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Inventory and nutritional and microbiological quality of food sold in the vicinity of schools: The case of municipality of Tiassalé, Agneby-Tissa region, Ivory Coast

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ABSTRACT: The present study carried out in the town of Tiassalé aimed to contribute to the improvement of the nutritional and microbiological quality of foods sold in order to preserve the health of learnes. Data collection took place from May to June 2021 in four schools. The actors in the school food chain were made up of 26 vendors and 132 students. The results of this study showed that the students consume the various foods which enter into the composition of the seven different food groups. These foods provide essential nutrients to cover needs and to the proper functioning of the organism. Health analysis of the consumption food chain revealed that the actors of the school food chain in general, doses not follow good food hygiene practices. The results of microbiological analysis testify to the presence of some germs (aerobic mesophilic germs, total coliforms and thermo tolérants). The presence of these germs in food reflects the insufficiency or non-compliance with good food hygiene pratices. Thus, hygiene measures and the training of stake holders in good hygiene practices should be undertaken in schools in order to minimize the risk of contamination.

KEYWORDS: Food, quality, nutrition, hygiene, microbiology, schools, Tiassalé.

1 INTRODUCTION

Food is a basic human need, as it provides the body with the nutrients and energy it needs to maintain good healt and function **[1].** Today, urbain centres are increasingly experiencing the emergence of food provided outside the home. This situation is particularly noticeable in and around schools. School feeding has been the subject of increased interest in recent years and is positioned as a lever to be used to achieve the objectives of quality education. In developed countries, the institutional framework for organizing school feeding is well developed **[2],** and schools have canteens, spaces in which the meals consumed by students are prepared in conditions that comply with health standards. This is not the case in some developing countries **[3].** In Côte d'Ivoire, the school feeding sector does not generally benefit from sanitary surveillance. In the majority of its towns, particularly Tiassalé, schools do not have any canteens and their students obtain their food from vendors installed inside and outside of schools. The food produced and sold in this environnement must respect the conditions of food hygiene and the nutritional composition table. Otherwise the lack of food hygiene and the poor composition of food could cause functional disorders in schoolchildren bodies and affect their school performance. The general objective of this study is to contribute to the improvement of the nutritional and microbiological quality of food in schools in order to preserve the good health of learners.

2 MATERIALS AND METHODS

2.1 MATERIAL

The study was conducted in the town of Tiassalé located in the Agneby-Tiassa Region in the south of Côte d'Ivoire. The town of Tiassalé has four (4) secondary schools, including two (2) public schools and two (2) private schools. Then, five (5) primary schools, four (4) of which are public and one (1) private. The choice of this town for the study was made arbitrarily. The study included all schools that had a sales point at the entrance and inside the school at the same time, or only schools

where the food sales points were located at the entrance. Participants were selected based on case selection available in the schools. Thus, forty-four (44) elementary school students and eighty-eight (88) high school students were selected. Twenty-six (26) female vendors were interviewed in the schools.

BIOLOGICAL MATERIALS

Biological materials consisted of food samples sold in schools.

2.2 METHODS

2.2.1 FOOD INVENTORY

To inventory the food sold and collect information on the frequency of consumption and quality of food, cross-sectional surveys based on a questionnaire and observation form were conducted from May to June 2021. This involved interviewing 132 students available in the schools on the different types of food sold and their frequency of consumption during the five (5) school days.

2.2.2 SANITARY ANALYSIS OF THE FOOD CHAIN OF CONSUMPTION

The sanitary analysis consisted in evaluating the hygiene from a systematic observation grid, on the food chain of consumption. It was carried out over a period of one (1) month (May 2021) in the food outlets of the four targeted schools. This study was made on the basis of the HACCP method in two parts (risk analysis and control of critical points).

2.2.3 PHYSICOCHEMICAL ANALYSIS OF DIFFERENT TYPES OF FOOD

2.2.3.1 DETERMINATION OF MOISTURE CONTENT

The method used for the determination of the moisture content is the one described by **[4]** which consists in drying a sample until a constant mass is obtained, after weighing in an electric precision balance (1/100g) of Denver brand and grinding in an electric mill.

