Scientific Research Publishing

Food and Nutrition Sciences, 2025, 16(3), 269-282
https://www.scirp.org/journal/fns
ISSN Online: 2157-9458
ISSN Print: 2157-944X

Physico-Chemical Characteristics of Some Infant Ffours Produced in the City of Bongor/Province of Mayo-Kebbi East/Chad

Makalao Mouti Marceline[1*], Ndad Nouba[1], Brahim Boye Otchom[2], Alfred S. Traore[3]

[1]Faculty of Life and Earth Sciences, Higher Normal School of Bongor, Bangor, Chad
[2]Toumaï Institute, N'Djamena, Chad
[3]Faculty of Life and Earth Sciences, New Dawn University, Bobbo Dioulasso, Burkina Faso
Email: *moutimarceline@yahoo.fr

How to cite this paper: Marceline, M.M., Nouba, N., Otchom, B.B. and Traore, A.S. (2025) Physico-Chemical Characteristics of Some Infant Ffours Produced in the City of Bongor/Province of Mayo-Kebbi East/Chad. *Food and Nutrition Sciences*, **16**, 269-282.
https://doi.org/10.4236/fns.2025.163015

Received: January 26, 2025
Accepted: March 9, 2025
Published: March 12, 2025

Abstract

The study aimed to produce complementary infant flour with local ingredients available in the town of Bongor for children aged 6 to 24 months. The study took place at the Department of Life and Earth Sciences, nutrition option in Bongor, Chad from December 2022 to June 2023. The formulated flours are called SHAB (70% Sorghum + 13% Bean + 16% Peanut + 1% Baobab), SHAM (70% Sorghum + 13% Bean + 16% Peanut + 1% *Moringa oleifera*) and SHAP (63% Sorghum + 20% Bean + 16% Peanut + 1% Potato). Physicochemical analyzes and sensory evaluations were carried out. The dry matter and protein contents were determined according to AOAC standards and the lipid content according to IUPAC standards. The total sugar content was determined by the spectrophotometric method. The calcium, zinc, iron and magnesium contents were determined by atomic absorption. Vitamin C was determined by titrimetry. The flours made are called SHAB (Sorghum + Bean + Peanut + Baobab), SHAM (Sorghum + Bean + Peanut + *Moringa oleifera*) and SHAP (Sorghum + Bean + Peanut + Potato). The study of the nutritional value gives for SHAB levels of 12.89% proteins, 18.22% lipids and 65.5% carbohydrates with an energy value of 477.54 kcal/100g; for SHAM rates of 13.12% proteins, 18.2% lipids and 65.35% carbohydrates with an energy value of 479.83 kcal/100g. Regarding SHAP flour, the levels are 14.03% proteins, 17.89% lipids and 64.77% carbohydrates, with an energy value of 478.43 kcal/100g. Comparison with standard flour shows that our flours per 100 g have satisfactory contents and conform to the standards set in proteins, lipids, ash, dry matter, iron, magnesium, vitamin C, energy contents, total sugars, zinc and calcium. All these results show that these porridges could be made available to local populations.

Keywords

Infant Flour, Complementary Food, Local Ingredients from Bongor, Child Aged 6 to 24 Months, Malnutrition

1. Introduction

Malnutrition and micronutrient deficiencies, according to Kamdar [1], are very present in many developing countries [2]. This childhood malnutrition is characterized by an imbalance in protein, lipid, energy and micronutrient intake. Inadequate nutrition is a public health problem. Studies have shown that in children aged 6 to 24 months, when nutritional needs exceed what they can obtain from breast milk or traditional family meals, nutritional deficiencies are severe [3]. In Africa, many scientific studies aimed at the implementation of fortified infant flours have been carried out in order to facilitate access to certain nutrients [4] [5]. In the context of sahelian countries, access in sufficient quantities and at a reasonable price for certain food groups such as fruits and vegetables and products of animal origin, crucial to ensure adequate intakes of essential nutrients is weak, particularly in the driest rural areas. Generally speaking, it is clear that children living in rural areas are more at risk than children living in urban areas [6].

