

Short Research Article

Feasibility of cassava semolina (Attiéké) as a vehicle for food fortification: A survey in areas of Côte d'Ivoire with high levels of childhood micronutrient deficiencies

ABSTRACT

Aims: This study constitutes the first approach of a food program. It was carried out in order to constitute a useful database for a nutritional intervention by evaluating the level and practices of consumption of cassava semolina (Attiéké) among school children in rural communities.

Study design: This study was conducted from May 14 to 21, 2021 in elementary school in six villages in an area of Côte d'Ivoire that previously had a high prevalence of childhood anemia.

Methodology: A cross-sectional survey collected data from first- to sixth-grade school children and aged from five to fifteen years ($n = 460$). Children provided data on their cassava semolina consumption in response to individual structured interviews conducted in their elementary schools and in the presence of one of their parents.

Results: The results suggest that cassava semolina is an accessible, familiar and acceptable vehicle for food fortification to overcome nutritional deficits in children in this area. Cassava semolina is available throughout the year in this area. Children consumed an average of 95.5 g/day of cassava semolina and more than three quarters of them (88.5%) had consumed this food on at least one day during the week prior to the survey. Cassava semolina was most often eaten for the midday meal (77.2%) in combination with fish (86.3%) and/or vegetables (79.1%). Finally, although cassava can be grown in this area, most children's families (75.9%) purchased processed cassava semolina.

Conclusion: The fortification of semolina would have high penetration in the population. However, the survey also identified a major challenge to using cassava semolina as a vehicle for micronutrient fortification. This is the shelf life of fresh cassava semolina, which is only 3 to 4 days in the absence of refrigeration.

Key words: Food fortification, micronutrient deficiencies, school-age children, West Africa, Cassava

1. INTRODUCTION

Many of the children whose development is placed at risk by micronutrient deficiencies live in West Africa [4]. For example, diets deficient in iron, zinc and vitamin B9 have a high prevalence among rural children in Cote d'Ivoire. Diets in many regions of West Africa are dominated by carbohydrates (e.g., yams, rice and cassava), with low intake of foods rich in protein and iron (e.g., meat and beans) and other micronutrients (e.g., fruit and

vegetables) [5], and consequentially, these diets are often implicated in nutritional deficiencies [6].

One public health intervention that is effective in addressing widespread micronutrient deficiencies is the fortification of staple foods [7]. A variety of grains have proven to be cost-effective vehicles for food fortification to overcome micronutrient deficiencies among African children [8,9]. However, grains are not the main source of carbohydrates in many West African diets. In many communities, cassava fills this role. Indeed, since the 1980s, cassava has supplied over one-third of caloric requirements in Africa [10]. Although the vast majority of Africa's cassava production has traditionally taken place in West Africa [10], cassava production is rapidly increasing across Africa. Between 1961 and 2013, cassava production in sub-Saharan Africa increased nearly five-fold, and the area under cultivation increased almost three-fold, partly due to it supplanting alternative crops, including grains [11].

In Cote d'Ivoire, cassava is widely consumed in the form of semolina (attiéké), a granular flour produced from the roots of the cassava plant. This food can be consumed both hot and cold [12], and is widely valued across subpopulations that differ in social, cultural and geographic location [13]. However, there is a lack of research on the accessibility, familiarity and acceptability of cassava semolina among children in communities in Cote d'Ivoire that have a high prevalence of micronutrient deficiencies. This research sought to determine the current consumption of cassava semolina among rural schoolchildren in such communities, and their taste preferences, as a first step in evaluating the feasibility of fortifying this food as a means of overcoming children's micronutrient deficiencies.

2. MATERIEL AND METHODES

2.1. Type of study

The survey conducted for the collection of data was a cross-sectional survey with a descriptive aim by means of questionnaires. It focused on the retrospective description of consumption practices of cassava semolina (Attiéké) among school children

2.2. Area and Period of Study

This survey took place from May 14 to 21, 2021 in rural communities in the department of Issia. This department is located in the central west of Côte d'Ivoire, in the Haut Sassandra region. Its climate is very favorable to cocoa, coffee, rubber, and rice but also to other crops such as cassava, yams, bananas, corn, fruits, and vegetables [14,15]. The population of the department of Issia has increased very rapidly in recent years, from 351292 inhabitants in 2016 to 410628 in 2021.

