou

Table 1 showed that 53.93% of households surveyed get their supplies by purchase, thus validating our hypothesis (H_0 = 50%, p = 0.947). Purchasing is therefore the primary means of supplying cereals in Djougou. Concordant results have been published by other researchers. Indeed, it is reported that purchase is the characteristic mode of acquisition of households in Benin and in Cotonou in particular where it represents 50.7% of supply methods [20]. In addition, purchase is the essential mode of cereal acquisition and represents 51% of expenditure according to [21]. Production (self-consumption) and donations are other forms of cereal supply in Djougou. Indeed, 30.08% of the households surveyed received cereals by donation thus validating our hypothesis (H_0 = 25%, p = 0.988). The donation is the second mode of cereal supply in Djougou. Lourme Ruiz (2017) [22] 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. The higher proportions of donations observed in Djougou could be explained by strong socialization within this population.

Table 1 showed that 20.6% of households surveyed produce their own cereals. Our null hypothesis H_0 = 25% is rejected.

In Djougou, less than 25% of the population is engaged in the production of cereals for self-consumption. [9] Reports in his communication on the supply and distribution of food in French-speaking African cities that: "self-consumption still remains one of the modes 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 [22] estimates at 5.4% the rate of households that produce their own cereals.

3.4. Cereal Suppliers and Places of Acquisition

In the cereal distribution chain in Djougou, the main suppliers identified are: retailers, wholesalers, producers and supermarkets. The results of our survey reveal that 61.79% of surveyed households get their supplies from retailers. This result validates our hypothesis (H_0 = 55%, p = 0.997). Retailers are therefore the main suppliers of cereals in Djougou (**Figure 8**). 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.

Table 1. Modes of supply in Djougou.

Modes of cereals supply	Adoption, n = 369 (number/percentage)		H_0	p-Value
	YES	NO		
Purchase	199 (53.93%)	170 (46.07%)	50% or more	*0.947*
Production	76 (20.6%)	293 (79.4%)	25% or more	*0.025*
Donation	111 (30.08%)	258 (69.91%)	25% or more	*0.988*

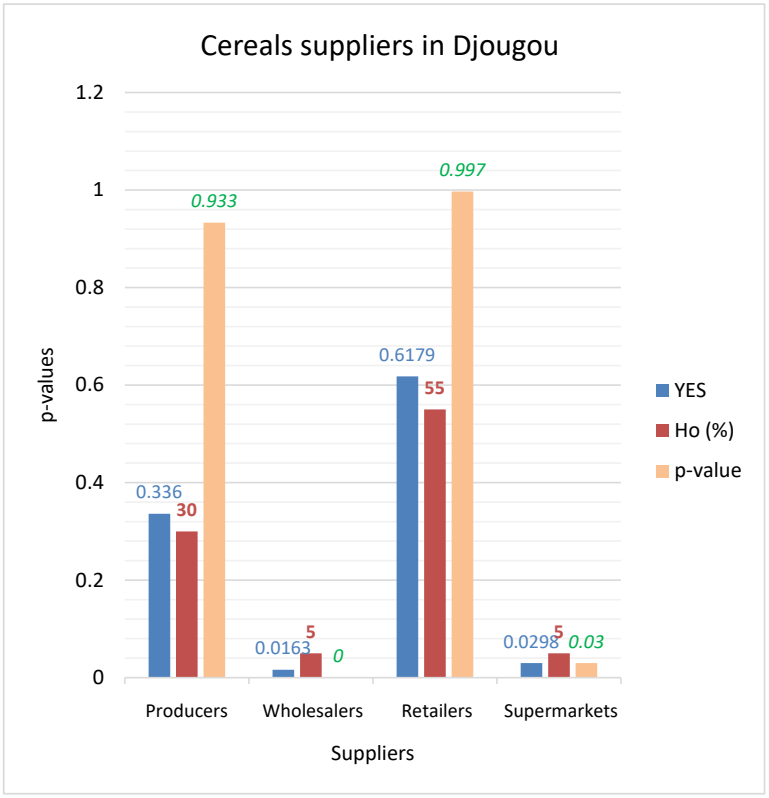

Figure 8. Proportions of supply from different grain suppliers.