In Chad, industrial complementary foods for children sold in markets and large stores are inaccessible to a large part of the population, due to very high prices (Vitafort 750FCFA) [7]. Generally speaking, our dear country Chad is faced with issues of food insecurity. A precarious situation, such as poor access to health care for populations as well as certain inappropriate practices regarding infant and young child feeding, adds to the issue of food insecurity [8].

These malnutrition factors contribute to the deterioration of the nutritional situation of vulnerable groups (children aged zero to two years) [8]. It is becoming a crucial problem in Chad. According to MICS 2000, the underweight rate increases from 28 to 30%, chronic malnutrition 28 to 39% and acute malnutrition from 14.6 to 16%. In 2021, growth retardation (chronic malnutrition) affects 30.4% of children aged 6 to 59 months. Wasting (acute malnutrition) affects 10.9% and 12% of children are underweight (severe malnutrition) [9].

The province of Mayo-Kebbi Est, like the other provinces of Chad, is not spared from the issue of the nutritional crisis. A SMART nutritional survey from September 2017 indicated that the prevalence of acute malnutrition has deteriorated nationally with an emergency threshold of 2% for severe acute malnutrition. The result is that this province has reached a threshold of around 3%, which proves a food deficiency [8]. Access to nutrients in the provincial markets remains difficult for a majority of the population due to scarcity or price (such as infant flour or nutritional paws) [10]. For the entire province of Mayo-Kébbi Est, a single infant flour called Manisa was set up by a project, its access remains precarious to all levels of society and yet the need is felt everywhere [1].

In view of the overwhelming situation, to fight against child malnutrition in the province of Mayo-Kebbbi Est, we are proposing an investigation into the implementation of fortified infant flour for children based on local ingredients found on the markets of Bongor.

2. Materials and Methods

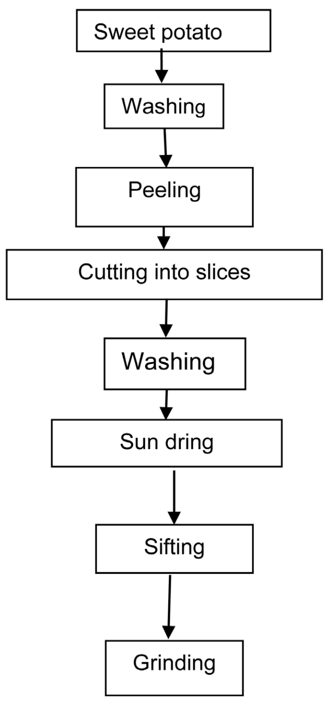
2.1. Food Material

The criteria that guided our choice of foodstuffs used in the formulation of local flours are being well suited to the nutritional needs of young children; be locally produced and available all year round; be well accepted from a cultural point of view. as a source of vitamin and minerals; moringa (vegetable) as a source of vitamins and minerals; white beans (legumes) as a source of vitamins and minerals and peanuts as a source of lipids and proteins. These ingredients were purchased from the Bongor market.

2.2. Manufacturing Processes for Different Flours

2.2.1. Sweet Potato (*Ipomoea batatas*)

Sweet potato tubers are washed in water, peeled and cut into small pieces then dried and ground using a wooden pestle and mortar to produce flour according to Figure 1.



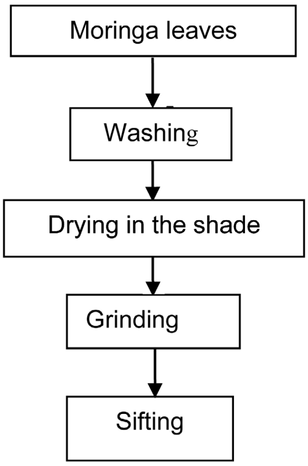
Source: [11] With slight modification.

Figure 1. Diagram for manufacturing *Ipomoea batatas* flour.

2.2.2. Moringa Leaves

- The leaves are washed by soaking them in a basin of clear water. All you have to do is put them in the water and take them out immediately, then shake gently to remove the excess water.

- The powder is sifted to remove all stems and twigs.
- The leaves are pulverized using a wooden mortar and pestle. The leaves are dried in the shade in a well-ventilated room according to **Figure 2**.