2.2.3.2 DETERMINATION OF ASH CONTENT

Ash represents the mineral composition of a sample. The method used for the determination of ash was that described by **[4]** which consisted of incinerating a sample in an oven until whitish residue was obtained.

2.2.3.3 DETERMINATION OF PROTEIN CONTENT

Crude protein was determined by the Kjeldhal method **[4],** based on the determination of total nitrogen. Nitrogen in dry matter is determined by the Kjeidahl method after sulfuric mineralization in the presence of selenium catalyst. The nitrogen content is multiplied by 6.25 (nitrogen to protein conversion coefficient).

2.2.3.4 DETERMINATION OF LIPID CONTENT

The lipid content was determined according to the method described by [**5]** AFNOR (1996), using the Soxhlet as extractor. The extraction of the fat was carried out by a system of flow and reflux for 6 hours. After 6 hours of extraction, the solvent (n-hexane) was recovered using a rotary evaporator (ROTAVAPOR) brand BUCHI.

2.2.3.5 DETERMINATION OF TOTAL AND REDUCING SUGAR CONTENT

The extraction of ethanosoluble sugars was carried out according to the method proposed by **[6].**

The free sugars were extracted by an aqueous solution of 80% ethanol and then purified with a solution of lead acetate and 10% oxalic acid.

The total sugar content was determined by the phenol-sulfuric method as described by **[7].** The method of **[8]** was used for the quantification of reducing sugars based on the reducing property of simple sugars.

2.2.3.6 DETERMINATION OF TOTAL CARBOHYDRATE

The total carbohydrate content was determined by difference following the calculation method recommended by **[9].**

2.2.3.7 DETERMINATION OF THE ENERGY VALUE

The theoretical energy value of the samples was calculated from the specific coefficients for protein, fat and total carbohydrates **[9].**

2.2.3.8 DETERMINATION OF PH

The pH was determined according to the **[4]** whose principle consists in measuring the concentration of hydronium ions (H+) of a solution by dipping the electrode of a pH meter in this solution.

2.2.4 MICROBIOLOGICAL ANALYSIS OF FOODS

The **[10]** standard was used for the research of Mesophilic Aerobic Germs (MAG), the medium used for the enumeration of MAG is PCA (Plate Count Agar). Sulfito-reducing anaerobes (SRA) were tested using Tryptone Sel Neomycin (TSN) agar **[10].** Staphylococcus aureus were enumerated on Baird Parker (BP) agar.

The search for Salmonella (Standard NF ISO 03459) was done in several steps. The first step consists of enrichment in non-selective medium (pre-enrichment), then the second step in enrichment in selective medium and finally isolation on selective agar. The culture medium used is crystal violet and neutral red lactose agar (VRBL) which inhibits the growth of gram positive and gram negative bacteria. Ovens of 37°C and 44°C (Selecta and Labnet France) were used for incubation. A Certoclav mulching autoclave (Deutsch land) was used for sterilization of culture media and destruction of waste. An olimpuce C*23 light microscope was used to visualize the colonies of germs and a colony counter (comecta digital) was used to count the colonies of microorganisms.

3 PROCESSING AND STATISTICAL ANALYSIS OF RESULTS

GRAPHPAD Prism version 7.00 software is used for statistical analyses. The analysis of variances of the physicochemical parameters is performed by ANOVA, followed by the Newman Keuls multiple comparison test used with a significance level of $\alpha \leq 0.05$. Finally, the statistical analysis of the data from the consumption survey and food hygiene was done with the IBM SPSS statistics version 19 software followed by the chi-square comparison test with a significance level set at 5%.