Data on the nutritional status of school children are very rare at both the regional and national levels. However, a few years back, the department of Issia had the highest incidence of anemia (164.68‰) in children aged 0-4 years in the Haut Sassandra region [16]. This situation and its consequences could persist throughout childhood or even adolescence in the absence of an effective nutritional program. Thus, six villages in the department, namely Béliéguhé, Zédéguhé, Béréguhé, Maboguhé, Dibléguhé and Guéguhé were selected. This selection was made in a reasoned way, on the one hand because of their consent to participate in the planned nutritional intervention and on the other hand because of the presence of school canteens in the schools of these villages (Figure 1). The survey was conducted in a school setting to interview the majority of children. Since some villages have only one school in common, children from the villages of Béliéguhé and Zédéguhé (BZ) were interviewed in the Béliéguhé public elementary school (PES), those

from the villages of Béréguhé, Maboguhé and Dibléguhé (BEMADI) were interviewed in the Béréguhé public elementary school (PES), and those from the last village were interviewed in the Guéguhé public elementary school (PES).

UNDER PEER REVIEW

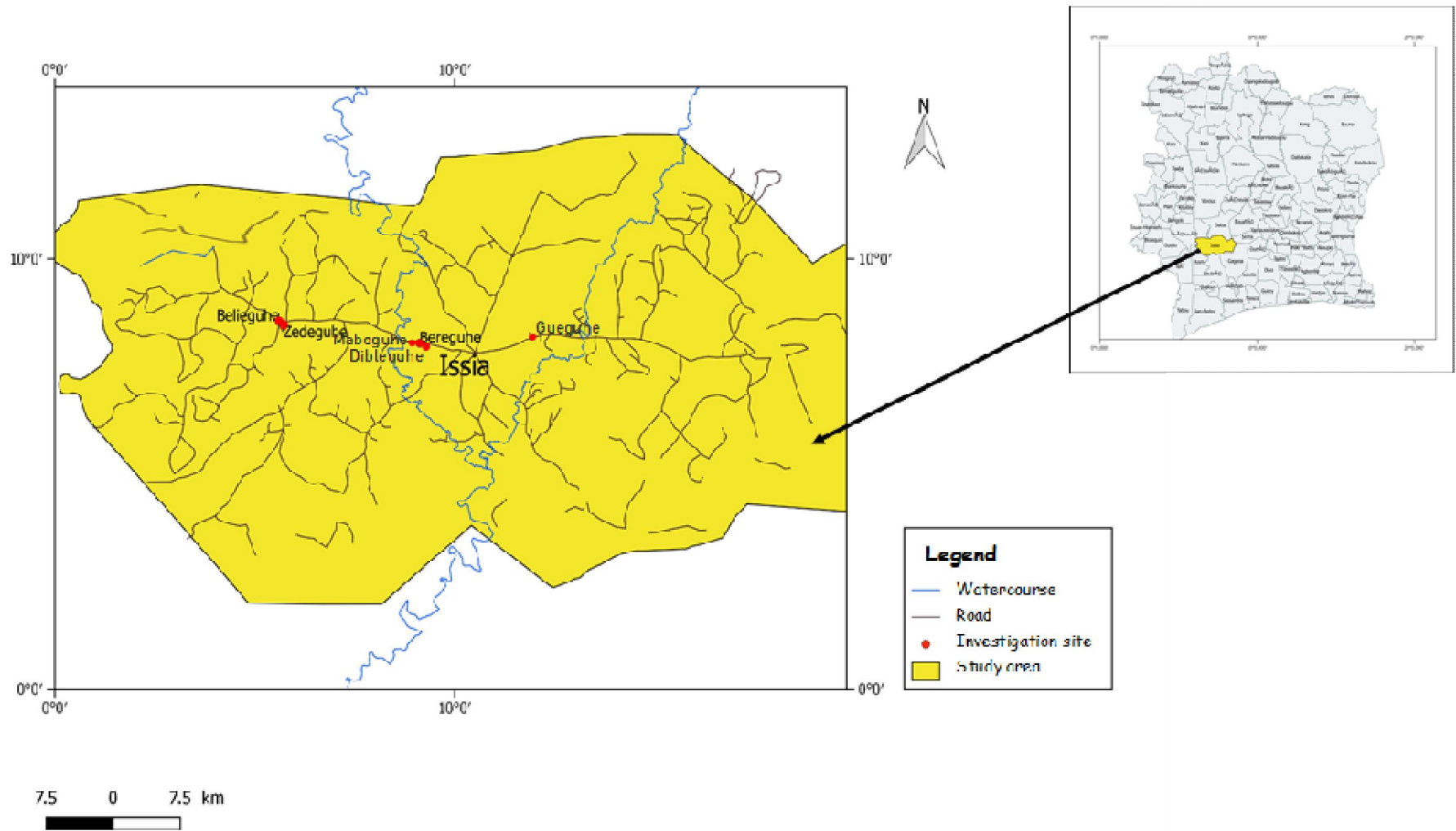


Fig 1 : Map of the study area

2.3. Study population and sampling

The survey was conducted on school children from first- to sixth-grade and aged from five to fifteen years. Schwartz's equation (1) [18], was used to determine the number of subjects needed for the study. It provided an estimate of approximately 384.16 or 385 individuals.

$$N = \frac{t^2 \times p(1-p)}{d^2} \quad (1)$$

N = minimum desired sample size ;

t = 95% confidence level (standard value is 1.96) ;

p = estimated prevalence of micronutrient deficiency among school-aged children in the study area (p= 50% by default, as prevalence is unknown) ;

d = margin of error at 5% (value is 0.05).

The selection of the individuals was made through a call for applications. They were selected after an interview explaining the conditions of participation and obtaining informed consent from the children and parents. A total of four hundred and sixty (460) children participated in this study and fully answered the questions, for a response rate of 119.5%.

2.4. Inclusion criteria

All schoolchildren from the first to the sixth grade, aged five years or more, and present in the schools with a parent during the survey period were included in this study.

2.5. Non-inclusion criteria

In this study, schoolchildren whose parents were absent on the day of the survey, those under the age of five, and those who refused were not included.