Source: [11] With slight modification.

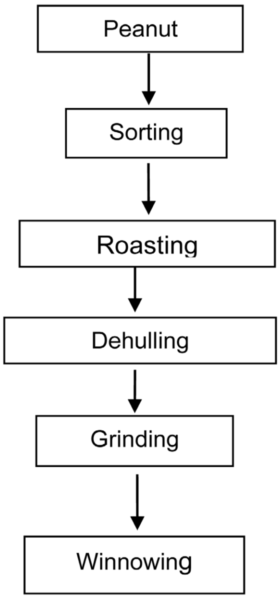
Figure 2. *Moringa oleifera* powder manufacturing diagram.

2.2.3. Peanut (*Arachis hypogaea*)

- Sorting: the shelled and winnowed seeds are carefully sorted. Sorting is done manually and consists of eliminating bad seeds;
- Roasting the seeds in a pan and over low heat to significantly reduce humidity and viscosity, destroy bacteria and insects and allow the development of a particularly appreciated taste;
- Cooling: the roasted seeds are spread out in the shade on a clean, dry place to cool them;
- Dehulling: the roasted and cooled seeds are removed from their husks using a board;
- Grinding in a very clean VICTORIA brand disc mill;
- Winnowing: it consists of removing the hulls from the peeled seeds according to **Figure 3**.

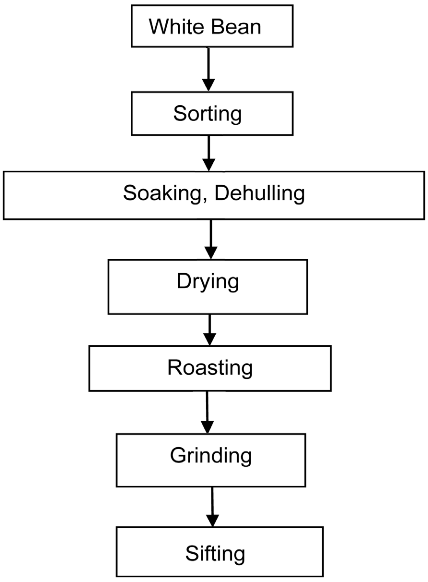
2.2.4. White Bean (*Phaseolus vulgaris*)

- Sorting: is necessary to avoid incorporating damaged products or impurities;
- Dehulling: preliminary step to dehulling is soaking which facilitates removal of the husk. Grains that have been soaked in water for a certain time shell more easily because the husk, absorbing more water, comes off more easily;
- Drying: the hulled seeds are dried in the sun;
- Roasting: the beans are roasted in a pan over low heat;
- Grinding: the bean grains are ground in a wood mortar using a pestle;
- Sifting: the powder is sifted to recover large pieces according to **Figure 4**.



Source: [11] With slight modification.

Figure 3. *Arachis hypogaea* paste manufacturing diagram.



Source: [11] With slight modification.

Figure 4. *Phaseolus vulgaris* flour manufacturing diagram.

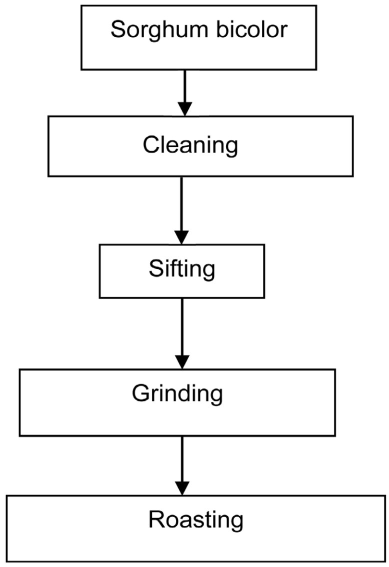
2.2.5. Red Sorghum (*Sorghum bicolor*)

- Cleaning: it consists of eliminating impurities, straws, foreign cereals, and immature grains by sieving and having a homogeneous raw material. The seeds are then washed and dried in the sun;

- Roasting: the beans are roasted in a pan over low heat;

- Grinding is done using a hammer mill. This operation consists of pulverizing the grain against the wall of the grinding chamber in order to obtain a very fine flour;

- Sieving consists of removing indigestible fibers using a small mesh sieve (0.5 mm) according to **Figure 5**.