4 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 FOOD INVENTORY AND FREQUENCY OF FOOD CONSUMPTION

4.1.1.1 FOOD INVENTORY

The results on the food inventory in the four schools showed the different types of food consumed by the primary and secondary school students. These foods are classified into seven (7) food groups which are, starchy foods (bread, attieke and vermicelli), meats, fish, eggs and legumes (chicken, fish paste, omelette, peas and soybeans), fruits and vegetables (avocado, orange), fats (palm oil, animal fat), sweet products (bissap juice, candies and cookies) and water.

Some foods such as sweet-omelette and attieke-chicken bread are sold and consumed only in secondary schools. The same is true for attoupkou (steamed cassava cake) and sauce, which is only sold in elementary school.

4.1.1.2 WEEKLY FREQUENCY OF FOOD CONSUMPTION BY ELEMENTARY SCHOOL STUDENTS

The study indicated that primary school students consume the different types of food at frequencies ranging from 1 to 5 times per week. The number of students who consume bread and condiments 4 times a week, is significantly higher (58 %; $P \leq 0.05$) than the others who consume less in primary school. Next to these, come the number of students who consume fruit 2 times and 3 times doughnuts-bissap, which were respectively higher (50% and 48%) than the number of other remaining students who consume the studied foods. As for the consumption of attoupkou, it is consumed only in primary school. The

number of students who consume this food four and five times a week is significant (38% and 36% respectively). The consumption of sweets and cookies remains the lowest compared to all other foods consumed during the week **(Fig1).**

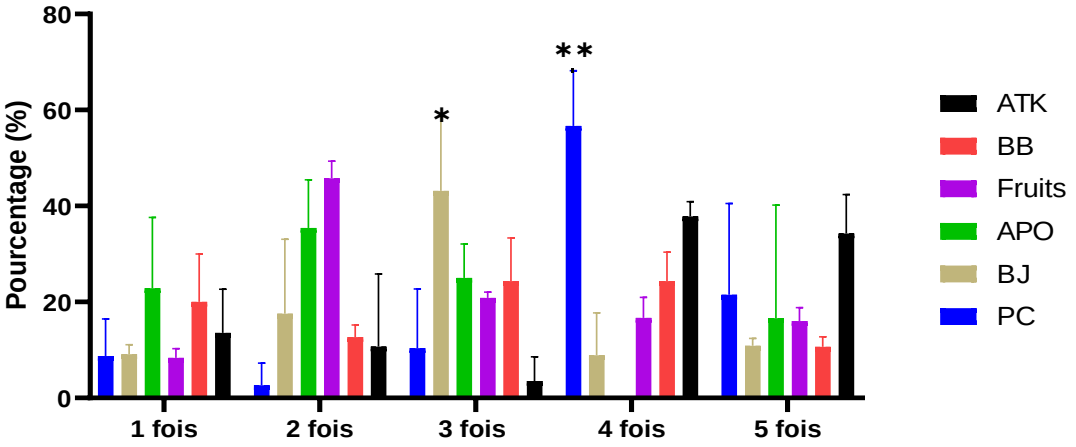

Fig. 1. Weekly frequency of food consumption by primary school students

ATK: Attoupkou and sauce; BB: Sweets and cookies; APO: Attieke and fish; BJ: Fritters and bissap juice; PC: Bread and condiments; (*): the observed difference is not significant; (**): the observed difference is significant

4.1.1.3 WEEKLY FREQUENCY OF FOOD CONSUMPTION ACCORDING TO HIGH SCHOOL STUDENTS

The results obtained from **Figure 2,** showed that high school students, consume the different types of food at frequencies ranging from 1 to 5 times a week. Foods such as sweet-omelette bread and attieke-chicken are sold only in secondary schools. The number of students who consume sweet-omelette bread twice a week and those who consume fruit three times a week were higher (40% and 39%) than the number of all other high school students who consume the foods, respectively. Next to these, the number of students who consume attieke-chicken once a week and donuts-bissap 5 times a week were high (35%) compared to the remaining number of students who consume the food.

