International Journal of Innovation and Scientific Research
ISSN 2336-0046 Vol. 76 No. 2 Jan. 2025, pp. 176-185

http://www.ijisr.issr-journals.org/

Formulation of *kossam* and rice porridge enriched with baobab fruit pulp to upgrade the coverage of the nutritional iron and zinc needs of children in the city of Maroua-Cameroon

A. Tagne Tadié[1], A.G. Kamda Silapeux[1-2-3], R. Ponka[4], and Elie Fokou[1-3]

[1]Department of Biochemistry, University of Yaoundé I, Laboratory for Food Sciences and Metabolism, Yaoundé, Cameroon

[2]Department of Social Economy and Family Management, HTTTC, University of Buea, Kumba, Cameroon

[3]Nutrition Food Safety and Wholesomeness, Prevention, Education and Research Network, Yaoundé, Cameroon

[4]Department of Agriculture, Livestock and Derivated Product, National Advanced School of Engineering of Maroua, University of Maroua, Maroua, Cameroon

ABSTRACT: Nutritional deficiencies in iron and zinc remain real public health problems for children in the town of Maroua in the Far North of Cameroon despite it has being a dairy production area. The availability of foods rich in micronutrients including the combination of some of these foods could help to improve coverage of children's nutritional needs.
The objective of this work was to formulate a milk product locally called *kossam* and rice porridge enriched with baobab fruit pulp to cover the nutritional needs in iron and zinc of children in the city of Maroua-Cameroon. A weekly food consumption survey was carried out in the town of Maroua after which samples of the different foods consumed by the children were taken and weighed. The most consumed products *(kossam)* and rice porridge have been enriched in various doses with baobab fruit pulp powder, resulting in improved products approved by sensory analyses. Sensory analyzes were determined following standard protocols.
Sensory parameters revealed a higher panelist preference for the *kossam* F530 formulation (4.75) not significantly different ($p > 0.05$) from the preference for the standard F550 (5.00). Also, a non-significant difference ($p > 0.05$) regarding the general appreciation of the formulation of rice porridge (5.00) and ordinary rice porridge (4.63). Iron and zinc experienced a significant increase in levels ($p < 0.05$). The daily diet of children coupled with the consumption of the F530 formulation and the formulated porridge makes it possible to cover 100% of children's daily iron requirements, and 51.03% coverage of children's daily zinc requirements.

KEYWORDS: malnutrition, *Kossam*, rice porridge, baobab fruit pulp, nutritional deficiencies, sensory analyses.

1 INTRODUCTION

In Cameroon, child malnutrition remains a public health problem and its distribution is very uneven. In the Far North region, iron and zinc deficiencies affect 68% and 76.9% of children respectively **[1].** The North and Far North regions do not only experience the highest rates of severe acute malnutrition (SAM) with 8.6% and 5.8% respectively; but also the highest rates of severe chronic malnutrition (SCM) with 1.8% and 1.2%, respectively **[2].** According to a Multiple Indicator Cluster Surveys (MICS) **[3]** carried out on 6270 children including 3234 boys and 3036 girls aged six (06) to fifty-nine (59) months, it appears that 15% of children in the Far North suffer from insufficiency weight and 9% of them are wasted.

Many actions have been carried out aiming at solving the problem of malnutrition in the Far North region. This is the case of the program to fortify locally produced flours and oils to improve the nutritional situation of populations. Furthermore, other programs have been set up in this region such as the FAO, WFP and Counterpart programs, as well as vaccination and disease control strengthening programs.

Despite all the programs to combat malnutrition set up in this region, in 2015, according to the world hunger index, Cameroon was ranked 68th out of 104 countries; going from 39.8 in 1990 to 24.2 points in 2015, a situation described as serious with the objective being

Corresponding Author: Elie Fokou

to be below the threshold of 5 points **[4].** Successive demographic and health surveys (EDS) and multiple indicator cluster surveys **[5], [6], [3]** show a trend of worsening malnutrition prevalence in Cameroon since the beginning of the 1990s with a recent stagnation in prevalence (around 15% for underweight, 30% for stunting) **[7].** Iron and zinc deficiencies affect 68.8% and 70% of children respectively **[8].** Despite all these measures and programs, iron and zinc deficiencies persist in the diets of children in this region **[9].** It would be important to pay particular attention to these iron and zinc deficiencies given their high prevalence.

