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STUDY ON THE NUTRITIONAL PROFILING OF COMPLEMENTARY FOODS MARKETED IN NIAMEY, NIGER

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ABSTRACT

Improving complementary feeding is one of the interventions implemented during the first 1,000 days of life to avoid the consequences of malnutrition in all its forms. In Niger, despite all our efforts, improvements in nutrition and food-related behavior are still limited. Inappropriate labelling practices and/or inadequate nutrient content of complementary foods for children under 2 years old could hamper the government's efforts to combat malnutrition. The aim of this study was to investigate the nutritional profiling of complementary foods for children aged 6-36 months marketed in Niger. It targeted all outlets and types of local and imported complementary foods for children aged 6-36 months. The European nutrient profile model developed by WHO in 2019 was used to assess the compliance of surveyed complementary foods with the model's requirements in terms of labeling practices and nutritional composition. At the end of the survey, 57 sale outlets were registered. After elimination of duplicates, 20 sale outlets corresponding to the 85 complementary foods were retained. The result shows that local complementary foods represent 18.82%, those from the sub-region 17.68%, those from Asia 8.25% and those from Europe 55.25%. The compliance rate with the nutritional profile model is 00% for local complementary foods, 3.55% for the sub-region, 00% for Asia and 8.25% for complementary foods from Europe. According to our results, the nutritional profile of marketed supplementary foods is a cause for concern. Improving these foods would promote the physical and mental well-being of children.

Keywords: children, nutritional profiling, complementary foods, marketing, Niger

INTRODUCTION

Africa's nutritional situation is currently marked by the triple-burden phenomenon of malnutrition (**PCNS, 2020**). On the one hand, deficiency malnutrition and hidden hunger, which have been present for years and are priority areas in the development of nutrition policies, and on the other, excess malnutrition, which is becoming increasingly prevalent in low- and middle-income countries (**WHO, 2020**). In West and Central Africa, the prevalence of acute malnutrition in children under 5 years old is 7.5% and 6.7% respectively, and the prevalence of stunting is 27.7% and 31.5%, respectively (**UNICEF/WHO/World Bank, 2020**). These figures testify to the unsatisfactory nutritional status of a large majority of African children, exposing them to severe short- and long-term consequences (**Black *et al*., 2008; De Souza *et al*., 2011; Bjelland *et al*., 2013**). The consequences of this state of malnutrition range from poor cognitive and motor development (**Bagget, 2013**) to an increased risk of child death (**WHO, 2013**).

In Niger, despite all efforts, improvements in nutrition and food-related behaviors are still limited. During the 2011 campaign, the latest national nutrition survey reveals that the proportion of children suffering from acute malnutrition is 12.3% and 51% suffer from chronic malnutrition (**INS, 2011**). According to epidemiological data from the SMART 2021 survey carried out by the National Institute of Statistics, the prevalence of global acute malnutrition (GAM) in children under 5 years old is 12.5%. This prevalence is above the high threshold (10%) according to the WHO classification. Moreover, it is virtually unchanged from the 2020 figure of 12.7%. It varies from one region to another, and is higher in the Diffa region with a prevalence of 16.1% than in Niamey, where it is 8.7% for GAM and 1.1% for the severe form (**INS, 2021**). Similarly, the analysis of the country's nutritional situation carried out by the Plateforme Nationale d'Information pour la Nutrition (PNIN) in Niger (2020) reveals that over 2 million children under five (5) years old are affected by stunting, half of women of childbearing age and around 2 out of 3 children are anemic (**INS, 2022**).

According to The Lancet (2008), maternal malnutrition, severe acute malnutrition, stunting and micronutrient deficiencies are responsible for over 21% of deaths in children under 5 years old in developing countries (**Robert et *al*., 2013**). The period from birth to 2 years old corresponds to a phase of rapid physiological change; environmental, hormonal or dietary disturbances during this phase lead to nutritional and health problems. Indeed, malnutrition most often occurs between 4 and 36 months old. It is therefore vital to circumvent the harmful effects of malnutrition by acting early and directing interventions during this period (**Schwarzenberg et *al*., 2018**). It is within this framework that the crucial period of the first 1000 days of life has been defined as a window of opportunity to prevent malnutrition in all its forms and its consequences in children (**Black *et al*., 2008**). Optimal infant and young child feeding practices are among the specific interventions implemented during this period to prevent malnutrition. These include exclusive breastfeeding for the first 6 months after birth and continued breastfeeding for up to 2 years or more, and adequate complementary feeding practices between 6 and 36 months (**WHO, 1981, 2013; AMS, 2002**). Improving complementary feeding is the most effective intervention to ensure optimal child growth (**Mangasaryan *et al.*, 2012**). Thus, **WHO** (**2003**) recommends "the use of fortified complementary foods, at low cost in certain circumstances, promoted in such a way as to protect breastfeeding and the consumption of diversified diets based on locally available foods". It is difficult to meet the very high nutritional requirements from of six months old onwards when breast milk contains insufficient levels of micronutrients, or when the infant's diet contains factors that prevent the absorption of nutrients. In addition, some industrialized complementary foods are of concern as they have high levels of added salt or sugar and/or industrially produced trans-fatty acids (**Chassaing *et al*., 2015; Zinöcker and Lindseth. 2018**). The manufacturing company must therefore ensure that complementary foods intended for children under 2 years old provide all the nutrients essential for the child's development and growth, and in quantities adequate to promote their physical and mental well-being (**OPS and WHO, 2003**). Nutrient profiling involves classifying or prioritizing complementary foods according to their nutritional composition, and can be used as a guide to restrict the promotion of unhealthy products, especially those aimed at children (**WHO, 2021**). Labels must contain all the necessary product information (**CFIA, 2011**). To this end, standards and recommendations relating to labeling practices or/and nutritional composition have been established by the *Codex Alimentarius* (**FAO/WHO, 1981, 1991, 2017, 2019**) or the **WHO** (**2019**) for the formulation of complementary foods suitable for children's needs. Sub-Saharan Africa has no specific standards for the manufacture of complementary foods sold on the market; these must be assessed against international standards to determine their suitability for infant and young child feeding. Inappropriate labeling practices and/or inadequate nutrient content of complementary foods for children under 2 years old can hamper governments' efforts to combat malnutrition (**WHO, 2019**).