The comparative frequency of the remaining high school students who consume candy and cookies 1, 2, 3 and 5 times a week was about equal (25%). Concerning bread and condiment, the number of students who consumed 3 times and 4 times a week were significant respectively (24 and 22%).

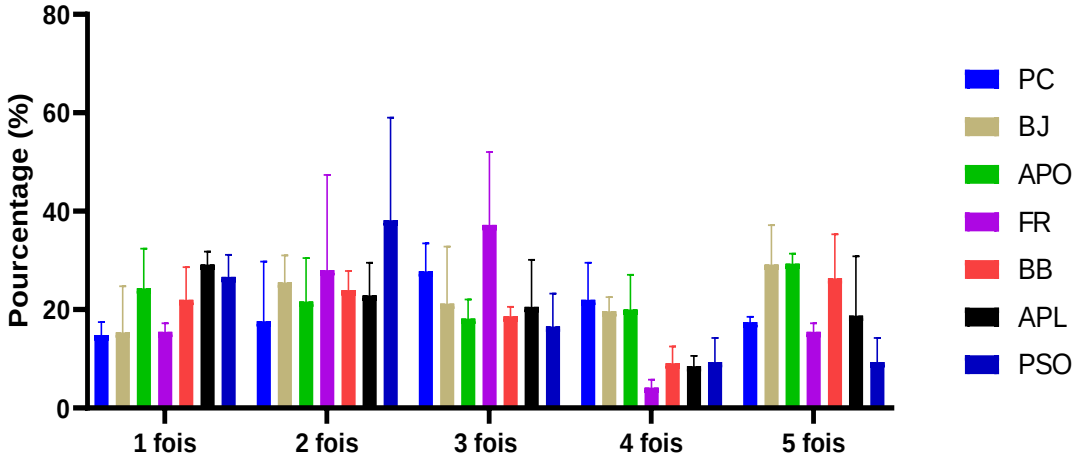

Fig. 2. Weekly food consumption frequency by high school students

PC: Bread and Condiments; BJ: Doughnuts and Bissap; APO: Attieke and Fish; FR: Fruit; BB: Candy and Cookies; APL: Attieke and Chicken; PSO: Sweet Bread and Omelette

4.1.2 HEALTH ANALYSIS OF THE CONSUMER FOOD CHAIN

The results of the sanitary analysis of the consumer food chain carried out in the four (4) targeted schools showed that: Only four (4) food vendors out of twenty-six (26) have received training on good food hygiene practices, i.e. 11.5%.

The places where food is sold are built in the form of sheds by the vendors. All the vendors have a daily cleaning program for the premises. The majority (92.3%) do not have garbage cans with covers adapted to household waste management.

With regard to utensils, observations showed that the utensils offered to students were generally clean in 84.6% of cases. All vendors reported that their equipment was washed after each use. However, the remaining utensils considered not clean (15.4%), are due to the use of cloudy rinsing water that is not changed frequently even though it is used by the students. Food is kept in containers with covers or protective bags and kept in 80.8% of the vendors. For the remaining (19.2%), the food is displayed in trays. All the vendors interviewed, except one (1) out of twenty-six (26), have practically no hand washing facilities, and the majority of students use only water destined for washing utensils. The hand towels offered by the vendors are for multiple use. As far as staff hygiene and good practices are concerned, the results showed that, most of the time, vendors operate in their own street clothes (88.5%) and these were ound to be clean. The majority of vendors (76.9%) did not practice proper hand washing before serving food. Observations revealed that female vendors generally do not use nail polish and rings when selling food. Concerning the size of the nails with varnish, 11/26 do not have short nails, that is 42.3%. Concerning the hair coverage, most of the visited saleswomen have covered hair (53,8 %). Interviews on the medical visit and sputum examination gave respectively (76.9%) and (96.2%) of female vendors having undergone a medical visit. The number of female vendors not vaccinated against typhoid fever remained high (73.1%) **(See Table I).**