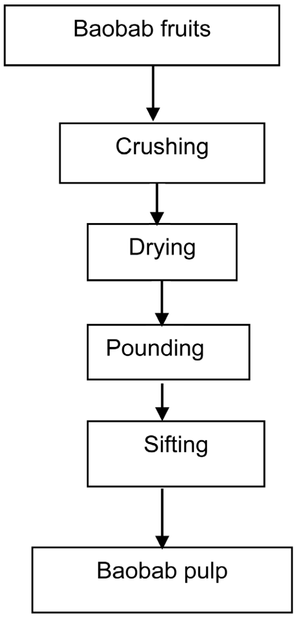


Source: [11] With slight modification.

Figure 5. Sorghum bicolor flour manufacturing diagram.

2.2.6. Baobab Pulp (*Adansonia digitata*)

The extraction of baobab pulp from baobab fruits is as follows: the capsules are crushed to release the seeds coated in pulp. These latter (seeds + pulp) are then dried and then pounded. After extracting the pulp, the pounded product is sieved and the pulp is separated from the seed according to **Figure 6**.



Source: [11] With slight modification.

Figure 6. Diagram of preparation of *Adansonia digitata* pulp.

2.3. Physico-Chemical Analyzes

The contents of water, ash, lipids, proteins and some minerals were determined by the AOAC 940.26 method [12].

Calculation of the energy value of flour samples

The theoretical energy value was calculated using the coefficients of Merrill and Watt [13], adopted by FAO (1970). L, P, G, L be the respective percentages of proteins, carbohydrates and lipids. The energy value of the sample was obtained as follows: Energy value (Kcal/100g) = $P \times 4 + G \times 4 + L \times 9$.

2.3.1. Determination of the Calcium, Iron, Magnesium and Zinc Contents by Atomic Absorption (AAS)

After mineralization by dry drying, the ashes obtained contain the major elements (Na, Ca, Mg, K, etc.) and trace elements (Fe, Zn, etc.). These minerals are measured by Atomic Absorption Spectrometry with a PELKIN ELMER model 3110 type device (Connecticut, USA). Al-Ca-Cu-Fe-Mg-Si-Zn hollow cathode lamp was used [14].

The results are expressed in mg/100g DM.

2.3.2. Determination of Fibers, Proteins and Minerals

Fibers, proteins and minerals were determined at the Food Quality and Control Study Center (CEQOCDA) in N'Djamena, Chad [15].

2.3.3. Protein Analysis

Protein analysis was carried out by the KJELDALHL method which consists of evaporation of the sample, mineralization and titration which will lead to obtaining the percentage of proteins found in the protein sample [12].

2.3.4. Determination of Lipid

The determination of lipids is done by the Sohlet method [16].

2.3.5. Ash Content

The analysis of the minerals was firstly carried out by incineration of the sample in an oven for 2 hours at a temperature of 450˚C, then weighing the sample at 2 g per crucible, the place it in the oven for 8 hours, dose it with nitric acid, finally, titrate it in order to obtain the percentage of minerals found in the sample [12].

2.3.6. Determination of the Content of Calcium, Iron and Magnesium

These minerals are contained in the ash obtained. These contents were determined using Atomic Absorption Spectroscopy [17]. The Spectroscope is a PELKINE lmer model 3110 device brand (Connecticut, USA). An Al-Ca-Cu-Fe-Mg-Si-Zn cathode lamp was used.

2.3.7. Determination of Fibers

The fibers were determined by the grinding and filtering method [18].