The results of our survey also reveal that 33.6% of surveyed households get their supplies from producers. This result validates our hypothesis (H_0 = 30%, p = 0.933). Producers are the second cereal suppliers in Djougou (**Figure 8**). This result is explained by the fact that producers act as wholesalers in Djougou by supplying their products to retailers but also to other wholesalers who intend to resell these products in southern Benin and on other local and sub-regional markets. Wholesalers are almost non-existent in Djougou due to the presence of producers. Less than 3% of the population in Djougou get their supplies from supermarkets due to the distribution role that wholesalers play.

Figure 9 shows that 48.51% of households surveyed get their supplies from local markets, thus validating our hypothesis (H_0 = 45%, p = 0.920). 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. [23] 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 rate is much higher in Djougou in view of our results due to the absence of major commercial infrastructures.

Some households surveyed (31.71%) get their supplies in the streets and alleys, thus validating our hypothesis (H_0 = 30%, p = 0.765). The lack of market infrastructure close to the population was still the cause of the high rate of grain acquisitions in streets and alleys.

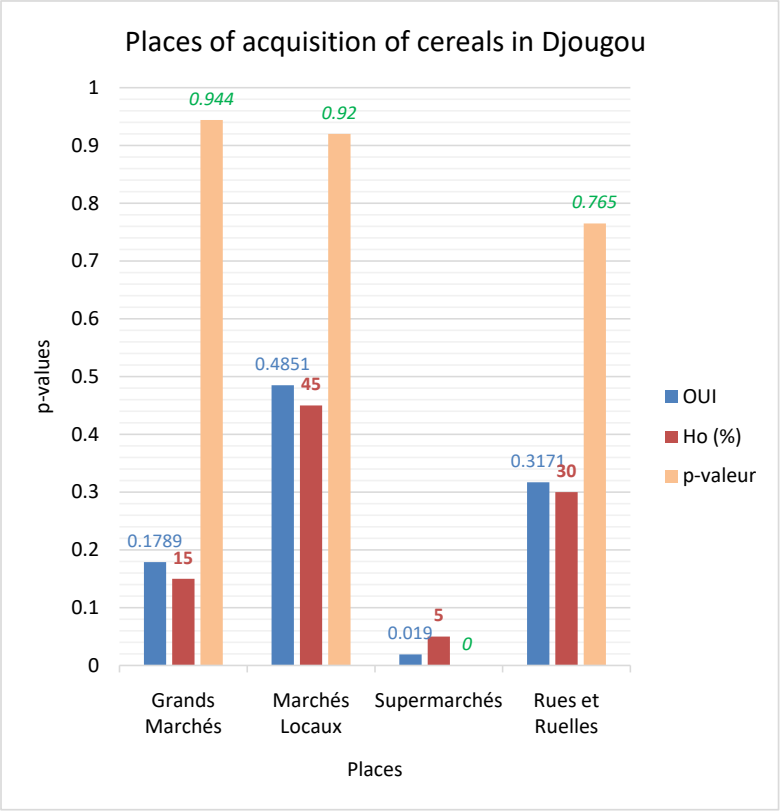

Figure 9. Results of the study on the places of acquisition of cereals.

3.5. Conservation Techniques, Drying and Storage Areas

Figure 10 revealed that 75.61% of households in Djougou dry cereals at room temperature, thus validating our hypothesis (H_0 = 70%, p = 0.995). Drying at room temperature is the primary technique for preserving cereals in Djougou. Cereal storage in Benin has not undergone significant modernization. In addition, the abundant availability of solar energy favors the technique of preserving cereals by drying at room temperature. In Djougou, 4.07% of households surveyed preserve cereals by protecting them from light and this same proportion of households uses chemical preservatives (Figure 10).

Whether by placing the product away from light or by using chemical preservatives, our hypothesis (H_0 = 5%, p = 0.248) is validated. However, the validation threshold (5%) as well as the low p-value suggests that these techniques are hardly used. The same is true for the technique of preservation by drying in a controlled enclosure used by approximately 3.52% of the households surveyed (Figure 10).

In view of these results, it should be noted that the main technique for preserving cereals in Djougou is drying. [24] [25] [26] also consider drying as the main technique for preserving cereals. As an example, Figure 11 shows field-dried maize.