The aim of this study is to assess the status of complementary foods for children aged 6-36 months marketed in Niamey, Niger, in relation to the Nutrient Profile Model (NPM).

MATERIAL AND METHODS

Site, duration and type of study

The study targeted complementary food outlets at the level of the different municipal districts of Niamey, Niger, over a period of 3 months. It was a mixed (quantitative and qualitative), cross-sectional study with descriptive and analytical aims.

Principle of the study methodology

The European Nutrient Profile Model (NPM) developed by WHO (**WHO, 2019**) was used to assess the compliance of complementary foods sold in Niamey outlets with the model's requirements in terms of labeling practices, nutritional composition and promotion of these foods.

Mapping of complementary foods

Creation of the reference database

The study targeted all types of local and imported complementary foods (CF) for children aged 6-36 months available at sales outlets in Niamey, Niger. Any product suitable for the feeding of toddlers and young children and meeting one of the following characteristics was considered a complementary food: recommended for introduction at an age below 3 years; labeled with the words *"baby", "infant", "toddler", "young child"* or synonym; has an image on the label of a child who appears to be under 3 years old or bottle-feeding; otherwise presented as suitable for children under 3 years old (**WHO 2016, 2019**). A database of these complementary foods has been compiled on the basis of scientific and grey literature. It was used to draw up a list that served as a reference for the inventory of complementary foods available at points of sale. Each CF on the reference list was given its own number.

Outlet sampling plan

A sample of 57 outlets including 42 small stores and 15 large stores were carried out in accordance with the WHO protocol on monitoring the marketing of breast-milk substitutes: protocol applicable to periodic assessments (**WHO/UNICEF, 2018**). Large stores include supermarkets and stores specializing in the sale of products for infants and young children. Small stores include mini-markets, pharmacies, petrol station stores, neighborhood stores and markets. The first step was to visit each study area and identify all the above-mentioned outlets. In order to respect the sample size, the supermarkets to be surveyed were selected on the basis of their reputation and the variety of products sold there. For small stores, a random draw was made after a census.

Nutritional profiling of complementary foods

The nutritional quality of complementary foods was determined on the basis of the nutritional composition indicated on the label, particularly for packaged foods. Parameter values *(energy, protein, carbohydrates, total sugars, added sugars, total fat, saturated fat, trans-fatty acids, salt, sodium, iron, zinc, calcium, iodine, vitamins A, C and B12*) per 100g of each product were characterized according the formula $N = \frac{Yx100}{X}$. The listed complementary foods were categorized according to the model nutritional profile of complementary foods for children aged 6-36 months for the European region (**WHO, 2019**).

Data collection

Data collection took place from 03 to 15 October, 2023. Two questionnaires, in electronic format, were drawn up for this purpose: one relating to points of sale and the complementary foods sold, and the other to the perception and preference of parents/guardians of toddlers and young children regarding the complementary foods available, in order to understand how the packaging of these foods influences their purchasing decision. The interviewers visited all the points of sale together. On average, four (4) points of sale were surveyed per day.
Information relating to the regulatory and legislative framework for complementary feeding was also provided. This involves describing the current and future actions envisaged by the government of Niger for the promotion of complementary feeding. Several interviews were held with administrative executives in the sector, notably at the National Directorate of Nutrition, Health Ministry, the NFN High Commission (Nigerien's feed Nigeriens), the Ministry of Trade and Industry, and the Nigerien Agency for Standardization, Metrology and Certification.The infant formula specification standard NN 01-010-002, drawn up by this institution, was purchased and analyzed.

Data collection method and steps

The largest of the targeted stores was surveyed in first. Data collection took place in three (3) phases:
Phase 1: Each type of complementary food present in the store and mentioned on the reference list was listed on the collection sheet. A photograph of the label of each of the products listed was taken during this phase, and the data on labeling practices was collected in laboratory.
Phase 2: Products present in the points of sale but not on the reference list were added.
Phase 3: Once all products had been inventoried, a comparison was made between the complementary foods available at the outlets visited and those on the reference list. Products on the reference list but not listed were excluded from the study.

Data processing and analysis

Data entry, processing and statistical analysis were carried out using Kobo Collect Tool Box software, Excel 2016 spreadsheet software (Microsoft Corporation Redmond USA) and STATA/SE 16.0 software (STATA Corporation, Texas, USA). The tables were generated by word 2016 software (Microsoft Corporation Redmond USA) and the map with google maps. Descriptive analysis was carried out to describe the characteristics of supplement foods in terms of labeling, promotions, composition and nutritional claims. Results are expressed as mean ± standard deviation or median plus 95% confidence interval [95% CI] and percentage.

Ethical considerations

The research protocol was approved by the national ethics committee. In addition, a set of ethical provisions was taken into account to ensure anonymity and data protection. The protocol complies with the 1975 Declaration of Helsinki, revised in 2008. Participation in the study was voluntary. The purpose of the study was explained to participants, and their informed consent was obtained.

RESULTS AND DISCUSSION

Results

Location of points of sales

The geolocation of the various outlets visited in Niamey and their positions are shown in Figure 1. The five (5) communal districts of the city visited were represented. The districts are scattered throughout the city area, from the city center to the outlying districts.