Table 1. Characteristics of food hygiene in schools

Food hygiene characteristic	Present n (%)	Absent in (%)	P	X2
Training on good practices	3 (11,5)	23 (88,5)	0,04	≤ 0,05
Site Maintenance Program	26 (100)	0	0	0,0
Garbage disposal near the point of sale	2 (7,7)	24 (92,3)	0,03	≤ 0,05
Presence of closed garbage cans	2 (7,7)	24 (92,3)	0,03	≤ 0,05
Regular maintenance of the equipment	22 (84,6)	4 (15,4)	0,08	≥ 0,05
Food covered	21 (80,8)	5 (19,2)	0,37	≥ 0,05
Hand washing device	1 (3,8)	25 (96,2)	0, 004	≤ 0,01
Work clothes	3 (11,5)	23 (88,2)	0,04	≤ 0,05
Hand washing practice	6 (23,1)	20 (76,9)	0,48	≥ 0,05
Sputum examinations	25 (96,2)	1 (3,8)	0,004	≤ 0,01
Short nails without polish	15 (57,7)	11 (42,3)	0,94	≥ 0,05
Respect for good hygiene practices	4 (15,4)	22 (84,6)	0,08	≥ 0,05
Medical visit	20 (76,9)	6 (23,1)	0,24	≥ 0,05
Typhoid fever vaccines	7 (26,9)	19 (73,1)	0,27	≥ 0,05

- P≥ 0.05: the observed difference is not significant
- P≤ 0.05: the observed difference is insignificant
- P≤ 0.01: the observed difference is significant

4.1.3 PHYSICOCHEMICAL ANALYSES

The study of the physicochemical composition of the food samples reveals that the moisture contents of the different foods are statistically different (P≤ 0.01) except for those of bread-sweet-omelette and bread-avocado-omelette which have respective contents of 42.6± 5.37 and 46.4± 0.28. On the other hand, the rate of donut-bissap (66.1 ± 0.42% MF) is significantly higher than the other foods. Regarding the ash content, the bread-vermicelli-pea-fish has a content of 4.1 ± 0.42 % DM which is significantly higher than other foods. The ash content of the different feeds are statistically different (P≤ 0.01) except those of attieké-chicken-fish, attieké-fish and attoupkou-sauce which have statistically identical contents (2.4 ± 0.1 % DM). The same is true for the content of the bread-sweet and donut-bissap foods, respectively 1.9±0.14 and 1.1±0.14 % DM. As for the protein content, the different feeds were statistically different (P≤ 0.01). The sweet-omelette bread has the highest protein content (14 ± 0 % DM), followed by the avocado-omelette bread (13.63 ± 0.53 % DM) and the vermicelli-pea-fish bread (12.68 ± 0.61 % DM). The attoupkou and sauce (0.875 ± 0.0% DM), has the lowest protein content compared to the other foods studied.

On the other hand, the fat content recorded in sugar-omelette bread (21.60 ±1.13 % DM), attieke-chicken (20.7 ± 0.98 % DM) and attieke-fish (15.9 ± 2.97 % DM), is higher than that of the other foods. Bissap fritters have the lowest content (4.8 ± 0 % DM). The observed difference is significant (P≤0.01). The contents of reducing sugars and total sugars of different foods are statistically different (P≤ 0.01). Foods such as bread-avocado-omelette and sweet bread-omelette have contents of 1.500±1.006% DM and 1.041± 53.50% DM, respectively, which are higher than the other foods studied. Next to these comes chicken attieke with a content of 0.862 ± 34.80 % DM. These results reveal that attoupkou-sauce of content (89.72 ± 0.56 % DM) and donut- bissap of content (87, 54 ± 3.30 % DM), are highly concentrated in carbohydrates than the other foods. The observed difference is significant (P≤0.01). On the other hand, the foods attieke-fish and attieke-chicken have statistically identical contents 75.42 ± 2.82 % DM and 72.52 ± 0.98 % DM. Regarding energy values, foods such as attieke-chicken, sweet bread-omelette and attieke-fish appear to have more energy. They provide respective energy values of 442.8 ± 3.36 % DM, 438.10 ± 4.19 % DM and 417.5 ± 10.44 % DM which are significantly higher than the other studied foods (P≤0.01) **(Table II)**