Reading Table 2 revealed that 51.76% of the households surveyed dry the cereals on site in the field, which validates our hypothesis (H_0 = 50%, p = 0.783).

The availability of vast expanses of land and the sun on the one hand and the absence of domestic animals in the field on the other hand favor the drying of cereals in the areas laid out in the field.

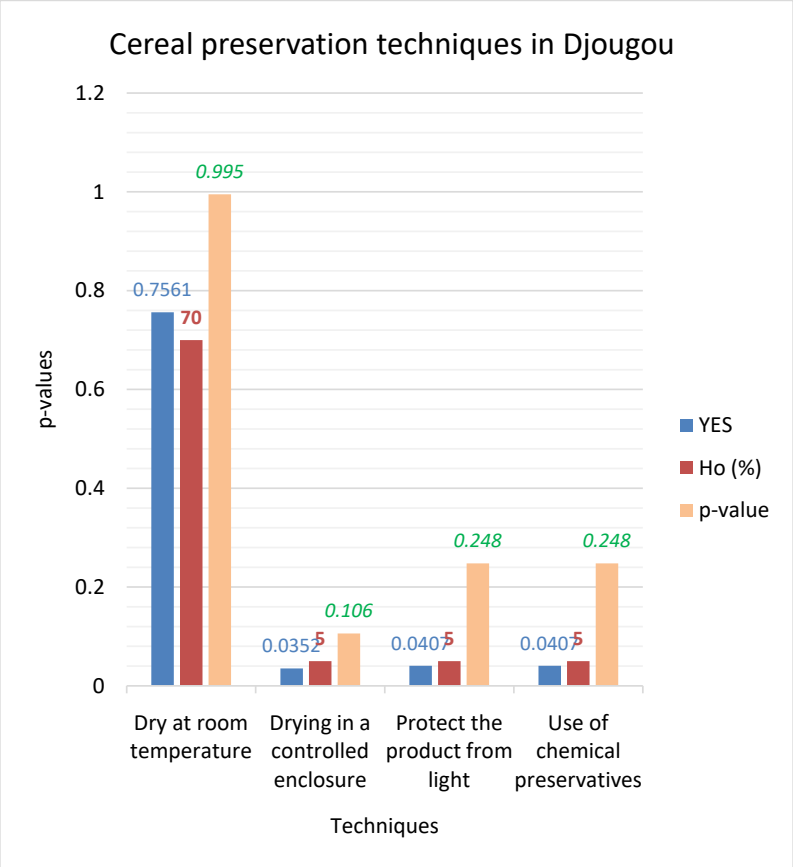

Figure 10. Results of the study on cereal preservation techniques.

Figure 11. Cereal drying on an area set up in the field.

Table 2. The drying places.

Drying places	Adoption, n = 369 (number/percentage)		H_0	p-value
	YES	NO		
On site in the field	191 (51.76%)	178 (48.24%)	50% or more	*0.783*
Areas set up at home	151 (40.92%)	218 (59.08%)	40% or more	*0.643*
Along the road	3 (0.81%)	366 (99.19%)	5% or more	*0.000*

About 40.92% of households surveyed dry in areas equipped at home (**Figure 12**), validating our hypothesis (H_0 = 40%, p = 0.643). The areas set up at home are the second place for drying cereals in Djougou. This result is explained by the availability of space, the ease of monitoring and storing the dried products in the storage places. Houansou *et al.* (2020) and Rochat *et al.* (2013) mentioned the importance of drying in areas fitted out at home. The image below shows home-dried maize.

Very few households in Djougou dry their cereals near roads (**Figure 13**). This is due to the availability of drying space in the field or at home. However, some households dry their cereals in appropriate stores, but these are often owned by agricultural cooperatives (**Figure 14**).

About 61.79% of households in Djougou store cereals in the kitchen (**Figure 15**), validating our hypothesis (H_0 = 60%, p = 0.790). The kitchen is used as a place for preparing meals but also as a privileged place for storing foodstuffs, including cereals.

The results show that 20.87% of the households surveyed store cereals in the bedroom, validating the hypothesis (H_0 = 20%, p = 0.669).

About 14.91% of households surveyed store cereals in the store (**Figure 15**) validating the hypothesis (H_0 = 15%, p = 0.522). The storage of cereals in the living room is observed in 14.09% of the households surveyed.