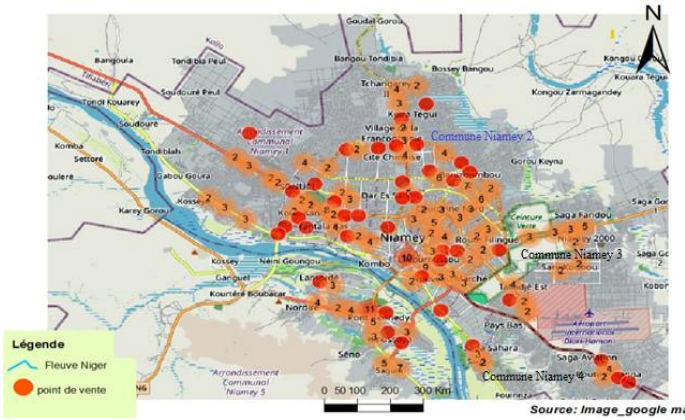

Figure 1 Map of outlets visited in the city of Niamey

Data on outlets surveyed and food supplements identified

Name, type of sale outlets surveyed and number of products surveyed by commune

Table 1 shows that of the 57 points of sale surveyed, minimarkets/service station stores/ neighborhood shops were the most represented (54.50%), followed by Supermarkets/hypermarkets (26.50%), then pharmacies (12.25%) and local markets (7%).

Table 1 Type and number of outlets visited, by municipal district (MD) of Niamey.

Outlets	MD-I	MD-II	MD-III	MD-IV	MD-V	Total
Markets	1.75(1)	1.75(1)	1.75(1)	-	1.75(1)	7.00(4)
Pharmacies	3.50(2)	3.50(2)	1.75(1)	1.75(1)	1.75(1)	12.25(7)
Minimarkets/Gas station shops	8.75(5)	12.27(7)	8.75(5)	12.25(7)	12.27(7)	54.50(31)
Supermarkets/ hypermarkets	5.25(3)	8.75(5)	7.00(4)	1.75(1)	3.50(2)	26.50(15)
Total	19.25(11)	26.25(15)	9.25(11)	5.75(9)	19.25(11)	100.00(57)

The number in brackets indicates the number of infant formulas. MD = Municipal District

After "splicing" the repeated foodstuffs, the number of points of sale fell from 57 to 20, of which 40% were supermarkets/gas station shops/neighborhood stores, 40% supermarkets/hypermarkets, 15% neighborhood markets and 5% pharmacies (Table 2).

Table 2 Type and number of outlets surveyed and retained after "splicing of repeated foods.

Outlets	outlets survey %	outlets after splicing of repeated foods %
Markets	7.02(4)	15 (3)
Pharmacies	12.28(7)	5 (1)
Minimarkets/Gas station shops	54.39(31)	40 (8)
Supermarkets / hypermarkets	26.31(15)	40 (8)
Total	100.00(57)	100.00(20)

The number in brackets indicates the number of outlets.

Data relating to complementary foods before repeated food and infant milks cleaning

At the end of the survey, 474 entries were recorded. Around 52% of entries came from minimarkets/gas stations and local stores, 34% from supermarkets, 7% from markets and 6.5% from pharmacies. The proportions of complementary foods recorded by communal district were 18.80% (MD-I), 24.0% (MD-II), 17.70% (MD-III), 21.70% (MD-IV) and 16.70% (MD-V) (Table 3).

Table 3 Proportion of complementary foods by type of outlets visited, by municipal district

Outlets	MD-I	MD-II	MD-III	MD-IV	MD-V	Total
Markets	3.35(16)	0.21(1)	0.21(1)	-	3.35(16)	7.15(34)
Pharmacies	1.50(7)	9.00	1.00(5)	1.00(5)	0.85(4)	6.50(30)
Minimarkets/Gas station shops	9.00(43)	9.70(46)	8.50(40)	16.25(77)	8.90(42)	52.50(248)
Supermarkets / hypermarkets	5.90(28)	12.20(5)	8.00(38)	4.40(21)	3.60(17)	34.10(162)
Total	18.80(94)	24.00(11)	17.70(84)	21.70(103)	16.70(7)	100.00(47)

Data relating to complementary foods after repeated food cleaning

During the course of the survey, 57 points of sale were visited, 103 foods were identified and 474 entries were made. After elimination of 18 foods not eligible as complementary foods (CF), 85 CF were retained, from 52 points of sale and corresponding to 274 entries. After elimination of points of sale repeated, 20 points of sale corresponding to the 85 CF were retained (Table 4).

Table 4 Raw data from the survey.

Operation	Products	Outlets	Entries	Repetition Rate
Raw data	103	57	474	4.60%
After elimination of 18 foods not eligible	85	52	274	3.22%
After elimination of repeats	85	20	85	1.00%

Proportion of products surveyed by municipal district after elimination of ineligible products.

The 274 entries were distributed as follows: 47% were from Minimarkets/gas station shops/neighborhood shops, 41% from Supermarkets/hypermarkets, 7% from markets and 5% from pharmacies (Table 5).

Table 5 Number of entries by type of outlet visited and by communal district after elimination of ineligible products.

Outlets	MD-I	MD-II	MD-III	MD-IV	MD-V	Total
Markets	9.00	0.35(1)	0.35(1)	-	3.30(9)	7.30(20)
Pharmacies	1.10(3)	1.10(3)	1.45(4)	0.35(1)	0.70(2)	4.75(13)
Minimarkets/Gas station shops	8.00(22)	8.75(24)	9.85(27)	13.50(37)	6.60(18)	46.70(128)
Supermarkets / hypermarkets	5.10(14)	14.60(40)	12.80(35)	4.00(11)	4.75(13)	41.25(113)
Total	17.50(48)	24.80(68)	24.45(67)	17.90(49)	15.30(42)	100.00(274)

The figure in brackets indicates the number of infant meals. MD = Municipal district.