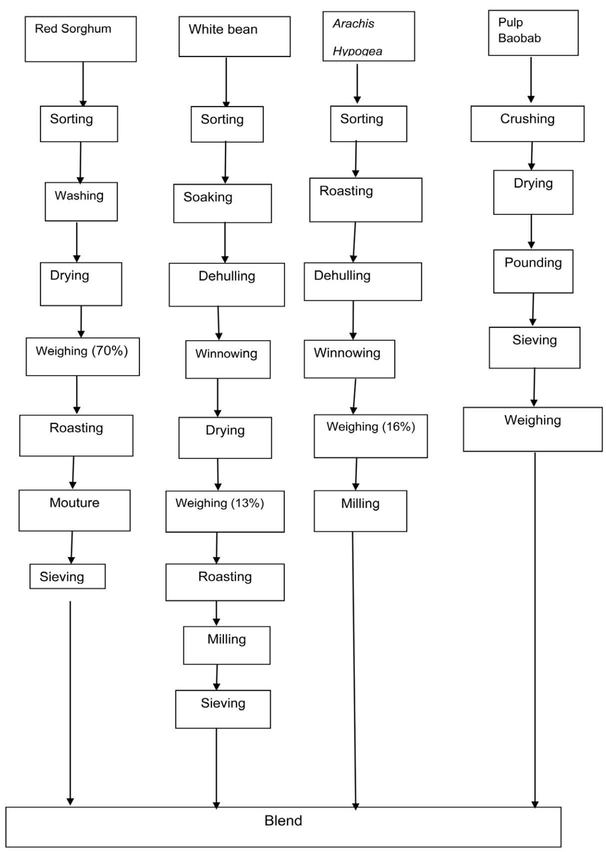
2.3.8. Determination of Vitamin C by the 2,6 Dichlorophenol-Indophenol (DIP) Method

The titrimetric method of Sullivan and Carpenter (1993) was used to measure vitamin C. It is based on discoloration (reduction) 2,6-dichlorophenolindophenol (2,6-DIP) at PH). < 3.

The vitamin C content of the sample expressed in mg/100g of fresh or dry weight is determined by the relationship $Q = (XV/PV')$ 6-DIP; V: Volume of the total extract of the sample; V': Volume of the extract reducing 1ml of 2,6-DIP; P: Weight of the sample (g). H: Water content [19].

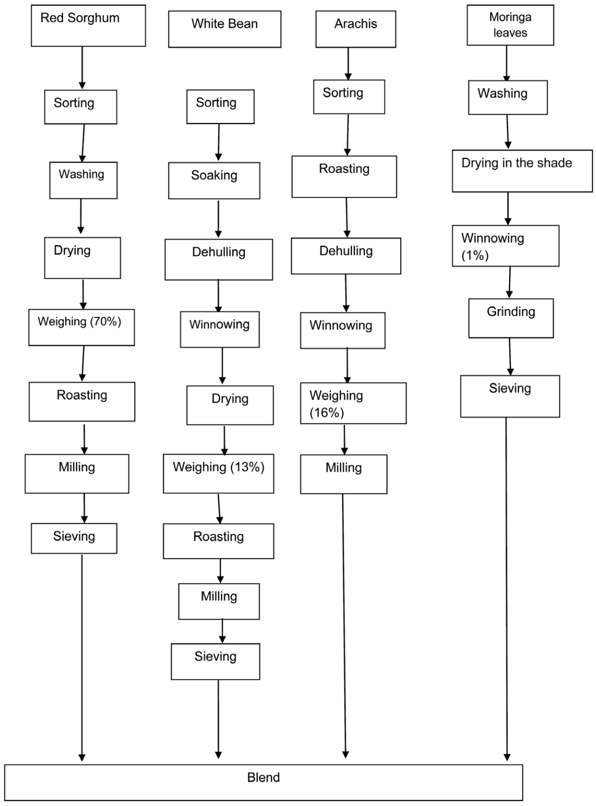
2.3.9. Formulation of Flours

Three flours were formulated taking into account the physicochemical composition of each ingredient obtained and the recommendations of the Codex Alimentarius Commission [20]. The formulated SHAB flour (red sorghum, white bean, peanut and baobab) is obtained from an incorporation rate of 70% of red sorghum, 13% white beans, 16% peanuts and 1% Baobab pulp according to **Figure 7**. SHAM flour (red sorghum, bean, peanut and moringa) is obtained from 70% red sorghum, 13% white bean, 16% peanut and 1% moringa and SHAP flour (red sorghum, white bean) according to **Figure 8**. Peanut and Sweet Potato) obtained from 63% red sorghum, 20% bean, 16% peanut and 1% sweet potato according to **Figure 9** [21].