4.1.4 MICROBIOLOGICAL ANALYSIS OF FOOD

The result of the microbiological analysis showed that the attoupkou-sauce contains 29000 ufc of (GAM). This value found, is lower than the minimal threshold of (3.105 m/g). As for the thermo tolerant coliforms, their presence in this food (420 cfu) is higher than the maximum threshold (1000M/g). Concerning the food attieke-chicken fried, the presence of the GAM is 15300ufc and the total coliforms of 1000ufc. These values are lower than the respective minimal threshold (3.105 m/g) and (1000 m/g) whereas the presence of thermo tolerant coliforms in this food (350 cfu/g) is higher than the maximal threshold (100M/g). The GAM, counted in the food attieke-fish is (3200 000 ufc/g). This value is higher than the maximum threshold (106M/g). The other germs are absent in this food. Regarding the food (bread-pea-fish-soy and vermicelli), the enumeration gave 13000 cfu of total coliforms and 14000 cfu/g of thermotolerant coliforms. These values are above the defined criteria while the presence of GAM is 24000 cfu in this food is below the criteria. The doughnut-bissap and the sugar-omelette bread contain 6,000 cfu and 4,300 cfu respectively. These values are below the minimum threshold. Other germs are absent in these foods **(TableIII).**

Table 2. Physicochemical parameters of samples of different types of food

Food	Moisture (%)	Protein (g/100g)	Fat (g/100g)	Reducing sugars (g/100g)	Ash (g/100g)	Total sugars (g/100g)	Total carbohydrates (g: 100g)	Energy values (kcal/100g)
Attieke chicken	55,07 ± 1,10^{a}	4,37 ± 0^{b}	20,7 ± 0,98^{a}	0,86 ± 0,034^{b}	2, 4 ± 0^{c}	42,38 ± 3,54^{d}	72,52 ±0,98^{b}	442,8 ± 3,36^{a}
Attieke fish	50 ± 0,56^{c}	6,12 ± 0^{b}	15,9 ± 2,97^{b}	0,067 ± 0,009^{e}	2,5 ± 0,14^{c}	25,27±10,59^{e}	75,47 ± 2,82^{b}	417,5±10,44^{b}
Sweet bread omelette	42,6 ± 5,37^{d}	14 ± 0^{a}	21,60 ± 1,13^{a}	1,041 ±0,053^{b}	1,9 ±0,14^{d}	73,25±23,60^{a}	62,50 ± 0,98^{c}	438,1 ± 4,19^{a}
Bread-worm-pea-fish	51,7 ± 0,707^{c}	12,68±0,61^{a}	12 ± 2,54^{b}	0,34 ± 0,019^{d}	4,1 ±0,42^{a}	26,88 ± 3,36^{e}	71,21 ± 2,82^{b}	370,6 ± 5,85^{e}
Attoupkou and sauce	54,39 ± 3,92^{e}	0,43 ± 0,61^{c}	9,7 ± 4,66^{c}	0,462 ± 0,054^{c}	2,70 ± 0,14^{c}	28,76 ± 5,90^{e}	89,72 ± 0,56^{a}	392,9±15,49^{c}
Bread-avocado-omelette	46,4 ± 0,282^{d}	13,63 ± 0,53^{a}	11,40 ± 0,28^{c}	1,501 ± 0,1^{a}	3,2 ± 0,28^{b}	65,43± 1,08^{b}	71,84 ± 0,04^{b}	385,0 ± 0,74^{c}
Doughnut-bissap	66,1 ± 0,42^{b}	6,56 ± 0,62^{b}	4,8 ± 0^{d}	0,521 ± 0,028^{c}	1,1 ±0,14^{d}	31,29± 2,40^{c}	87,54 ± 0,47^{a}	368,7 ± 0,13^{e}

Each value is the mean ± SEM (n = 3)
Attieke: manioc semolina; attoupkou: steamed manioc cake; vermi: vermicelli
a, b, c,d, e
Values with different letters in the same column are significantly different.