It is in this context that the question arises as to why this problem persists? This situation is more paradoxical as the Far North region is one of the most important centers for the production of dairy products, namely locally made yogurts, also called *kossam*. We also find a diversity of foods such as the pulp of baobab fruit, rich in different trace elements, including copper, zinc (0.064mg in 100g of dry pulp of baobab fruit), manganese and iron (7mg in 100g of dry pulp of baobab fruit) **[10], [11].** Iron deficiency leads to anemia and zinc deficiency reduces immunity.

If there are so many food products rich in trace elements in this region, would it not be wise to question the consumption practices of vulnerable populations? Have processing practices not affected the micronutrient contents of the foods consumed? Can't we amend the composition of the foods consumed in relation to current dietary intake?

The objective of this work is to enrich *Kossam* and rice porridge with baobab fruit pulp powder to improve coverage of the daily iron and zinc needs for children aged 6 to 15 years in the city of Maroua.

2 METHODOLOGY

2.1 SURVEY ON FOOD CONSUMPTION DATA AND FOOD SAMPLE COLLECTION

A cross-sectional study design was used to carry out the survey in the city of Maroua (Cameroon). 135 children aged 6-15 years of both sexes located in the urban area of Maroua were the participants of the study. Children selected for the studies were physically and mentally in good health, living in some quarters in the city of Maroua (Doualare…Domayo) Children in good physical and mental health at the time of the study were recruited from families in the main districts (Doualare, Makabay, Douggoi, Pitouaré and Domayo) of the city. The selection of households was based on a stratified sampling strategy, with the strata being the 5 main quarters of the city. In each quarter, the selection of households was performed randomly and the number was proportional to the size of the quarter. Children were excluded from the study if they have not stayed in the locality for more than 3 years.

After steps to obtain parental consent, each child was interviewed to collect socio-demographic, lifestyle and consumption data, using a questionnaire form. Information about socio-demographic and lifestyle characteristics of the study participants included sex of the child, mother's education levels and employment status, and marital status of the mother. Concerning food consumption data, participants should provide information on the nature, frequency and estimated quantity (household unit) of the meals they consume on daily basis.

2.1.1 COLLECTION AND WEIGHING OF COUSCOUS, SAUCES AND PORRIDGE SAMPLES

The record of the main foods (couscous, sauces and porridge) that children had consumed during the week was done, with the amount, recipe and preparation method used at the level of household. We used the double weighing method to calculate the size of the food portion that was actually BEEN consumed at each meal, as opposed to the size of the food portion served to each child. This method took into account the amount of food that was edible and non-edible in each meal **[12].** The amount of food served to the participant on each dish was weighed before they began to eat. When they had finished eating, the plate waste was weighed again to estimate the true weight of the food consumed by each individual.

2.2 RECIPES SELECTED FOR FORMULATION

Two recipes consumed by children aged 6–15 years were identified based on a list of foods obtained from the food consumption survey previously carried out in the city of Maroua. The 2 main criteria applied to select recipes are: 1-) the recipe has theoretically low nutritional density and is frequently consumed by the majority of children living in the city of Maroua. 2-) the ingredients used for the formulations are available and low cost. The recipes which have been selected are *kossam* and rice porridge.

2.3 FORMULATION OF ENRICHED BAOBAB KOSSAM AND BAOBAB RICE PORRIDGE

RAW MATERIAL PROCUREMENT AND PREPARATION

Baobab fruits, rice, raw fresh milk, sugar and roasted peanut paste were obtained from local market in Maroua. The artisanal starter was collected from "bororowomens" in the form of curd milk. Portable water was strictly used throughout this experiment. The fruits were stored in polythene under room temperature while awaiting sample preparation. The hard woody shells were carefully crushed to

expose the white flesh pulp which is surrounded by the seeds. Separation of the pulp from the seeds was done by grinding using a pestle and mortar. The resulting mixture was sieved using a 0.09 micron sieve to obtain a fine pulp. The pulp was then packed in a polythene bag and stored in a dark cool place.

FORMULATION

For each of the foods enriched with baobab pulp powder (*kossam* and baobab rice porridge), 4 formulas which differ in the quantity of baobab powder were produced (tables 1 and 2). Fortification rates were defined based on local practices (unpublished data) and literature data on conclusive studies of food fortification with baobab pulp powder **[13], [14].**

Table 1. Formulation of enriched baobab kossam

Yoghurt samples				
Ingredients	**F 550**	**F 530**	**F 510**	**F 490**
Baobab pulp (g)	0	5	10	15
Fresh Milk (ml)	1000	1000	1000	1000
Starter (ml)	100	100	100	100
Sugar (g)	50	50	50	50

Table 2. Formulation of enriched rice porridge

Rice porridge samples				
Ingredients	**F 550**	**F 530**	**F 510**	**F 490**
Baobab pulp (g)	0	5	10	15
Rice (g)	200	200	200	200
groundnut (g)	30	30	30	30
milk (ml)	50	50	50	50
Sugar (g)	10	10	10	10