2.6. Data collection

A questionnaire was developed as a data collection tool with the help of KoboCollect software. This questionnaire was administered by the interviewer to the children and filled out jointly, with input from the parent, in order to gather as much information as possible on the consumption of cassava semolina (attiéké) by the children. The questionnaire has four important sections.

2.6.1. Socio-demographic characteristics

This section collected personal information about the child such as area of residence, gender, ethnicity, grade, and age.

2.6.2. Knowledge and level of consumption of cassava semolina

This part of the questionnaire consisted in collecting information on the knowledge or not of cassava semolina, the potential preferences of the children as well as the quantity of cassava semolina consumed per day and per child during the week preceding the survey. The estimation of the quantity of cassava semolina taken for consumption was done by the quantification method per household unit [19]. During the interview, several household

measures (plate, bowl) commonly used in the study area were filled with semolina, presented to the children for a choice and then weighed. Thus the quantity of cassava semolina consumed per day was determined according to the following equation (2) :

$$Q(g) = \frac{q \times n}{7} \quad (2)$$

Q : The average quantity of cassava semolina consumed per day during the week ;
q : Quantity of cassava semolina taken per consumption in grams ;
n : Number of times the semolina is taken per week ;
7 : Number of days a week

2.6.3. Cassava semolina consumption practices over the past seven days

This part consisted in collecting data on the frequency of consumption, the origin of the consumed cassava semolina, the accompanying ingredients and the different periods of consumption during the day.

2.6.4. Availability of cassava semolina in the study area

This aspect of the survey was identified through items such as the annual period of availability, the most available varieties, the methods and duration of storage.

2.7- Statistical exploitation of the results

The results of this study were presented in tables and figures. The figures were produced using the 2016 version of the Excel software. The different parameters studied were expressed as numbers, percentages and averages with standard deviation. Statistical processing was performed using the version 25.0 of IBM SPSS software. Student's t-test, analysis of variance test (one-factor Anova) and correlation test were used to determine the associations between socio-demographic characteristics and the quantity of cassava semolina consumed.