Around 59% of CF were found in supermarkets/hypermarkets and 28.20% in minimarkets/ gas station shops/neighborhood stores, compared with 9.40% and 3.50% in markets and pharmacies respectively. The distribution by communal district is as follows: MD-I (16.50%), MD-II (23.35%), MD-III (48.20%), MD-IV (4.70%) and MD-V (8.20%) (Table 6).

Table 6 Number of food supplements identified by type of outlets visited, by communal district, after elimination of ineligible products.

Outlets	MD-I	MD-II	MD-III	MD-IV	MD-V	Total
Markets	4.70(4)	-	1.20(1)	-	3.50(3)	9.40(8)
Pharmacies	-	3.50(3)	-	-	-	3.50(3)
Minimarkets/Gas station shops	7.00(6)	7.00(6)	10.60(9)	-	3.50(3)	28.20(24)
Supermarkets / hypermarkets	4.70(4)	11.80(10)	36.50(31)	4.70(4)	1.20(1)	58.80(50)
Total	16.50(14)	23.35(19)	48.20(41)	4.70(4)	8.20(7)	100.00(85)

The number in brackets indicates the number of infant flours. MD= Municipal District; -: absent

Distribution of products by recommended age of use

Of the 36 brands of complementary foods identified, approximately 54% were proposed for use from 6 months, 2.35% from 8 months, 5.88% from 12 months and 2.35% beyond 12 months. For the remaining 25%, the age of introduction was not specified on the packaging. CF proposed for use from 4 months and beyond were encountered; they accounted for 8.24% (Table 7).

Table 7 Distribution of complementary foods by age of introduction.

Age of introduction	CF %(N)
4≥ months	8.24(7)
6≥ months	54.12(46)
8 months	2.35(2)
12 months	5.88(5)
> 12 months	2.35(2)
Not available	25.88(22)
Total	100.00(85)

The number in brackets indicates the number of infant flours. CF: Complementary Food

According to the NPM model, the complementary foods listed belong to 5 food categories and 8 sub-categories (Table 8). Sub-category 1.1 is the most represented (69%). Around 13% of complementary foods belong to category 2 represented by sub-category 2.2 (2.35%), sub-category 2.3 (7.00%), sub-category 2.6 (1.00%) and sub-category 2.7 (2.35%). Category 3 is represented by sub-category 3.2 (2.35%) and category 4 by sub-category 4.3 (8.23%). Sub-category 5.1 accounts for 7% of CF recorded, yet this sub-category would not be authorized for marketing.

Table 8 Distribution of complementary feeds (CF) by feed categories and sub-categories

Complementary Food Category	Complementary Food Sub-category	CF %(N)
1. Dry, powdered and instant cereals/starchy foods	1.1 Dry, powdered and instant cereals/starchy foods	69.50(59)
2. Soft or semi-pureed foods, ready-to-eat, generally smooth or semi-paste, packaged in small jars or sachets and can be eaten with a spoon.	2.2. Fruit paste with or without added vegetables, cereals or milk	2.35(2)
	2.3. Vegetable paste only	7.00(6)
	2.6. Pureed meal with meat or fish listed as first food in product name	1.17(1)
	2.7. Pureed meal with meat or fish but not listed first in product name	2.35(2)
3. Chunky meals sold in trays or jars for older infants and young children	3.2. Vegetable-based meals with large chunks	2.35(2)
4. Snacks and snacks	4.2. Other snacks and appetizers	8.25(7)
5. Juices and other beverages	5.1. Single or mixed fruit juices, vegetable juices or other drinks without formula	7.00(6)
Total		85.00

The number in brackets indicates the number of infant formulas

Nutritional composition of complementary foods by sub-category

Infant flours imported from Nigeria are local or artisanal brands, like those from Niger, and unlike other well-known international brands. All flours presented protein, carbohydrate and fat contents (Table 9). Flours from Belgium and Ghana did not report total sugar or saturated fat content. Some manufacturers indicated the presence of sugar in the ingredients list, but without specifying the quantities used. This is indicated in Table 9 by the sign (+). Other manufacturers made no mention of added sugars in their list of ingredients; this is indicated by the sign (-). The presence of trans-fatty acids (TFAs) was not reported on any of the labels. They are therefore considered "non-existent", and 100% of products comply with this requirement, which was not taken into account in the profiling model. The average contents of protein, carbohydrates, total sugars, fat and saturated fat are 3.21±0.59; 17.58±2.03; 5.95±2.30; 1.73±0.83 and 0.78±0.50 g/100 kcal, respectively.

Sodium levels were reported on all labels. Of the 31 flours surveyed, only one did not specify iron content, compared with 10 for zinc, 5 for calcium and 14 for iodine. As for vitamin content, 3 flours did not specify vitamin C, 7 flours vitamin A and 18 flours vitamin B12 (Table 10). The average contents of sodium (Na), iron (Fe), zinc (Zn), calcium (Ca) and iodine are 28.02±18.19; 1.84±0.35; 1.28±0.21; 111.76±40.55 and 13.55±4.94 mg/100 kcal respectively. The respective median values are 26.32; 1.86; 1.33; 110.08 and 13.93 mg/100 kcal. The respective mean contents of Vit C, Vit A and Vit B12 are 14.43±2.25µg/100 kcal, 135.72±69.27 µg/100 kcal and 0.27±0.06 µg/100 kcal, and the corresponding median values are 14.67 µg/100 kcal, 105.41 µg/100 kcal and 0.27 µg/100 kcal (Table 10).