PREPARATION OF ENRICHED BAOBAB *KOSSAM*

The preparation of enriched baobab *kossam* was done according to the protocole set by **[15]** with a slight modification. The milk was heated to about 90°C to kill any undesirable bacteria and to partially break down the milk proteins. The samples were cooled to about 45°C. The starter culture (100 ml) was activated at 45°C for two hours. This active culture was used to inoculate each of the 1000 ml of milk, at the same temperature of 45°C which was maintained for 2-3 hours to allow for fermentation and the rapid production of lactic-acid by the inoculated bacteria, which led to the coagulation of the milk. The powder of baobab pulp and sugar were then mixed in the *kossam* produced. The product was cooled rapidly at 6±2°C and refrigerated for sensory analysis. The Flow chart of enriched baobab pulp *kossam* is presented in figure 1.

PREPARATION OF ENRICHED BAOBAB RICE PORRIDGE

Clean tap water (400 ml) was boiled in an electric kettle and rice and groundnut paste were added to the saucepan followed by 20ml of cold water poured while stirring to produce a paste. The boiled water was then added to the sauce pan as stirring continued to avoid lumps. A pinch of salt was added and the mixture was allowed to boil for 10 minutes. Then powder of baobab pulp, milk and sugar were added and stirred to homogenize the preparation. The porridge was served in a flat plate and allowed to cool down before serving and performing sensory evaluations.

2.4 SENSORY ANALYSIS OF FORMULATED KOSSAM

This was carried out by 32 untrained panelists aged 6 to 15 years randomly selected on voluntary basis (approval and consent of parents) in the city of Maroua where people are accustomed with the consumption of rice porridge and kossam. The assessment was done using the 9-point hedonic scale, as described by **[16].** The 4 formulas of each receipt were evaluated by each of the 32 panelists for colour, flavour, texture, taste and overall acceptability using the 9-point hedonic scale, 1 representing 'dislike extremely', 5 representing 'neither like nor dislike', and 9 representing 'like extremely'. The best formula of each receipt was picked after analysing the sensory analysis data, by dividing the sum of the score for taste, colour, flavour texture and overall acceptability by 5, to come up with a value

representing overall acceptability for each of the formulas, and then finding the mean score by summing each panelist's score and dividing by 32.

For each receipt, the formula with the highest mean score were considered most desirable, and were used for determination of iron and zinc intakes and iron and zinc coverage rates

Fig. 1. Rice porridge

Fig. 2. Rice porridge + baobab pulp

2.5 DETERMINATION OF IRON AND ZINC INTAKES

An average mass of food corresponding to the consumption of each child for each food is weighed. The water contents being provided by the literature; the mass of dry matter has been calculated.

The intake calculation formulas are as follows:

Iron intake = mass of dry matter x iron content

Zinc intake = mass of dry matter x zinc content

2.6 DETERMINATION OF IRON AND ZINC COVERAGE RATES

The values of the daily iron and zinc needs of children from 6 to 15 years old being provided by international standards **[17],** the percentage of the report of daily iron or zinc intakes of each food by daily needs give the coverage.

The formulas to calculate the coverage rates are as follows:

Iron coverage rate (%) = (daily iron intake / Iron daily needs) x 100.

Zinc coverage rate (%) = (daily zinc intake / daily zinc needs) x 100.

STATISTICAL ANALYSIS

The characteristics of the study population were compared by the student's t-test and the 2 tests. The variables of food intake, energy, energy density and protein intake had a normal distribution (Kolmogorov and Shapiro-Wilk test of normality was > 0.05) and the results were expressed as the mean and confidence interval 95% (CI 95%). To make comparisons, the Student's t-test was used for the gender variable. Analysis of variance (ANOVA) was used for comparisons among centers. The significance level used was 0.05 ($p < 0.05$). The data were analyzed using SPSS v.16.0 (2008, SPSS, Inc, Chicago, IL)

3 RESULTS AND DISCUSSION

3.1 TYPES OF FOODS CONSUMED BY CHILDREN, THEIR CONSUMPTION FREQUENCIES, IRON AND ZINC NUTRITIONAL INTAKE AND COVERAGE RATES

3.1.1 TYPES OF SAUCES CONSUMED

Table III presents the types of sauces consumed by children in the city of Maroua their textures, the scientific names of the ingredients that constitute them, local appellations, their average consumption frequencies and the quantities consumed