3. RESULTS

3.1. School-age children's socio-demographic characteristics

In this study, the children ranged in age from five to fifteen years with a mean of 8.4 years. There were 51.5% boys and 48.4% girls. The distribution according to area of residence is such that 43.3% of the children were from Béréguhé, Maboguhé and Dibléguhé (BEMADI); 40.0% from Béliéguhé and Zédéguhé (BZ) and 16.7% from Guéguhé. The children interviewed were from various ethnic groups with a predominance of Krou (62.2%). Regarding the school level, the results showed a high proportion of children from the Preparatory grades (53.0%). They were followed by those of the Elementary grades (31.5%) and the Middle grades (15.4%) (Table 1).

Table 1 : Distribution of the study population according to socio-demographic characteristics

Variables	M±SD	N (%)
Âge	8,4±2,4	
Gender		
Male		237 (51.5)
Female		223 (48.5)
Residence area		
<i>Béréguhé, Maboguhé et Dibléguhé</i>		199 (43.3)
<i>Béliéguhé et Zédéguhé</i>		184 (40.0)
<i>Guéguhé</i>		77 (16.7)
Ethnicity		
Krou		286 (62.2)
Gour		26 (5.6)
Akan		48 (10.4)
Mande		21 (4.6)
Other		79 (17.2)
School level		
Preparatory grades		244 (53.0)
Elementary grades		145 (31.5)
Middle grades		71 (15.4)

Preparatory grades : grade 1 to 2 ; Elementary grades : grade 3 to 4 ; Middle grades : grade 5 to 6 ; Mean ± SD : Mean values ± Standard Deviation of means. N(%): number (percentage)

3.2. Quantity of semolina consumed according to socio-demographic characteristics

The average quantity of cassava semolina consumed per day per child was estimated at 95.5 ± 17 g. Results on socio-demographic characteristics showed a weak positive correlation between the quantity of cassava semolina consumed and the age of the children ($r=0.41$; $p<.01$ (Figure 2). In addition, the quantity of cassava semolina consumed also varied significantly according to the children's school level ($F=27.73$; $P=.000$) with statistically higher quantities among children in Elementary grades (107.7g) and Middle grades (113g) (Table 2).

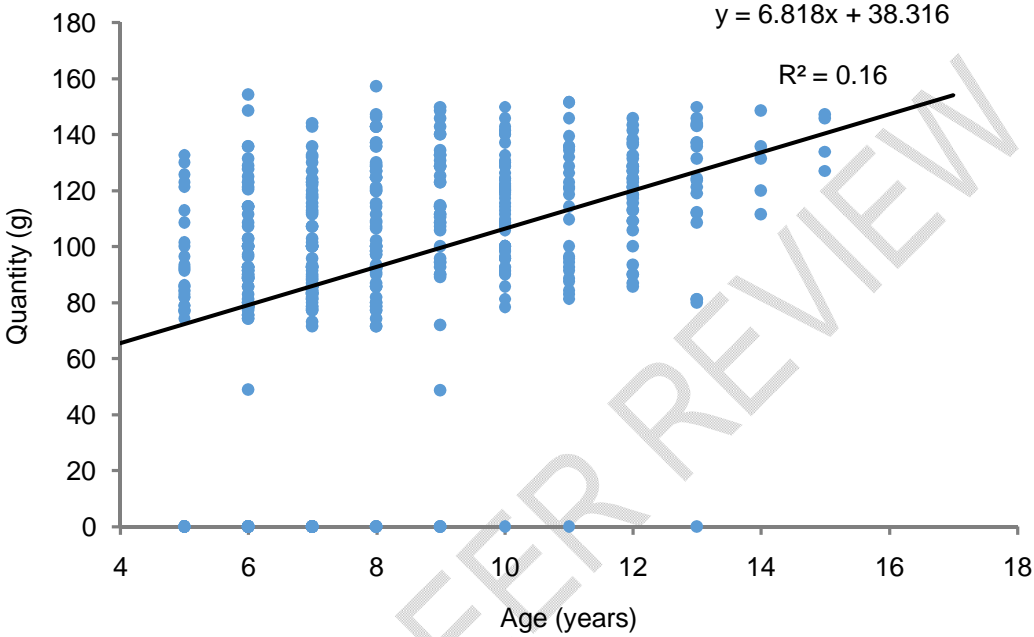


Fig 2 : Correlation between the quantity of cassava semolina consumed and the age