Table 3. Germ counts from the microbiological analysis of the different types of food studied

Microorganismes	Types of food						Criteria CECMA/2009	
	Attoupkou Sauce	Attieke Chicken	Attieke Fish	Doughnut-bissap	Bread-vermicelli Soy and peas	Sweet bread Omelette	m/g	M/g
GAM 30°C	29000	15300	3200000	6000	24000	4300	3.10^5	10^6
Total coliforms 30°C	520	1000	00	00	13000	00	1000	10 000
Coliform thermotolerant 44°C	420	350	00	00	14000	00	10	100
E. coli 37°C	00	00	00	00	00	00	10	100
A.S.R 46°C	00	00	00	00	00	00	30	300
Staphylococci 37°C	00	00	00	00	00	00	100	1000
Salmonella 37°C	Absence	Absence	Absence	Absence	Absence	Absence	Absence/25g	Absence/25g
Interpretations	**QMNS**	**QMNS**	**QMNS**	**QMA**	**QMNS**	**QMA**	-	-

QMNS: Microbiology Quality Not Satisfactory;
QMA: *Microbiological Quality Acceptable; m/g: minimum threshold; M/g: maximum threshold*

4.2 DISCUSSION

The foods listed after surveys in schools are diverse and are among the seven (7) food groups. These foods are composed of Attieke-fish, Attieke-chicken, donut-bissap, attoupkou-sauce, sweet-omelette bread, bread-condiment (from ready meals), fruits, candies and cookies (sweets). This same finding was demonstrated in the work done by **[11].** Indeed, these authors showed that the foods sold in different schools in the city of Yaoundé (Cameroon), were diverse. The foods were, cooked dishes, pastries, vegetables, sweets, drinks.

The data collected on the weekly frequency of food consumption showed that bakery breads (cereal product) and condiments (omelette, avocado, fish, peas and soy) are the most consumed by primary school students. Secondly, doughnuts, made with cereal accompanied by bissap juice have a significant consumption in primary school. Indeed, these foods bread and cereals and doughnut-bissap are more accessible, very appreciated for their organoleptic qualities and less expensive for most schoolchildren and especially those of primary school. This would explain their high consumption. These data are similar to the work done by **[12],** where he found that the consumption of cereal foods was important in eight out of ten schools. According to Ministry of Public Health **[13],** the most sold cereal foods in schools, are doughnuts made from wheat flour, chocolate bread, bread with meat, samossas and bread with vegetables. Some foods such as Attieke (cassava semolina) with chicken and sugar-omelette bread were sold and consumed only by secondary school students. Indeed, these foods provide many more calories to young adolescents to last throughout the course. Fruit is consumed in both primary and secondary schools. The frequency of consumption in primary school is higher than in secondary school. Fruit is well perceived by children because of its sweet taste. Sweetened products (candy and cookies) rank high in the usual consumption of students, especially in secondary school. In fact, these foods are the most popular and serve as snacks for most students.

The physicochemical analysis of the foods revealed that the doughnuts and bissap are wetter than the other foods. This high moisture content is due to the amount of water contained in the bissap juice. The other foods contain less water. Protein content is high in foods such as sweet-omelette bread, avocado-omelette bread, and vermicelli-pea-fish bread. These foods contain high quality proteins of animal and vegetable origin. Concerning the fat content, the sweet-omelette bread, attieke-chicken, attieke-fish have the highest content. Indeed, these