Table 3. Types of sauces consumed by children in the city of Maroua

N°	Types of sauces	Textures	Scientific names of basic ingredients	local Appellation	Average frequency of consumption / weeks	Average quantity per serving (g)
1	Okra fruit sauce	Sticky sauce	*Hibiscus esculentus*	*Bascodjè*	1-2	255.25 ± 1.83
2	Baobab leaf sauce	Slightly sticky sauce	*Adansonia digitata*	*Tasba*	1-2	262.12 ± 1.81
3	Guinea sorrel leaves and defatted peanuts sauce	Very thick sauce	*Hiiscuss abdarifa, Arachis hypogea*	*Folèrè*	1-2	271.18 ± 1.91
4	*Hibiscus articulatus* leaf sauce	Light sticky sauce	*Hibiscus articulatus, Vigna unguiculata*	*Lalo*	1-2	251.06 ± 1.89
5	White guinea sorrel flower sauce	Very thick sauce	*Hiiscuss abdarifa, Arachis hypogea*	*Basco*	1-2	254.76 ± 1.87
6	Boungou leaf sauce	slightly sticky sauce	*Ceratothecea sesamoides, Vigna unguiculata*	*Gouboudo*	1-2	263.22 ± 1.84
7	Black nightshade leaf sauce	Very thick sauce	*Solanum nigrum, Arachis hypogea*	*Guiliguandia*	1-2	269.05 ± 1.82
8	Corchorus leaf sauce	Light sticky sauce	*Corchorus fassicularis, vigna unguiculata*	*Boko*	1-2	268.25 ± 1.79
9	Celtis leaf sauce	Fluid and viscous sauce	*Celtis fassicularis*	*Woula-haala*	1-2	270.89± 1.85

Table III shows that nine types of sauces are consumed by children in the city of Maroua. These sauces have similar textures for some and different for others. They are consumed on average once or twice a week. This frequency of consumption can be due to the great diversity of available sauces and the daily variation of these sauces can be attributable to the concern for children's diversification. In a similar study, **[18]** also identified a diversity of sauces consumed in the Cameroon Far North region.

3.1.2 TYPES OF COUSCOUS CONSUMED

Table IV has the types of couscous consumed by children in the city of Maroua, their food forms, the scientific names of the ingredients that constitute them and their average frequencies of consumption.

Table 4. Types of couscous consumed by children in the city of Maroua

N°	Types of couscous	Food forms	Scientific names of basic ingredients	Average frequency of consumption / weeks	Average quantity per serving (g)
1	Rice couscous	ball	*Oryza sativa*	1-2	445.86 ± 3.90
2	White millet couscous	ball	*Digitaria exilis*	1-2	435.56 ± 3.88
3	Red millet couscous	ball	*Digitaria iburua*	1-2	412.7 ± 3.92
4	Yellow millet Couscous	ball	*Pennisetum glaucum*	1-2	415.05 ± 3.86
5	Maize Couscous	ball	*Zea mays*	1-2	458.02 ± 3.94

Table IV shows a diversity of couscous consumed by children in the town of Maroua. These are rice, white millet, red millet, yellow millet and corn couscous. These are prepared and served in the form of balls. This different couscous is consumed on average once or twice a week. This frequency of consumption may be due to the great diversity of couscous available and their daily variation may be attributable to the desire to diversify children's diets. In a similar study, **[18] also** identified a diversity of couscous consumed in the Far North region of Cameroon.

3.1.3 TYPES OF PORRIDGE CONSUMED

Table V presents the types of porridges consumed by children in the town of Maroua, their dietary forms, the scientific names of the ingredients and their average frequencies of consumption.

Table 5. Types of porridge consumed by children in the town of Maroua

N°	Types of porridges	Textures	Scientific names of ingredients	Average frequency of consumption / weeks	Average quantity per serving (g)
1	Porridge of rice	Thick Liquid	*Oryzasativa, Arachis hypogea, Citrus limon.*	2	389.7 ± 1.32
2	Porridge of white millet	Thick Liquid	*Digitaria exilis, Archis hypogea, Citrus limon*	2	387.3 ± 1.24
3	Porridge of red millet	Thick Liquid	*Digitaria iburua, Arachis hypogea, Citrus limon*	1	386.5 ± 1.25
4	Porridge of yellow millet	Thick Liquid	*Pennisetum glaucum, Arachis hypogea, Citrus limon*	2	388.2 ± 1.3
5	Porridge of corn	Thick Liquid	*Zeamays, Arachis hypogea, Citrus limon*	1	390.3 ± 1.28

Table V shows a diversity of porridges consumed by children in the town of Maroua. These are rice porridge, white millet, red millet, yellow millet and corn porridge. They contain various ingredients and are consumed at varying frequencies. Once a week on average for corn and red millet porridges and twice a week for rice, yellow millet and white millet porridges. The variation in porridge consumption may be due to the great diversity of porridges available and the desire to diversify children's diets. **[18]** also identified a diversity of porridges consumed in the Far North region of Cameroon.