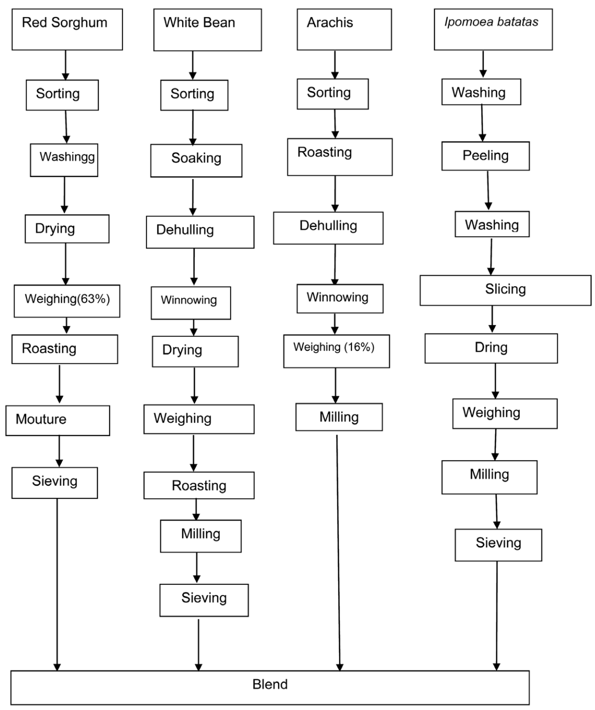
Source: [21] With slight modification.

Figure 7. SHAB flour manufacturing diagram.



Source: [21] With slight modification.

Figure 8. SHAM flour manufacturing diagram.



Source: [21] With slight modification.

Figure 9. SHAP flour manufacturing diagram.

2.3.10. Statistical Analyzes of the Data

Microsoft Office Excel 2007 software was used for data entry, statistical analysis and construction of graphs and tables. SPSS 20.0 software was used to compare means through descriptive analysis, and the significance level of the results was set at 5%.

3. Results

The different physico-chemical results are presented in Table 1.

Table 1. Physico-chemical characteristics and nutritional composition of porridge recipes per 100 g of dry matter.

FLOURS	SHAB	SHAM	SHAP	AJR
Dry matter (%)	98.73 ± 0.01	98.82 ± 0.11	98.91 ± 0.02	95[b]
Ash (g /100g)	2.12 ± 0.02	2.15 ± 0.007	2.22 ± 0.01	2.9[b]
Protein (g/100g)	12.89 ± 0.01	13.12 ± 0.03	14.03 ± 0.01	15[a]
Lipid (g/100g)	18.22 ± 0.04	18.2 ± 0.01	17.89 ± 0.01	10-25[a]
Total Sugar (g/100g)	65.5 ± 0.03	65.35 ± 0.02	64.77 ± 0.03	68[b]
Energy (kcal/100g)	477.54 ± 0.79	479.83 ± 0.08	478.43 ± 0.38	400[a]
Calcium (mg/100g)	363.65 ± 0.06	378.36 ± 0.04	363.7 ± 0.007	400[b]
Iron (mg/100g)	39.6 ± 0.01	36.98 ± 0.26	36.72 ± 0.01	11.6[b]
Magnesium (mg/100g)	177.85 ± 0.04	177.96 ± 0.03	177.7 ± 0.02	60[b]
Zinc (mg/100g)	3.09 ± 0.02	3.09 ± 0.01	3.05 ± 0.04	4.8[b]
Vitamin C (mg/100g)	57.01 ± 0.1	59.01 ± 0.07	49.7 ± 0.74	30[b]

RDA: recommended daily intake; [a]: CAC (Codex Alimentarius Commission) 2013; [b]: FAO/WHO, 2002.

4. Discussion

The physicochemical characteristics and nutritional composition of the porridge recipes per 100g of dry matter are presented in Table 1.