Table 2 : Variation in the quantity of semolina consumed according to gender, area of residence, ethnicity and school level

Variables	Quantity	
	M±SD	F ; P
Gender		
Male	93.5±40.6 ^a	1.2 ; .27
Female	97.6±39.6 ^a	
Residence area		
<i>Béréguhé, Maboguhé et Dibléguhé</i>	92.7±37.9 ^a	0.9 ; .40
<i>Béliéguhé et Zédéguhé</i>	98.2±41.6 ^a	
<i>Guéguhé</i>	96.2±42.5 ^a	
Ethnicity		
Krou	97.7±38.7 ^a	1.9 ; .11
Gour	104.1±37.6 ^a	
Akan	91.6±44.4 ^a	
Mande	100.1±39.5 ^a	
Other	85.7±42.6 ^a	
School level		
Preparatory grades	83.2±43.1 ^a	27.7 ; .000
Elementary grades	107.7±31.6 ^b	
Middle grades	113±30.7 ^b	

Preparatory grades : grade 1 to 2 ; Elementary grades : grade 3 to 4 ; Middle grades : grade 5 to 6 ; Mean ± SD : Mean values ± Standard Deviation of means. Means followed with the same letter are not significantly different at 5% level of probability using Student's t test and tukey test

3.3. School-age children's overall level of knowledge of cassava semolina

The results of this survey showed that cassava semolina occupies an important place in the eating habits of children in all study areas. All children (100%) reported knowledge of

cassava semolina. Three varieties of cassava semolina are generally found in these areas, namely, the big-grain (*agbodjama*), normal-grain and small-grain varieties. However, the small-grain variety seems to be the preferred variety according to 66.9% of children, followed by the normal-grain variety (29.6%) and big-grain (3.5%) (Figure 3).

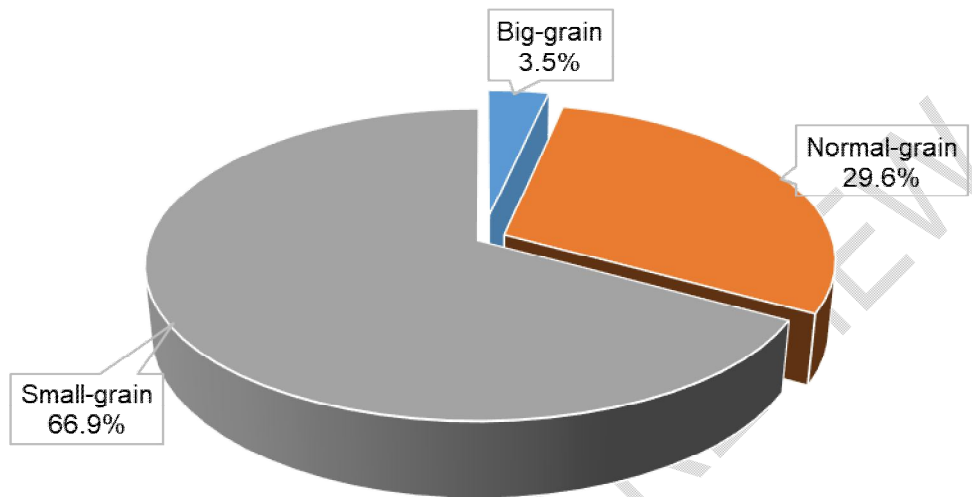


Fig 3 : Preference level of cassava semolina

3.4. Consumption practices of cassava semolina by children

About 88.5% of the population interviewed consumed cassava semolina over the last seven days prior to the survey; 35.2% of them "regularly" ate it for about four to seven days a week, and 53.3% "often" consumed it for about one to three days a week. In addition, about three quarters of the population that consumed cassava semolina (75.9%), bought it on the market. According to 77.2% of interviewed children, cassava semolina was preferably eaten as midday meal and almost always with fish (86.3%) and vegetables (79.1%) during the last seven days (**table 3**).