3.2 DAILY INTAKES OF IRON AND ZINC

Table VI presents the daily intake of iron and zinc in the diet of children.

Table 6. Daily intake of iron and zinc in the diet of children

Foods	Quantities consumed in g of fresh matter	Water content (%)*	Dry matter (g)	Iron content (mg) /100g dry matter	Iron intake (mg)	Zinc content (mg) /100g dry matter	Zinc intake (mg)
Okra fruit sauce	255.5 ± 1.83	95.26 ± 1.03	12.11 ± 1.16	08.07 ± 1.37	0.97 ± 1.04	1.74 ± 1.01	0.21 ± 1.08
Baobab leaf sauce	262.12 ± 1.81	96.42 ± 1.05	10.17 ± 1.15	15.88 ± 1.4	1.61 ± 1.08	1.19 ± 1.11	0.12 ± 1.01
Guinea sorrel leaves and defatted peanuts sauce	271.18 ± 1.91	95.43± 1.03	12.39 ± 1.18	17.32 ± 1.38	2.14 ± 1.02	2.90 ± 1.14	0.35 ± 1.03
Hibiscus articulatus leaf sauce	251.06 ± 1.89	96.45 ± 1.06	8.91 ± 1.14	14.24 ± 1.35	1.26 ± 1.07	1.59 ± 1.15	0,14 ± 1.02
White guinea sorrel flower sauce	254.76 ± 1.87	96.23 ± 1.07	12.49 ± 1.23	9.34 ± 1.26	1.16 ± 1.01	5.55 ± 1.12	0.69 ± 1.01
Boungou leaf sauce	263.22 ± 1.84	96.47 ± 1.05	9.29 ± 1.12	15.76 ± 1.36	1.46 ± 1.05	4,39 ± 1.16	0.40 ± 1.06
Black nightshade leaf sauce	269.05 ± 1.82	96.46 ± 1.04	9.52 ± 1.21	12.55 ± 1.30	1.19 ± 1.03	1.70 ± 1.13	0,16 ± 1.04
Corchorus leaf sauce	268.5 ± 1.79	95.86 ± 1.03	11.12 ± 1.19	13.23 ± 1.34	1.47± 1.06	2.56 ± 1.05	0,28 ± 1.09
Celtis leaf sauce	270.89 ± 1.85	96.02 ± 1.02	10.79 ± 1.17	7.37 ± 1.32	0.80 ± 1.03	0.71± 1.14	0.076 ± 1.02
Average intake for sauces	**262.86 ± 1.84^{b}**	**96.06 ± 1.04^{a}**	**10.35± 1.17 ^{a}**	**12.64± 1.34^{a}**	**1.34± 1.04^{a}**	**2.48 ± 1.11^{a}**	**0.26 ± 1.19^{a}**
Rice Couscous	445.86 ± 3.90	11.19 ± 3.25	395.96 ± 3.90	0,66 ± 3.04	2.61± 3.12	0.26 ± 3.22	1,02± 3.09
White millet Couscous	435.56 ± 3.88	10.40 ± 3.16	390.26 ± 4.10	0.24 ± 3.07	0.93± 3.10	1.92 ± 3.15	3.59 ± 3.05
Red millet Couscous	412.17 ± 3.92	10.40 ± 3.23	369.30 ± 4.06	0.58 ± 3.04	2.14 ± 3.15	3.2 ± 3.26	3.72 ± 3.03
Yellow millet Couscous	415.05 ± 3.86	10.40 ± 3.15	371.88 ± 4.09	0.46 ± 3.03	1.71± 3.12	2.01± 3.25	3.49 ± 3.04
Maize Couscous	458.02 ± 3.94	08,37 ± 3.26	419.68 ± 4.08	0.45± 3.01	1.88 ± 3.14	0.99 ± 3.26	4.15 ± 3.06
Average intake for couscous	**433.33 ± 3.82^{ab}**	**10.15 ± 3.21 ^{a}**	**389.41± 4.04 ^{ab}**	**0.47 ± 3.05^{a}**	**1.85 ± 3.12 ^{a}**	**0.82 ± 3.22^{a}**	**3.19 ± 3.05^{a}**
Rice porridge	389.7 ± 1.32	96 ± 1.16	15.58 ± 1.64	1.31 ± 1.015	0.20 ± 1.01	0.87 ± 3.07	0.13 ± 1.03
White millet porridge	387.3 ± 1.24	97 ± 1.18	11.62 ± 1.72	1.35 ± 1.015	0,15 ± 1.01	1.83 ± 3.08	0.21 ± 1.02
Red millet porridge	386.5 ± 1.25	97 ± 1.2	11.59 ± 1.66	1.25 ± 1.02	0.14 ± 1.002	0.75 ± 3.07	0.08 ± 1.04
Yellow millet porridge	388.2 ± 1.3	97 ± 1.14	11.64 ± 1.7	1.47 ± 1.015	0.17 ± 1.003	1.20 ± 3.08	0.14 ± 1.01
Corn porridge	390.3 ± 1.28	95 ± 1.18	19.51 ± 1.68	1.29 ± 1.015	0.25 ± 1.01	1.07 ± 3.08	0.21 ± 1.06
Average intake for porridges	**388.4 ± 1.27 ^{ab}**	**96.4 ± 1.17^{c}**	**13.9 ± 1.53^{b}**	**1.3 ± 1.08^{a}**	**0.18 ± 1.007^{a}**	**1.14 ± 3.07^{a}**	**0.15 ± 1.03^{a}**
kossam	300 ± 1.005	96.63 ± 1.001	10.11 ± 1.003	0.076 ± 1.003	0.0076 ± 1.004	0.137 ± 1.16	0.013 ± 1.004
Total intake					3.37 ± 1.60^{a}		3.61 ± 1.57^{a}