4.1. Dry Matter Content

The results show that our flours have satisfactory dry matter contents. The highest content for flours is noted for SHAP flour with a content of 98.91% and the lowest content is noted for SHAB flour with a content of 98.73%. These results are superior to those of Angèle *et al.* [4] who formulated flours made from a mixture of cereals (corn and sorghum) and legumes (soy) using the germination technique and whose contents are from 94 to 95%. This difference is due to the lower water content of our ingredients compared to ingredients from Ivory Coast.

4.2. Ash Content

The results show that our flours have ash contents that meet standards. The highest content for flours is noted for SHAP flour with a content of 2.22% and the lowest content is noted for SHAB flour with a content of 2.12% which are similar to 2.12%.These results are superior to those of Angèle *et al*. [4] who formulated flours made from a mixture of cereals (corn and sorghum) and legumes (soy) using the germination technique and whose contents are from 94 to 95%. This difference is due to the lower water content of our ingredients compared to ingredients from Ivory Coast.

4.3. Protein Content

The results show that our flours have protein contents that meet standards. The highest content is noted for SHAP flour with a content of 14.03% and the lowest content is noted for SHAB flour with a content of 12.89%. These results are higher than that of Kayalto [11] found in 5 infant flours manufactured in Chad which vary from 7% to 12.69% and that of Ponka *et al*. [22] found in some artisanal flours in Cameroon which vary from 8.42% to 11.01%. This difference would certainly be due to a varietal difference or to the nature of the soil.

4.4. Lipid Content

The results show that our flours have contents that meet the standards for the lipid content of foods. The highest content for flours is noted for SHAB flour with a content of 18.22% and the lowest content is noted for SHAP flour with a content of 17.89% which are higher than those of Yomadji-Outangar [23] found in 1995 in Chad (11.5% to 13.5%). This difference would be due to a varietal difference.

4.5. Total Sugar Content

The results show that our flours have very low total sugar content. The highest content for flours is noted for SHAB flour with a content of 65.5% and the lowest content is noted for SHAP flour with a content of 64.77%. The total sugar contents of our flours are same than the Recommended Daily Allowance (RDA) which is 68% [24].

4.6. Energy into Our Flours

The results show that our flours have an energy content that does not meet standards. The highest content for flours is noted for SHAM flour, with a content of 479.83 Kcal/100g and the lowest content is noted for SHAB flour, with a content of 477.54 Kcal/100g. The energy contents of our flours are significantly high than the Recommended Daily Allowance (RDA is 400 Kcal [5]. They are the same as those of Ukegbu *et al*. [25] found in corn-based flours containing other elements such as soy, shrimp and peanuts in Nigeria (409.16% 0 490.17%) and those of Sika *et al*. [26] found in Ivory Coast (391.94% to 411.34%). Calcium content the results show that our flours are very low.

4.7. Calcium Contents

The highest content for flours is noted for SHAM flour with a content of 178.36

mg/100g of DM and the lowest content is noted for SHAB flour, with a content of 163.65 mg/100g of DM, which are greater than those found by Traoré [27] in 2005 in Ouagadougou in Burkina Faso which are 2.73 mg/100g of DM to 10.7mg/100g of DM. These contents could be improved by increasing the proportion of *Moringa oleifera*, which is rich in minerals. This difference is due to the nature of the soil or to a varietal difference.

4.8. Iron Content

The results show that our flours have iron contents that meet standards. The highest content for flours is noted for SHAB flour with a content of 39.6 mg/100g of DM and the lowest content is noted for SHAP flour with a content of 36.72 mg/100g of DM. Its contents are beyond 7.11 mg/100g of DM to 12.70 mg/100g of DM found by Kayalto [11] in Chad and 2.49 mg/100g found in corn flour produced in Umua-hiaAbia in Nigeria. This difference would be due to the nature of the soil.

4.9. Magnesium Content

The results show that our flours have magnesium contents well above standards. The highest content for flours is noted for SHAP flour with a content of 177.7 mg/100g of DM and the lowest content is noted for SHAM flour with a content of 177.96 mg/100g of DM Zinc content which are similar to those found by Compaoré *et al*. [28] which are 115 mg/100g of DM to 190 mg/100g of DM but higher than those found by Ponka *et al*. [22] which vary between 49.35 mg/100g to 80.56 mg/100g. This difference would be due to the different nature of the floors.