Table 9 Biochemical composition, expressed in g/100 kcal, of imported subgroup 1.1 complementary foods other than those from Nigeria

Code	State	Total protein	Carbohydrates	Total sugars	Added sugars	Total fat	Saturated fat	Trans fatty acids *	Dried fruits %**
01101001030	Belgium	3.94	18.71		+	1.03		-	4
01101001031	Belgium	3.73	17.36		+	1.74		-	4
01101001033	Belgium	3.95	17.12		+	1.74		-	0
01101001092	Belgium	3.73	17.36		+	1.74		-	0
02101003107	France	3.38	14.92	6.99	-	2.80	0.28	-	0
02101001010	France	2.15	21.79	0.72	-	0.31	0.09	-	0
01101003019	France	2.00	21.30	6.43	+	0.57	0.20	-	0
01101003020	France	4.00	18.35	7.71	+	1.01	0.44	-	0
01101003021	France	3.70	18.57	7.95	+	1.01	0.44	-	4
01101002022	France	4.50	17.72	8.96	+	1.06	0.50	-	0
02101002023	France	1.87	21.44	6.52	+	0.57	0.20	-	0
02101001068	France	3.01	15.93	7.38	+	2.55	1.33	-	5
02101001075	France	3.05	16.44	7.77	+	2.30	1.16	-	6
02101001076	France	3.36	16.12	6.76	+	2.31	1.16	-	0
02101003077	France	3.44	14.78	5.95	-	2.66	1.08	-	5
02101001078	France	2.99	15.86	7.43	+	2.57	1.33	-	1
02101001079	France	3.10	15.63	7.04	+	2.67	1.39	-	0
01101003081	France	3.33	18.32	6.89	+	1.35	0.68	-	0
01101001082	France	3.09	19.75	1.38	-	0.67	0.25	-	3
01101001083	France	3.15	16.32	7.55	+	2.31	1.17	-	10
01101001084	France	2.81	20.32	1.12	+	0.64	0.22	-	0
01101001085	France	3.14	20.25	1.68	+	0.64	0.22	-	0
02101003132	Ghana	3.59	16.05		-	2.39		-	0
01101003044	Ghana	3.55	16.11		+	2.37		-	0
01101003045	Ghana	3.59	16.05		+	2.39		-	0
01101001111	Serbia	3.22	15.84	5.69	+	2.48	1.34	-	0
01101001115	Serbia	2.93	16.38	5.87	+	2.44	1.37	-	0
01101001116	Serbia	2.96	16.17	6.47	+	2.53	1.37	-	13
01101001117	Serbia	2.40	18.03	5.77	+	1.80	0.79	-	0
01101001118	Serbia	2.60	20.31	6.51	+	0.55	0.31	-	3
01101001119	Serbia	3.26	15.76	6.25	+	2.42	1.33	-	12
Mean		3.21	17.58	5.95		1.73	0.78		

SD		0.59	2.03	2.30		0.83	0.50
Median		3.22	17.12	6.51		1.80	0.73

The + indicates the presence of sugar among the ingredients but the quantities have not been specified. *No information indicates the presence of trans-fatty acids. ** Fruits are expressed in g per 100g of CF.

Table 10 Mineral and vitamin composition, expressed per 100 kcal, of imported subgroup 1.1 complementary foods other than those from Nigeria.

Code	State	Na (mg)	Na* (mg/100g)	Fe (mg)	Zn (mg)	Ca (mg)	Iodine (mg)	Vit C (µg)	Vit A (µg)	Vit B12 (µg)
01101001030	Belgium	48.97	190.00	1.42	1.42	180.41	14.18	16.75	139.18	0.28
01101001031	Belgium	47.51	191.00	1.37	1.37	164.68	13.68	16.17	134.33	0.27
01101001033	Belgium	50.87	205.00	1.36	1.36	173.70	13.65	16.13	134.00	0.27
01101001092	Belgium	46.77	188.00	1.37	1.37	179.10	13.68	16.17	134.33	0.27
02101003107	France	27.97	120.00	2.33	0.82	104.90	17.02	17.48	93.24	
02101001010	France	2.59	10.10	2.05	1.81	4.49		19.85		
01101003019	France	0.90	3.60	2.00				17.71		
01101003020	France	28.50	116.00	1.87		111.20		14.74	98.67	
01101003021	France	25.46	103.10	1.93		133.58		14.79	98.67	
01101002022	France	39.60	160.00	1.86		118.56		14.60	98.27	
02101002023	France	0.47	1.90	1.94				17.41		
02101001068	France	31.49	137.00	1.47	1.33	110.80	17.70	11.72	94.71	
02101001075	France	22.56	97.00	1.51	1.40	135.12	17.91	11.86	100.00	
02101001076	France	23.52	103.00	1.74	1.42	109.59	17.58	12.10	97.72	
02101003077	France	26.35	112.00	1.79		123.53		13.41	92.24	
02101001078	France	25.06	109.00	1.47	1.31	110.34	17.70	11.72	94.94	
02101001079	France	25.51	112.00	1.50	1.37	115.26	18.68	11.85	98.63	
01101003081	France	27.04	107.90	1.83		109.82		15.09	99.10	
01101001082	France	2.22	9.00	2.47						
01101001083	France	22.14	95.00	1.49	1.40	124.24	17.72	11.66	99.30	
01101001084	France	1.25	5.10	2.05						
01101001085	France	4.44	18.00	2.07						
02101003132	Ghana	43.06	180.00	2.39	1.08	105.26	4.78	15.55	311.00	0.26
01101003044	Ghana	26.07	110.00	1.78	1.30	106.64	4.74	15.40	308.06	0.24
01101003045	Ghana	26.32	110.00	1.79	1.08	105.26	4.78	15.55	311.00	0.26
01101001111	Serbia	54.46	220.00	1.88	1.19	95.54		12.38	130.20	0.32
01101001115	Serbia	55.75	228.00	1.86	1.25	95.60		12.47	133.01	0.34
01101001116	Serbia	56.06	208.00	1.86	1.16	9.43		13.21	134.23	0.35
01101001117	Serbia	18.27	76.00	1.97	0.94	98.80	11.37	12.74	110.82	0.14
01101001118	Serbia	3.13	12.00	2.86	1.46	84.90	11.64	12.76	111.72	0.16
01101001119	Serbia	54.35	200.00	1.82	1.11	95.11		12.77		0.33
Mean		28.02		1.84	1.28	111.76	13.55	14.43	135.72	0.27
SD		18.19		0.35	0.21	40.55	4.94	2.25	69.27	0.06
Median		26.32		1.86	1.33	110.08	13.93	14.67	105.41	0.27