In view of these results, it was found that the bedroom, the store and the living room are in this order the alternative places for the storage of cereals. These results are explained by the fact that the quantities of cereals acquired by households are not so important to require storage in large infrastructures.

The use of the attic as storage infrastructure is observed in Djougou by 6.5% of the households surveyed. The hypothesis (H_0 = 5%, p = 0.920) is validated, however, granaries are used very little by households in the commune of Djougou (**Figure 16**). On the other hand, in Atacora in the northwest of Benin, the "banco" type granary used by 69% of households is the most common storage structure [27].

3.6. Average Cereals Supply Costs between 2021 and 2022

Table 3 shows that 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 [28]. 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%) [28]. The price increases thus observed are partly explained by the supply and distribution difficulties due to the COVID-19 pandemic, which paralyzed the freight transport network in general. 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 have fallen, explaining this price variation by the supply of markets.

Figure 12. Illustration of grain drying in home area.

Figure 13. Illustration of drying by the roadside.

Figure 14. A cereal store in the community of Djougou.

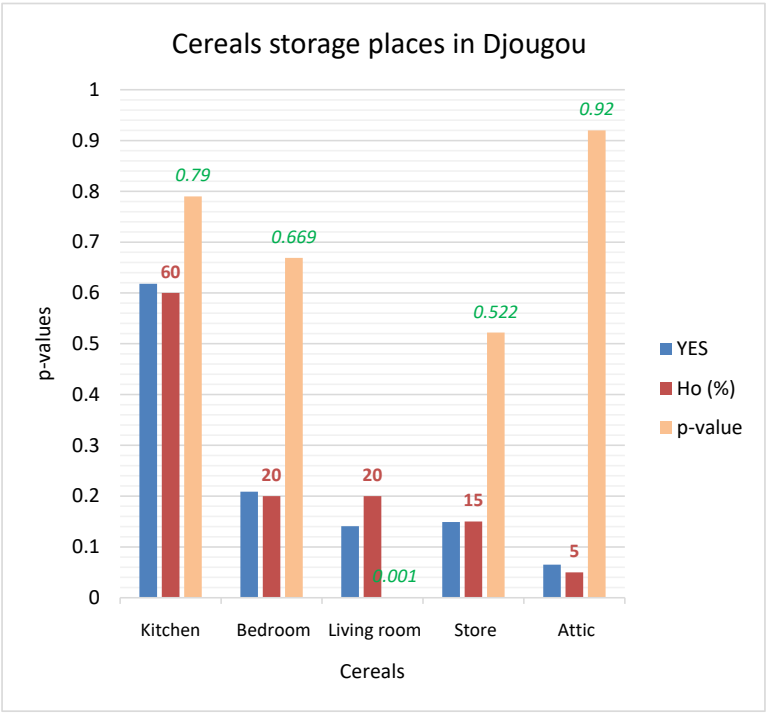

Figure 15. Results of the study on the issue of grain storage locations.

Figure 16. Illustration of a cereal granary used in the community of Djougou.

Table 3. Average cereals supply costs in Djougou.

Average cost per Kg	Maize	Rice	Millet	Wheat	Sorghum	Fonio
Average cost in 2020 (USD/Kg)	0.389	0.834	0.570	0.837	0.397	0.533
Average cost in 2021 (USD /Kg)	0.399	0.914	0.599	0.884	0.484	0.592
Average price variation (USD /Kg)	+0.01	+0.08	+0.03	+0.05	+0.09	+0.06

4. Conclusions

This study revealed that the most consumed cereals in Djougou are, in order of importance, maize, millet, sorghum, rice and wheat. 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 drying sites are areas set up in the field or at home. 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 producers in this distribution. An increase has been ob-

served on the average price of all the cereals covered by our study.

The data generated by this study on cereal consumption in the community of Djougou constitute a pool of food information and open the door to other aspects of research, in particular the evaluation of the exposure of the populations of Djougou to microbiological and chemicals in cereals.

Acknowledgements

At the end of this work, I thank Engineer Kponou S. Candide for his technical support. I would also like to express my deep gratitude to Dr. Malick Seibou, for his availability and for the financial and moral support he has given me.