Mean values ± standard deviation in the same column with different superscript letters are significantly different (P< 0.05).
**** [19].***

Table VI shows that sorrel leaf sauce with peanuts has the highest iron intake (2.14 mg). However, its zinc intake (0.35 mg) is low compared to boungou leaf sauce (0.40 mg) which has an iron intake (1.46 mg). Rice couscous has the highest intakes of iron (2.61 mg) and red millet couscous has the highest intakes of zinc (3.72 mg). Yellow millet couscous has lower but higher values than other types of couscous (1.71 mg) for iron and 3.49 mg) for zinc. Red millet porridge provides the lowest intake of iron (0.14 mg) and zinc (0.08 mg).

The average daily iron intake from sauces is 1.34 mg while the average daily zinc intake is 0.26 mg. We also observe that the average daily iron intake from couscous is 1.85 mg while the average daily zinc intake is 3.19 mg. The average daily intake of iron from porridge is 0.18 mg and that of zinc is 0.15 mg. The average daily intake of iron from *kossam* in the diet is 0.0076 mg and the average daily intake of zinc from *kossam* in the diet is 0.0138 mg.

The investigation revealed that several couscous dishes, sauces and various types of porridge are consumed by children in the town of Maroua. In a similar study on the nutritional study of food dishes and dairy products in the Far North region of Cameroon, **[20]** made a similar observation. The authors identified sauces and balls of millet, rice or sorghum which were used in their study.

3.3 DAILY IRON AND ZINC INTAKES COVERAGE RATES

Table VII presents the daily intake and coverage rate of the daily diet of children.

Table 7. Daily intake and coverage rate of the daily diet of children

	Daily iron intake (mg)	Recommended daily requirement (mg)*	Iron coverage rate (%)	Daily zinc intake (mg)	Recommended daily requirement (mg)*	Zinc coverage rate (%)
Daily diet	3.37	8	42.12	3.61	11	32.81

**Source: [21]*

Table VII shows that the daily dietary intake of children in the town of Maroua covers 42.12 % of the iron needs and 32.81% of the zinc needs. The daily iron intake is 3.37 mg for a recommended daily requirement of 8 mg, which gives a coverage rate of 42.12%. In a study, **[20]** observed a coverage of 37 % for iron and 32 % for zinc when formulating food supplements and assessing the coverage of the nutritional needs of children in southwest Cameroon. They made three complementary foods formulations. Maize, rice, soya beans and irish potatoes were the main food ingredients used in the preparation of children's food. The three formulas had more nutritional properties as compared to a control and contribute to upgrade the nutritional needs of children.

Table VIII presents the weekly intake of iron and zinc from formulations.