Table 11 shows the biochemical composition of local infant flours and those from neighboring Nigeria, expressed in g/100 kcal. Of the 16 local infant flours, only 3 (19%) carry information on both protein, carbohydrate, total sugar and fat content and one (1) infant flour carries information on the protein, carbohydrate and fat contents. The remaining 12 flours gave no indication of their nutrient composition. Of the 12 flours imported from Nigeria, 3 showed protein, carbohydrate and fat contents, 3 flours showed protein and fat contents, and 6 others had labels devoid of any information on their nutrient and sodium biochemical composition. No flour reported saturated fat content. The mean contents of protein, carbohydrates, total sugars and fat are 2.21±1.66; 18.47±4.57; 3.18±0.76 and 1.66±1.19 g/100 kcal respectively. The respective median values are 3.25; 16.36; 3.28 and 2.32 g/100 kcal.

Table 11 Biochemical composition expressed in g/100 kcal of complementary foods of subgroup 1.1 local or from Nigeria.

Code	Pays	Total protein	Carbohydrates	Total sugars	Added sugars	Total fat	Saturated fat	Trans fatty acids	Dried Fruits
01101001125	Niger	3.62	19.37		-	2.22		-	0
01101003129	Niger				+			-	0
01101003130	Niger				+			-	0
01101003002	Niger				-			-	0
01101003064	Niger	3.70	15.26	2.38	+	2.47		-	0
02101003035	Niger				-			-	0
02101001037	Niger	3.75	14.57	3.28	-	2.76		-	0
02101005043	Niger				-			-	0
02101005053	Niger	3.32	16.36	3.90	+	2.42		-	0
01101001063	Niger				+			-	0
02101005006	Niger				-			-	0
01101003072	Niger				-			-	0
01101003086	Niger				-			-	0
01101003090	Niger				-			-	0
01101001091	Niger				-			-	0
01101003093	Niger				+			-	0
01101001100	Nigeria	3.25	14.35		-	2.74		-	0
02101001042	Nigeria				-			-	0
02101001109	Nigeria	0.11			+	0.11		-	0
01101001052	Nigeria				-			-	0
01101002036	Nigeria	0.11	24.70		-	0.11		-	0
02101002070	Nigeria				-			-	0
01101003071	Nigeria				-			-	0

01101002024	Nigeria				-			-	0
01101001087	Nigeria	0.91			+	0.91		-	0
01101002088	Nigeria	3.25			-	2.74		-	0
01101002089	Nigeria	0.11	24.70		-	0.11		-	0
02101002097	Nigeria				-			-	0
Mean		2.21	18.47	3.18		1.66			
SD		1.66	4.57	0.76		1.19			
Median		3.25	16.36	3.28		2.32			

The + indicates the presence of sugar among the ingredients but the quantities have not been specified. *No information indicates the presence of trans-fatty acids. ** Fruits are expressed in g per 100g of CF.

Table 12 shows the mineral and vitamin contents per 100 kcal of local and imported infant flours from Nigeria. Of the 16 local flours in Table 12, only 3 flours include mineral and vitamin contents. Only one flour has an exhaustive composition. None of the 12 flours imported from Nigeria has a complete mineral or vitamin composition and 6 flours have no indication of their composition. Average compositions and median contents are shown in Table 12, although it would be difficult to assign any meaning to these parameters at this level.

Table 12 Mineral and vitamin contents per 100 kcal of subgroup 1.1 supplementary foods local or imported from Nigeria.

Code	State	Na (mg)	Na* (mg/100g)	Fer (mg)	Zinc (mg)	Ca (mg)	Iodine (mg)	Vit C (µg)	Vit A (µg)	Vit B12 (µg)
01101003064	Niger	72.86	276.00	4.86	1.45	79.91		12.59	82.91	
02101001037	Niger	73.63	292.00	4.60	1.40	81.82		12.03	80.12	
02101005053	Niger	74.52	286.90	4.60	1.58	80.78	24.42	14.55	102.60	0.18
01101001100	Nigeria	31.31	74.20			90.51			394.09	
02101001109	Nigeria	112.68	400.00							
01101002036	Nigeria	112.68	400.00						5.63	
01101001087	Nigeria	14.29	55.00			51.35			264.00	
01101002088	Nigeria	31.31	74.20			90.51			394.09	
01101002089	Nigeria	112.68	400.00							
Mean		70.66		4.69	1.48	79.15		13.05	189.06	
SD		38.08		0.15	0.09	14.43		1.32	160.18	
Median		73.63		4.60	1.45	81.30		12.59	102.60	

Nutritional profile of sub-category 1.1 complementary foods

The nutritional profile of infant foods other than cereal flours is summarized in Tables 9, 11 and 12. Vitamin and mineral contents are very patchy or non-existent. Protein, carbohydrate, total sugar and fat contents are expressed in g/100 kcal of CF. Sodium content is expressed both in mg/100 kcal and in mg/100g of CF. None of the products mentioned trans-fatty acids on their packaging. Some manufacturers declared sugar as an ingredient, but the quantities added were not specified.