Table 3 : Consumption of cassava semolina during the last 7 days prior to the survey

variables	N (%)

Frequency of consumption	
Regularly (4-7 days/week)	162 (35.2)
Often (1-3 days/week)	245 (53.3)
No consumption (average of less than 1 day/week)	53 (11.5)
Origin	
Own production	32 (7.0)
Purchase	349 (75.9)
Donation	26 (5.6)
No consumption	53 (11.5)
Timing of consumption	
Breakfast	11 (2.4)
Midday meal	355 (77.2)
Evening meal	41 (8.9)
No consumption	53 (11.5)
Other ingredients	
Fish	397 (86.3)
Meat	11 (2.4)
Fried plantain (“alloco”)	74 (16.1)
Onion/tomato/pepper or other vegetables	364 (79.1)
Soup	48 (10.4)
Egg	6 (1.3)

3.5. Availability of cassava semolina in the Study Areas

With the help of the parent present, the majority of the population (95%) reported that cassava semolina was available throughout the year. However, they all (100%) said that the small grain variety was easier to find in the market, which makes it the most available variety. the storage of cassava semolina is not a commonplace practice in most of the households from which the children come. Indeed, 68.7% of respondents said that they bough or got it for immediate consumption and only 31.3% often stored it for later consumption. In most cases, this storage is done at room temperature (29.6% of respondents), with a maximum storage period of 3 to 4 days for 18.5% of respondents and 5

to 7 days for 2.8% of them. However, for 1.7% of respondents, storage in the freezer or refrigerator allowed cassava semolina to be kept for more than a week (Table 4).

Table 4: Availability and storage practices of cassava semolina

Variables	N (%)
Annual period of availability	
Sunny season (December-April)	4 (0.9)
Rainy season (May-November)	19 (4.1)
Throughout the year	437 (95)
Variety easily found on the market	
Big-grain	52 (11.3)
Normal-grain	203 (44.1)
Small-grain	460 (100)
Storage method of cassava semolina	
Room temperature	136 (29.6)
Refrigerator / Freezer	8 (1.7)
No storage	316 (68.7)
Storage duration	
1 to 2 days	38 (8.3)
3 to 4 days	85 (18.5)
5 to 7 days	13 (2.8)
>7 days	8 (1.7)
No storage	316 (68.7)

4. Discussion

This research was conducted as a prelude to a nutritional intervention aimed at using cassava semolina (Attiéké) as a nutritional vehicle to combat micronutrient deficiencies, particularly anemia, in school-aged children in some rural communities of Côte d'Ivoire.

According to the survey results, the average quantity of cassava semolina consumed per child is 95.5 g per day. The fact that this quantity is significantly influenced by the children's school level could be due to the fact that the elementary and middle grades are generally composed of older children who are likely to consume larger quantities of semolina. This result is corroborated by the correlation study which revealed a positive correlation between the quantity of cassava semolina consumed and the child's age.

Three varieties of cassava semolina are most often found in the study area (Big grain, normal grain, small grain). The preference for the small grain variety could be justified by the fact that it is the most produced in this area. Accordingly, it is more deeply rooted in the eating habits of the inhabitants. These results differ from those of Krabi [20], whose investigations revealed a greater preference for the big grain variety by the population living in Abidjan (the economic capital). This gap in the study results would be due to the difference in the study areas. Indeed, Abidjan as well as the coastal regions of Côte d'Ivoire, constitute the original areas of cassava semolina production. To this end, the big-grained variety commonly called "prestige cassava semolina" is frequently produced with more care and mastery of processes.