Table 8. Daily intake of iron and zinc (mg) from 300g of formulations

Formulations	Constituents	Weigth (g)	Iron intake (mg)	Zinc Intake (mg)
F550 (standard)	*kossam*	300	0.0076	0.0138
F530	Baobab fruit pulp	15	1.05	0.0096
	kossam	285	0.0072	0.0131
	Total	300	1.0572	0.0227
F510	Baobab fruit pulp	30	2.1	0.0192
	kossam	270	0.0068	0.0124
	Total	300	2.1068	0.0316

Table VIII presents the different constituents of the formulations. It also shows that daily consumption of 300 g of standard F550 provides 0.0076 mg of iron and 0.0138 mg of zinc. Daily consumption of 300 g of the F530 formulation provides 1.057 mg of iron and 0.0227 mg of zinc. Daily consumption of 300 g of the F510 formulation provides 2.1068 mg of iron and 0.0316 mg of zinc. The iron intake is higher in the F510 formulation (2.1068 mg) while the zinc intake is higher in the F510 formulation (0.0316 mg). In a formulation study of a complementary food based on voandzou, **[22]** showed that the formulation contributed to improve the nutritional quality of this food. In fact, the formulation contributes to increase the iron and zinc intake respectively from 0.013mg to 1.135 mg and 0.0019mg to 0.0245mg.

Table IX presents the iron and zinc coverage rates of *kossam* and the formulations.

Table 9. Iron and zinc coverage rates (%) of kossam and the formulations

Formulations	Daily iron intake (mg)	Daily iron Gap (mg)	Iron coverage rate (%)	Daily zinc intake (mg)	Daily zinc Gap (mg)	Zinc coverage rate (%)
F550 (standard)	0.0076	4.63	0.164	0.0138	7.39	0.18
F530	1.0572	4.63	22.83	0.0227	7.39	0.30
F510	2.1068	4.63	45.5	0.0316	7.39	0.42

Table IX shows that the daily gap to be covered in iron is 4.63 mg and 7.39 mg for zinc. Thus, the F550 formulation provides 0.076 mg, F530 provides 1.0572 mg and F510 provides 2.1068 mg. Which corresponds respectively to iron coverage rates of 0.164% (F550), 22.83% (F530) and 45.5% (F510). Furthermore, the F550 formulation provides 0.0138 mg of zinc, F530 provides 0.0227 mg and F510 provides 0.0316 mg which corresponds respectively to coverage rates of 0.18% (F550), 0.30% (F530) and 0.42% (F510) rate of coverage of iron and zinc. And F550 have the low rate of coverage of iron and zinc. In a study where many varieties of porridge were formulated for babies in Yaoundé, **[23].** The authors obtained an augmentation in iron 2.01 to 2.19 mg/100g and in zinc 1.59 to 2.27 mg/100g.

Table X presents the coverage rate to be completed with the pulp.

Table 10. Iron and zinc coverage rate (%) to be completed with the pulp

	Coverage rate in Iron (%)	Coverage rate in Zinc (%)
Diet + F530	64.95	33.11
Coverage rate to be achieved	100	100
Remains to be completed with the pulp of the baobab fruit	35.05	66.89

It appears from Table X that for a complete coverage of iron need a child feeded by current diet and F530 should eat the quantity of porridge bringing 35.05 %. That mind 2.71 mg of iron requirement.

The nutritive data on baobab fruit pulp from **[24]** made it possible to determine the quantity of baobab fruit pulp to add to the same quantity of porridge that children usually consume to be able to completely cover iron needs. We therefore calculated that 162.81 g of baobab fruit pulp are needed to cover the remaining 35.05% iron coverage rate. Likewise, it was possible to determine that 162.81 g of powder covered 33.84% of the daily zinc requirements. Therefore, the daily diet of children coupled with the consumption of 300g of the formulation F530 the most appreciate by the panelist during sensory analysis and formulated rice porridge makes it possible to cover the daily iron needs and 33.05% zinc requirements.

4 CONCLUSION

The formulation of *kossam* and rice porridge with baobab pulp powder helped to improve iron and zinc intake and then the entire iron coverage and 33.84% zinc rates of these two foods in the daily diet of children. Indeed, the enrichment of these two foods widely consumed by children in the city of Maroua – Cameroon makes it possible to cover their daily iron and partially zinc needs by consuming rice porridge and *kossam* formulation F530.