Nutritional profile of complementary foods in sub-category 2.2: Fruit puree with or without added vegetables, cereals or milk

The two foods encountered have average protein, carbohydrate, total sugar and fat contents respectively to 1.97±2.08; 19.09±2.69; 8.66±8.71 and 0.46±0.22 g/100 kcal. The respective median values were 1.97; 19.09; 8.66 and 0.46 g/100 kcal. Only one food had a sodium content of 59.38 mg/100 kcal or 19.00 mg/100 g of CF (Table 13).

Nutritional profile of supplementary foods in sub-category 2.3: Vegetable puree only

Six foods (6) were identified in this sub-category. The mean contents of protein, carbohydrates, total sugars and fat are 2.89±0.57; 15.89±2.65; 7.69±6.63 and 1.34±1.64 g/100 kcal respectively. The respective median values are 2.80; 16.80; 3.13 and 0.40 g/100 kcal. The mean sodium content was 58.12±45.82 mg/100 kcal, with a median value of 59.38 mg/100 kcal (Table 13).

Nutritional profile of complementary foods in sub-category 2.6: Pureed meals with meat or fish listed as the first food in the product name

Only one food was listed in this sub-category. The respective contents of protein, carbohydrates, total sugars and fat are 4.89. 10.11. 0.64 and 4.15 g/100 kcal, and the sodium content is 106.38 mg/100 kcal (Table 13).

Nutritional profile of complementary foods in sub-category 2.7: Pureed meals with meat or fish but not as the first food in the product name

Two foods (2) were identified in this sub-category. The average contents of protein, carbohydrates, total sugars and fat are 4.18±0.25; 12.46±0.06; 3.86±0.90 and 2.95±0.07g/100 kcal respectively. The respective median values are 4.18; 12.46; 3.86 and 2.95. The mean sodium content is 48.63±23.15mg/100 kcal and the median value is 48.63 mg/100 kcal (Table 13).

Nutritional profile of complementary foods in sub-category 3.2: Vegetable-based meals with chunks

Two (2) foods were identified in this sub-category. The mean contents of protein, carbohydrates, total sugars and fat are 4.29±0.41; 12.04±0.16; 2.85±0.97 and 3.30±0.10g/100 kcal respectively.

The respective median values are 4.29; 12.04; 2.85 and 3.30. The mean sodium content is 76.90±56.53 mg/100 kcal and the median value is 76.90mg/100 kcal (Table 13).

Nutritional profile of complementary foods in sub-category 4.3: Other snacks and appetizers

Seven (7) foods were identified in this sub-category. The average contents of protein, carbohydrates, total sugars and fat are 1.48±0.78; 16.74±1.68; 6.06±0.58 and 2.97±0.74 g/100 kcal respectively. The respective median values are 1.61; 16.90; 6.06 and 2.88 g/100 kcal. The mean sodium content is 47.32±33.15 mg/100 kcal and the median value is 53.85 mg/100 kcal (Table 13).

Nutritional profile of complementary foods in sub-category 5.1: Single or mixed fruit juices, vegetable juices or other drinks without formula.

Six (6) foods were identified in this sub-category. The average contents of protein, carbohydrates, total sugars and fat are 0.74±0.21; 21.07±1.54; 16.56±2.13 and 0.89±0.11 g/100 kcal respectively. The respective median values are 0.65, 20.19, 15.58 and 0.88 g/100 kcal (Table 13).

Table 13 Biochemical composition expressed in g/100 kcal of listed complementary foods other than those in category 1

Code	Country of manufacture	Total protein	Carbohydrates	Total sugars	Added sugars	Total fat	Saturated fat	Trans fatty acids	Na (mg)	Na* (mg/100g)
2.2. Fruit puree with or without added vegetables. cereals or milk										
01101001105	France	3.44	17.19	2.50	-	0.31	0.05	-	59.38	19.00
0110100110	Serbia	0.49	20.99	14.81	-	0.62	0.00	-		
Mean		1.97	19.09	8.66		0.46	0.03		59.38	19.0
SD		2.08	2.69	8.71		0.22	0.04			
Median		1.97	19.09	8.66		0.46	0.03		59.38	19.00

2.3. Vegetable puree only										
01101001098	Spain	2.71	11.53	3.05	-	4.07	0.68	-	6.78	4.00
01101001102	France	3.44	17.19	2.50	-	0.31	0.05	-	59.38	19.00
01101001103	France	3.44	18.44	3.13	-	0.22	0.11	-	18.13	5.80
01101001104	France				-			-		
01101001106	France	2.07	15.52	13.79	-	1.72	0.34	-	110.34	32.00
01101001073	France	2.80	16.80	16.00	-	0.40	0.00	-	96.00	24.00
Mean		2.89	15.89	7.69		1.34	0.24		58.12	16.96
SD		0.57	2.65	6.63		1.64	0.28		45.82	11.96
Median		2.80	16.80	3.13		0.40	0.11		59.38	19.00
2.6. Pureed meal with meat or fish listed as first food in product name										
0110100112	Serbia	4.89	10.11	0.64	-	4.15	1.28	-	106.38	100.00
2.7. Mashed meal with meat or fish. but not listed as the first food in the product name										
01101001124	Serbia	4.00	12.50	4.50	-	3.00	0.38	-	65.00	52.00
01101001080	France	4.35	12.42	3.23	-	2.90	0.81	-	32.26	20.00
Mean		4.18	12.46	3.86		2.95	0.59		48.63	36.00
SD		0.25	0.06	0.90		0.07	0.31		23.15	22.63
Median		4.18	12.46	3.86		2.95	0.59		48.63	36.00
3.2. Vegetable-based meals with large chunks										
01101001101	France	4.00	12.15	3.54	-	3.23	0.77	-	36.92	24.00
01101001074	France	4.58	11.93	2.17	-	3.37	1.08	-	116.87	97.00
Mean		4.29	12.04	2.85		3.30	0.93		76.90	60.50
SD		0.41	0.16	0.97		0.10	0.22		56.53	51.62
Median		4.29	12.04	2.85		3.30	0.93		76.90	60.50
4.3. Other snacks and appetizers										
02101003001	India				+			-		
02101003126	India	1.61	18.24	6.47	+	2.08	0.88	-	80.32	355.00
02101003127	India	0.21	16.89		+	3.53		-	54.76	236.00
02101003099	India	1.63	16.90	5.65	+	2.88		-	52.95	240.90
02101001004	Iran	2.37	13.92		+	3.87		-	1.28	5.93
02101001003	Turkey	1.60	17.73		+	2.47		-		
02101003061	Turkey				+			-		
Mean		1.48	16.74	6.06		2.97	0.88		47.32	209.46
SD		0.78	1.68	0.58		0.74			33.15	146.40
Median		1.61	16.90	6.06		2.88	0.88		53.85	238.45
5.1. Single or mixed fruit juices, vegetable juices or other drinks without formula										
01101001112	Serbia	1.13	22.64	18.87	-	0.94	0.00	-	22.64	12.00
01101001113	Serbia	0.83	20.00	16.17	-	0.83	0.00	-		
01101001114	Serbia	0.67	20.00	14.83	-	0.83	0.00	-		
01101001120	Serbia	0.62	20.00	14.92	-	0.77	0.00	-		
01101001122	Serbia	064	23.40	19.57	-	1.06	0.00	-		
01101001123	Serbia	0.56	20.37	15.00	-	0.93	0.00	-		
Mean		0.74	21.07	16.56		0.89	0.00		22.64	12.00
SD		0.21	1.54	2.13		0.11	0.00			
Median		0.65	20.19	15.58		0.88	0.00		22.64	12.00