The high frequency consumption of cassava semolina during the seven days before the survey, could be associated with its cheapness and its small size compared to other cassava-based products. And most importantly, this could be relative to its characteristic of fast food that can be consumed both hot and cold [12]. The general consumption of cassava semolina with fish and vegetables could be justified by the fact that this food was formerly cooked and consumed exclusively by the Adjoukrou, Ebrie, Alladjan, Avikam and Ahizi ethnic groups living in the lagoon regions of the south of Côte d'Ivoire and thus are great consumers of fishing products. This consuming habit of this food with fish has therefore spread throughout the territory of Côte d'Ivoire. This is confirmed by Assanvo Assanvo [12] and Krabi [20] whose studies were conducted in the cities of Dabou and Abidjan respectively. For these authors, cassava semolina is generally accompanied by vegetables and a fish-based protein source. Regarding the mode of acquisition, the survey showed that this food was mainly purchased by consumers. They certainly purchase it because of its demanding production process which requires know-how, mastery of the production process, and enough time.

Cassava semolina is mostly consumed as a midday meal, which attests to its importance in this area. The fact that children eat this food at lunchtime could be explained by the absence of their parents. The fact that children eat this food at lunchtime could be explained by the absence of their parents. In fact, during this period of the day, most parents are swamped by their various farm and trade jobs which take them away from home almost all day. Children are therefore obliged to buy lunch. So, they opt for cassava semolina because of its low cost.

Generally, cassava semolina is available on the market throughout the year according to the majority of respondents. There are two main reasons for this. On the one hand, there is high production and availability of cassava roots. Indeed, cassava is a commodity that is produced throughout the year [21]. Grown on about 4/5 of the Ivorian national territory [22], cassava is the second most important food crop after yam [23,24]. On the other hand, the second reason could certainly come from the innovation of production processes with the advent of several processing technologies, including grinders, mobile or stationary motorized grinders, and double screws or mechanical cassava presses. These machines aim not only to increase productivity in a short time [25], but also to reduce the several tedious and tiring physical efforts as well. This favors frequent and steady production throughout the year. To these two main reasons, the very high demand for cassava semolina could be added. There are certainly no recent data on the level of consumption of this food. However, existing

documentation revealed in 1995 an annual consumption estimated between 28 and 30 kg per capita [26,27]. This quantity may well have increased over the years. Thus, satisfying this high demand means constantly increasing production levels and frequencies. These results are in agreement with those of Krabi [20], who reported that cassava semolina was produced throughout the year. And it is highly produced when the demand is very high.

According to all respondents, the small grain variety seems to be the most available on the market. As a matter of fact, this variety of cassava semolina commonly called "Garba" is purely produced for commercial reasons. Its production requires the least possible care and time and also many steps are almost not considered or quickly executed. This type of cassava semolina (Attiéké) is sold in many outlets at a very low price and is intended for the mass clientele with relatively little financial means such as pupils/students, teenagers, unemployed people [20].

For more than half of the respondents who stored this food for later consumption, the maximum storage time varied between three and four days. These results are identical to those of Djéni [29] who stated a shelf life of three days before unwanted coloration appeared. However, in some studies, more than half of the population interviewed argued that the maximum shelf life is one week [20,29]. This difference in results could be explained by the fact that the shelf life of cassava semolina is relative to each producer's cooking methods. Indeed, according to Kouamé [30], the shelf life of cassava semolina is determined by the cooking method and hygienic practices. The deterioration of this food is caused by its wetness, the storage conditions and the presence of micro-organisms that lead to changes in taste, color and increase in pH.

5. CONCLUSION

This work is a first approach to a nutrition intervention project among school-age children in selected rural communities. The objective was to determine the level and practices of consumption of cassava semolina (attiéké), which will serve as a micronutrient vehicle for these children in the project. We therefore opted for a descriptive approach.

Thus, this survey revealed that cassava semolina played a major role in the diet of children in all six villages surveyed, and the preferred variety was small-grain cassava semolina. It also revealed that children very often bought cassava semolina and consumed it most often as a midday meal with fish and vegetables. In addition, this food is available on the market throughout the year. Still, its shelf life still requires improvements. Finally, the survey showed that the quantity of cassava semolina consumed increased with the age of the children.

These results thus revealed the possibility of using cassava semolina as a nutritional vehicle in programs to combat malnutrition. This food could therefore be fortified for use in the universal school lunch program in Côte d'Ivoire. However, dehydration techniques for long shelf life as well as education of canteen staff for the adoption of this food are needed.

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