REFERENCES

[1] Minsanté, Cameroun-food and nutrition, 2011.
[2] SMART: Enquête nutritionnelle et de mortalité SMART dans quatre aires de sante des districts sanitaires de Goulfey, de Makary et Kousseri, Decembre 2020. Action contre la faim, 2013.
[3] MICS: Enquête par grappes à indicateurs multiples de 2014, cinquième génération de la MICS (Quatrième édition au Cameron.), 2014.
[4] GHI, «Evaluation rapide de la sécurité alimentaire à l'Extrême Nord du Cameroun». *African Journal of Clinical Nutrition.* vol.5.no.3.pp 14-19. 2015.
[5] EDS/MICS: Enquête démographique et de santé et a indicateurs multiples, (EDS-MICS) 2004.
[6] EDS/MICS: Enquête démographique et de santé et a indicateurs multiples, (EDS-MICS) 2011.
[7] SMART: Enquête nutritionnelle et de mortalité SMART dans quatre aires de sante des districts sanitaires de Goulfey, de Makary et Kousseri, Decembre 2020. Action contre la faim, 2015.
[8] MICS: Enquête par grappes à indicateurs multiples de 2014, cinquième génération de la MICS (Quatrième édition au Cameron.), 2014.
[9] U. Dama, D. Tchoffo, A. Onana, J. Abanda, M. Djeuta, A. Assobochia, P. Yoniene, « Prévalence de la malnutrition chez les enfants de moins de 5 ans dans le département du Mayo–Tsanaga et du Logone et Chari, Extrême –Nord, Cameroun». *panafrican–medecin journal*.vol.13, no.2, pp.2707–2797, 2024.
[10] Coulon and N. Rock, «Caractéristiques nutritionnelles des produits laitiers en variation selon leur origine». *inrae.france, vol.*29, no. 4, pp. 12 – 15, 2003.
[11] L. Maptouom, A. Tchuenchieu, B. Saha, Q. Metsatedem, F. Edoun, R. Feumba, G. Medoua, D. Njamen, E. Fokou, «Influence of différent traditionalpoductionpocesses on the antioxdantcapacity and vitamin C content of baobab (Adansoniadigitata) juice». *Afican journal of food sciences*. vol.14, no.3, pp.16-24, 2020.
[12] G. Block, « A review of validations of dietary assessment met hods». *Am J Epidemiol* vol. 115, no. 4, pp 492-505, 1982.
[13] M. Affonfere, E. Madode, J. Chadare, P. Azokpota, D. Hounhouigan, «A dual food-to-food fortification with moringa (*Moringaoleifera* Lam.) leaf powder and baobab (*Adansonia digitata* L.) fruit pulp increases micronutrients solubility in sorghum porridge».*Scientific african, Vol.*16, no.5, pp.361-369, 2022.
[14] A. Bankole, Communique de presse de la 1228 eme réunion du conseil de paix et de sécurité tenue le 19 Aout 2024. U n expose sur la situation au soudan. 2024 [Online] Available: http://www.peauceau.org.
[15] Mpopoa, L. Ngum, « Formulation of functional yoghurt by cofermentation of milk and papaya fruit». *American academic scientific research journal for engineering, technology and sciences. Vol.*9, no.4, pp. 867-888, 2020.

[16] Dzung, S. kaburi, F. Lamptey, G. serwaa, B. Nyame, « Effect of three different rates of application of cattle dung on the growth and quality of two traditional leafy vegetables (Amarathuserantus and corchorusolitoruis) » *journal of food technology*. Vol.9, no.4, pp. 176 – 193, 2022.

[17] AOAC: Official Methods of Analysis of the association analytical chemists, 19th edition, 2005.

[18] R. Ponka, «Etude nutritive des plats alimentaires et des produits laitiers dans la région l'Extrême-nord Cameroun» *hal. Sience,* 46p, 2013.

[19] H. Tourneux, « Préparation culinaire chez les peuls du Diamaré (Cameroun*). Ressources vivrières et choix alimentaires dans le bassin du lac Tchad»*.vol.7, no.3, pp.283-318, 2005.

[20] WHO: Report on health in the world, 2013.

[21] D. Harouna, Y. Vandi, and N. Caris, «Formulation and Evaluation of complementary foods for children from six to twenty-four months prepared from potential locally available foodstuffs in Tubah subdivision of Cameroun». *Food science nutrition technology*. vol.8, no.5, pp. 2574-2701, 2023.

[22] A. Fatime, C. Madou, D. Watching, L. Ngano. «Formulation d'un aliment de complément à base du voandzou «VignaSubteanea» (L) Vercourt (1980) pour relever la dénutrition dans l'extrême-Nord du Cameroun». *Journal of applied biosciences*. vol.12, no.3. pp.12319-12331, 2018.

[23] R. Ponka, Tchatchoua, E.L. Nankap, Tabot, S.Tambe and E. Fokou, «Composition nutritionnelle de quelques farines infantiles artisanales du Cameroun».*International Journal of Innovation and Applied Studies*. vol. 16, no.2, pp.280-292, 2016.

[24] Inecoba. Institute pour l'étude et la conservation du baobab, 2007. [Online] Available: http://www.*inecoba.fr.* 2007.