foods were produced by frying. This process brings a significant amount of fat to the food. In addition, chicken and fish contain fat. The foods (attoukou-sauce, beignet-bissap and attieke-fish) have a high carbohydrate content. These foods are made from wheat (fritters) and cassava (attieke) containing starch. Some foods appear to be more energetic than others because of their high carbohydrate and fat content. These include attieke-chicken, sugar-omelette bread and attieke-fish. Other foods are rich in sugar such as sweet bread-omelette and others rich in fat (sweet bread-omelette and attieke-chicken). All these foods studied provide nutrients necessary for the proper functioning and health of students, but the excessive consumption of fats and sugars leads to nutritional pathologies (obesity, diabetes, cardiovascular diseases). The foods studied contain the necessary nutrients to meet the needs of the students. Work done by **[11]** also showed that students need a diet that promotes harmonious growth and optimal development. The proposed foods certainly participate in covering these needs and are consistent with Cameroonian dietary habits as required by organizations such as **[14]** in the school feeding manual. The Consumer Food Chain Health Analysis revealed that the majority of female vendors (88.5%) in schools have not received training in good food hygiene practices. These values attest to those found by **[15],** where he showed that almost all female

vendors in schools were illiterate and untrained in hygiene. The ignorance of these vendors leads to non-compliance with basic hygiene rules. Concerning the food sales places, a regular maintenance program has been established and respected by the vendors. The premises are maintained, but the waste garbage cans are poorly managed, due to the lack of garbage cans adapted to the management of household waste. Most of the vendors cover their food to prevent the presence of flies and particle deposits. Regarding staff hygiene and good practices, shortcomings were reported. A proportion of 88.5% of vendors work in street clothes, 46.2% of them do not cover their hair. Hand washing is not properly practiced by female vendors (76.9%) and even students. These observations are similar to the studies conducted by **[12],** where he finds that the clothing and body hygiene of food vendors in schools, is marked by a low rate of wearing a gown or apron, a low rate of medical monitoring, non-compliance with hygiene rules such as clean hands, uncovered hair and non-use of protective equipment among almost all vendors. These results, very unsatisfactory, could lead to microbial contamination of food. The Consumer Food Chain Health Analysis revealed that the majority of female vendors (88.5%) in schools have not received training in good food hygiene practices. These values attest to those found by **[15],** where he showed that almost all female vendors in schools were illiterate and untrained in hygiene. The ignorance of these vendors leads to non-compliance with basic hygiene rules. Concerning the food sales places, a regular maintenance program has been established and respected by the vendors. The premises are maintained, but the waste garbage cans are poorly managed, due to the lack of garbage cans adapted to the management of household waste. Most of the vendors cover their food to prevent the presence of flies and particle deposits. Regarding staff hygiene and good practices, shortcomings were reported. A proportion of 88.5% of vendors work in street clothes, 46.2% of them do not cover their hair. Hand washing is not properly practiced by female vendors (76.9%) and even students. These observations are similar to the studies conducted by **[12],** where he finds that the clothing and body hygiene of food vendors in schools, is marked by a low rate of wearing a gown or apron, a low rate of medical monitoring, non-compliance with hygiene rules such as clean hands, uncovered hair and non-use of protective equipment among almost all vendors. These results, very unsatisfactory, could lead to microbial contamination of food.

5 CONCLUSION

From the results of the study, it is clear that students consume a variety of foods in the schools. The chemical composition of the foods indicates that they are rich in sugar, protein and fat and therefore provide nutrients necessary for survival, growth and contribute to the proper functioning of the nervous system and the entire body of the students. Nevertheless, the excessive consumption of fats and sugar could lead to nutritional pathologies (obesity, diabetes, cardiovascular diseases). The sanitary analysis of the food consumption chain carried out in the schools showed that most of the students do not practice hand hygiene and the saleswomen in general do not receive training on good food hygiene practices. The microbiological analyses carried out on the food samples, confirmed the presence of germs in the food. The microbiological quality of these foods is not satisfactory. The interest of this study in education and health, will open new guidelines in the regional and national school education including:

- Extend this study to schools throughout the Agneby-Tiassa region
- Evaluate the nutritional status of students in the town of Tiassalé and the Agneby-Tiassa region

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COMPETING INTEREST

The authors declare that they have no competing interests.

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