Funding

This study was funded by the authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Macauley, H. and Tabo, R. (2015) Les cultures céréalières: Riz, mais, mil, sorgho et blé. Africa Rice Center, Benin, 38 p. https://ir.ucc.edu.gh/xmlui/handle/123456789/4510

[2] Duru, M. (2018) Ro6: Agriculture, biodiversité et santé, par michel duru. https://sfecologie.org/regard/ro6-sept-2018-m-duru-agriculture-et-sante

[3] Gaigné, C., Capt, D., Faguer, E., Frappier, L., Hilal, M., Hovelaque, V., *et al.* (2011) Urbanisation et durabilité des systèmes alimentaires. Pour une alimentation durable. Réexion stratégique DuALIne. Quae, Paris, 123-142.

[4] del Villar, P.M. and Bauer, J.M. (2013) Le riz en Afrique de l'Ouest: Dynamiques, politiques et perspectives. *Cahiers Agricultures*, **22**, 336-344. https://doi.org/10.1684/agr.2013.0657

[5] Ahokpe, K.F. (2005) Valorisation des aliments traditionnels locaux: Evaluation des procédés traditionnels de préparation de Ablo, une pâte fermentée cuite à la vapeur. Mémoire de Maîtrise, Faculté des Sciences et Techniques, Université d'Abomey-Calavi, Bénin, 51 p.

[6] Waongo, A., Yamkoulga, M., Dabire-Binso, C.L., Ba, M.N. and Sanon, A. (2013) Conservation post-récolte des céréales en zone sud-soudanienne du Burkina Faso: Perception paysanne et évaluation des stocks. *International Journal of Biological and Chemical Sciences*, **7**, 1157-1167. https://doi.org/10.4314/ijbcs.v7i3.22

[7] Diop, A.S., Sarr, B., Ndong, M., *et al.* (2022) Evaluation des risques sanitaires liés à la présence d'aflatoxine dans le riz consommé au sénégal. *International Journal of Biological and Chemical Sciences*, **16**, 418-429. https://doi.org/10.4314/ijbcs.v16i1.35

[8] Dieme, E., Fall, R., Sarr, I., Sarr, F., Traore, D. and Seydi, M. (2016) Contamination des céréales par l'aflatoxine en Afrique: Revue des méthodes de lutte existantes. *International Journal of Biological and Chemical Sciences*, **10**, 2285-2299. https://doi.org/10.4314/ijbcs.v10i5.27

[9] Dia, I. (1997) Le consommateur urbain africain et les sada. FAO, Collection aliments dans les villes, Communication au séminaire sous régional FAO-ISRA. Approvisionnement et distribution alimentaires des villes de l'Afrique francophone, Dakar. https://www.fao.org/3/ab785f/ab785f.pdf

[10] Amiot-Carlin, M.-J. (2011) Evaluation du potentiel de couverture des besoins en vitamine a des jeunes enfants à partir des sauces accompagnant les aliments de base consommés au Bénin. PhD Thesis, Agrocampus Ouest. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers12-11/010055048.pdf

[11] Imbert, G. (2010) L'entretien semi-directif: À la frontière de la santé publique et de l'anthropologie. *Recherche en Soins Infirmiers*, **3**, 23-34. https://doi.org/10.3917/rsi.102.0023

[12] Lakshminarasimhappa, M.C. (2022) Web-Based and Smart Mobile App for Data Collection: Kobo Toolbox/Kobo Collect. *Journal of Indian Library Association*, **57**, 72-79. https://www.ilaindia.net/jila/index.php/jila/article/view/596

[13] Pilon, M., Mama, M.S. and Tichit, C. (1997) Les femmes chefs de ménage: Aperçu général et études de cas. Ménages et familles en Afrique. Approche des dynamiques familiales contemporaines, CEPED, Paris, 167-193. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_7/carton07/010012287.pdf

[14] Mathématiques appliquées L3—Cours complet avec 500 tests et exercices corrigés. Pearson, 2009. https://books.google.bj/books?id=fqOu6xKdmhcC&lpg=PR21&ots=6kl07BaNEi&lr&pg=PR20#v=onepage&q&f=false

[15] Arouna, A., Adégbola, P.Y. and Biaou, G. (2011) Analyse des coûts de stockage et de conservation du maïs au sud-bénin. *Bulletin de la Recherche Agronomique du Bénin*, **2**, 12-23. http://www.slire.net/download/618/article2_brab_sp_cial_2_sept-2011_ma_s_arouna_et_al_analyse_co_ts_stockage_conservation.pdf