The + indicates the presence of sugar among the ingredients, but the quantities have not been specified. *No information indicates the presence of trans-fatty acids. -: absent

DISCUSSION

The quality of children's diets is more important before 2 years old than at any other time in life. Appropriate complementary foods and feeding practices contribute to children's survival, growth and development.

They can also prevent micronutrient deficiencies, morbidity and obesity later in life (**UNICEF, 2020**). The results of this study showed that, in general, all imported flours had protein (< 5.5 g/100 kcal) and fat (≤ 4.5 g/ 100 kcals) contents below the specification thresholds of the NPM model. The compliance rate for these 2 requirements is 100%. In contrast to the local flours composed of the 16 products listed, only 4 supplementary feeds complied with the NPM standard. These results are in line with those of studies conducted on premixed and packaged complementary foods for sale in low- and middle-income countries: lack of standards threatens infant growth (**Master *et al*. 2017**). All 7 complementary foods in category 4 and those from Belgium and Serbia have a compliance rate of 00% against added sugar according to the NPM model; however, 77.78% (14/18) of products from France and 66.67% (2/3) from Ghana are non-compliant against this requirement. Only 5 products comply with the 6 NPM threshold values, giving an overall compliance rate of 12.90%. No product from Belgium or Serbia met the 6 conditions, compared with 22% and 33% for France and Ghana respectively. This requirement is in line with the standard for processed cereal-based foods intended for human consumption *codex alimentarius* (**CA, 2019**).

None of the products mentioned trans-fatty acids on their packaging. They are therefore considered "non-existent" and 100% of the products complied with this NPM requirement.

On the other hand, the presence of sugar among the ingredients was very often reported. According to this criterion, all flours from Belgium, Serbia and Ghana, plus 14 flours from France, listed sugar as an ingredient, and are therefore non-compliant with the NPM model. However, the quantities of added sugars were not specified on labeling. Foods and beverages rich in added sugars are generally less interesting from a nutritional point of view than those which naturally contain sugar; for sugar can contribute to excessive energy intake and also cause dental caries in children. Consumption of sugary foods also contributes to a preference for these foods, with the potential to define lifelong taste preferences for sugar (**UNICEF, 2020**).

The words "no sugar added, sweetened with (name of sweetening agent)" are no longer permitted on the labels of foods containing added sugars, ingredients with added sugars or ingredients containing sugars with sweetening power.

With regard to sodium content, we noted high levels in sub-categories 2.2, 2.3, 2.6, and 3.2, with an average content of 59.38; 58.12±45.82; 106.38 and 76.90±56.53 respectively. These results do not comply with the NPM requirement.

A diet lacking in variety and/or micronutrients, particularly Fe, Zn, vitamin A, iodine and essential fatty acids is not of good nutritional quality. Lack of dietary diversity and poor-quality complementary foods have been shown to have a short- and long-term negative impact on children's nutritional status and growth (**Dewey and Adu-Afarwuah, 2008; Onyango *et al*., 2014**).

Some imported or local supplementary foods do not at all contain the micronutrients (vitamins, iron, zinc, iodine) that contribute to a child's cognitive development. Micronutrient-rich foods help promote psychomotor and cognitive growth in infants and young children, particularly those vulnerable to malnutrition (**Michaelsen *et al*., 2011; Iannotti, 2018; Eaton *et al*., 2019**).

To avoid micronutrient gaps, it is therefore important to fortify the child's diet with rich and varied complementary foods that meet international standards for the production and marketing of complementary foods.

CONCLUSION

In general, all imported flours had protein (< 5.5 g/100 kcal) and fat (≤ 4.5 g/ 100 kcals) contents in line with the NPM model. All flours from Belgium, Serbia and Ghana plus 14 flours from France indicated the presence of sugar among the

ingredients. In fact, 5 imported food supplements had sodium contents in excess of 50 mg/100 kcals, and two (2) CF had fruit contents in excess of 10%. Of the 85 CF, 16 are local including 12 CF that provided no information on their nutritional composition. Three (3) local CF contained sodium levels above the NPM model threshold of 50 mg/100 kcal. The majority of CF on the market have a worrying nutritional profile. Improving these foods would help promote the physical and mental well-being of children.

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