[16] Gandonou, E., Chogou, S.K. and Mitchikpe, E. (2019) Mesure et profil de l'insécurité alimentaire individuelle au Bénin: Une approche en termes de consommation d'énergie et de protéines. *Revue Internationale des Sciences Appliquées*, **2**, 34-47. https://www.researchgate.net/profile/Mahamadou-Dahouda/publication/342917988_Les_strategies_d'utilisation_des_ressources_alimentaires_locales_par_les_caprins_dans_quatre_communes_du_Benin/links/5f0d774092851cc4bf730000/Les-strategies-dutilisation-des-ressources-alimentaires-locales-par-les-caprins-dans-quatre-communes-du-Benin.pdf

[17] MPDEPPCAG, CePED, BeCG (2010) Etude sur les normes de consommation des principaux produits vivriers au Bénin. Ministère de la Prospective, du Développement, de l'Evaluation des Politiques Publiques et de la Coordination de l'Action Gouvernementale, Centre de Partenariat et d'Expertise pour le Développement Durable et Bénin Consulting Group, République du Bénin.

[18] Bruno Lautier, P. (2006) Marie Poussart-Vanier. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers13-07/010041087.pdf

[19] Massieke, A.A.R.S., Tapsoba, F.W.-B., Kabore, D., Seogo, I., Tankoano, A., Dicko, M.H., Toguyeni, A. and Sawadogo-Lingani, H. (2017) Etude sur la capacité de production, du circuit de commercialisation et de la consommation du zoom-koom vendu dans la ville de Ouagadougou au burkina faso. *International Journal of Biological and Chemical Sciences*, **11**, 2294-2305. https://doi.org/10.4314/ijbcs.v11i5.27

https://revues.cirad.fr/index.php/cahiers-agricultures/article/view/30431/30191

[20] Mitchikpe, E.C., Ategbo, E.-A., Fanou, J.A. and Nago, M.C. (2001) Consommation alimentaire des ménages urbains au Bénin. CIRAD, Montpellier, 45 p. (Série ALISA) https://agritrop.cirad.fr/481447/

[21] Konkobo-Yaméogo, C., Chaloub, Y., Bricas, N., Karimou, R. and Ndiaye, J.L. (2004) La consommation urbaine d'une céréale traditionnelle en Afrique de l'Ouest: Le fonio. *Cahiers Agricultures*, **13**, 125-128.

[22] Lourme Ruiz, A. (2017) Les femmes, au coeur des liens entre production agricole et diversité de la consommation alimentaire au Burkina Faso. Ph.D. Thesis, Montpellier SupAgro, Montpellier.

[23] Cheyns, E. (1999) Les pratiques d'approvisionnement alimentaire des consommateurs de Ouagadougou (Burkina-Faso). Number 3. Editions Quae. https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/24857/IDL-24857.pdf

[24] Gandaho, P.S., Goudjinou, C., Tchobo, F.P. and Soumanou, M.M. (2017) Séchage du sorgho produit dans le Nord-Bénin: Caractérisation thermophysique et qualité microbiologique du produit séché. *Journal of Applied Biosciences*, **112**, 11016-11024. https://doi.org/10.4314/jab.v112i1.6

[25] Cruz, J.F., Hounhouigan, J.D. and Fleurat-Lessard, F. (2016) La conservation des grains après récolte. *Agricultures tropicales en poche*, 256. https://doi.org/10.35690/978-2-7592-2437-1

[26] Houansou, G.D., Ladekan, E., Adjagodo, A., Tchobo, P.F. and Agbangla, C. (2020) Identification des microflores mycologiques présentes dans les casse-croûtes à base de céréales produits et vendus dans sept departements du Bénin Micheline Agassounon Djikpo Tchibozo.

[27] Rochat, A. and Guenat, D. (2013) Pertes de grains secs durant le stockage au Nord-Ouest du Bénin. Agriculture + Food Security Network Brief, No. 4, 1-8. https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_hafl_network_brief4_fr.pdf

[28] INStaD (2021) Indice des prix des produits agricoles à la production du 1er trimestre de l'année 2021.