4.10. Zinc Content

The results show that our flours have zinc contents that comply with the standard. The highest content for flours is noted for SHAP flour with a content of 1.05 mg/100g of DM and the lowest content is noted for SHAM flour with a content of 0.9 mg/100g DM. Vitamin C content. These results are superior to those of Trèche and Broin [29] in 2003 who found 0.1 mg/100g of DM to 0.2 mg/100g of DM, during their work on MISOLA flour (Zinc content: 0.1 mg/100g to 0.2 mg/100g of DM) and lower than those of Ponka *et al*. [22] found in artisanal flours from Cameroon (1.59 to 2.27 mg/100g DM). The difference would be due to the nature of the soil.

4.11. Vitamin C Content

The results show that our flours have vitamin C contents that meet the standards (30 mg/100g) of FAO and WHO [7]. The highest content for flours is noted for SHAM flour with a content of 1159.01 mg/100g of DM and the lowest content is noted for SHAP flour with a content of 1049.7mg/100g of DM. Our results are higher than those found by Kayalto [11] in 5 infant flours (31.58 mg/100g to 37.89 mg/100g DM) in Chad.

5. Conclusion

The present study showed us that the different formulas of infant flours have acceptable energy values which can be recommended for children under 5 years old.

Conflicts of Interest

There is no conflict of interest between the different authors.

References

[1] Kamdar, E.K. (2019) Une farine infantile fortifiée. Tchad pour lutter contre la malnutrition.

[2] Gbogouri, G.A., Bamba, M.S., Digbeu, D.Y. and Brou, K. (2019) Elaboration d'une Farine infantile composée à base d'ingrédients locaux de Côte d'Ivoire: Quelles stratégies d'enrichissement en acides gras polyinsaturés oméga 3? *International Journal of Biological and Chemical Sciences*, **13**, 63-75. https://doi.org/10.4314/ijbcs.v13i1.6

[3] Brown, K.H. and Lutter, C.K. (2000) Potential Role of Processed Complementary Foods in the Improvement of Early Childhood Nutrition in Latin America. *Food and Nutrition Bulletin*, **21**, 5-11. https://doi.org/10.1177/156482650002100102

[4] Amoin, A., Agbo, E., Dago, A., Gbogouri, A., Brou, D. and Dago, G. (2015) Comparaison des caractéristiques nutritionnelles et rhéologiques des bouillies infantiles préparées par les techniques de germination et de fermentation. *International Journal of Biological and Chemical Sciences*, **9**, 944-950. https://doi.org/10.4314/ijbcs.v9i2.31

[5] Zannou, T.V. Ahui-bitty, L. Kouame, K. Bouaffou, K. and Dally, T. (2011) Utilisation de la farine de maÏs germée source d'alpha amylase pour augmenter la densité énergétique des bouillies de sevrage à base de manioc et de son dérivé, l'attiéké. *Journal of Applied Biosciences*, **37**, 2477-2484.

[6] INS & ICF (2012) Enquête Démographique Et De Santé à indicateurs Multiples De Côte d'Ivoire 2011-2012. Institut National de la Statistique et ICF International, 35-43.

[7] Leyvraz, M., Aaron, G.J., Poonawala, A., van Liere, M.J., Schofield, D., Myatt, M., *et al.* (2017) Coverage of Nutrition Interventions Intended for Infants and Young Children Varies Greatly across Programs: Results from Coverage Surveys in 5 Countries. *The Journal of Nutrition*, **147**, 995S-1003S. https://doi.org/10.3945/jn.116.245407

[8] OCHA (2017) Bulletin humanitaire octobre-novembre. 4.

[9] OCHA (2021) Rapport final de l'enquête SMART. 6.

[10] OCHA (2018) Aperçu des besoins Humanitaire. 2.

[11] Kayalto, B. (2016) Caractérisation des procédés, évaluation nutritionnelle et enrichissement de cinq (05) farines infantiles du Tchad en vitamines A et C, en fer et zinc à base de Moringaoleifera Lam. et de la pulpe de néré (Parkia biglobosa Jacq. Benth). Ph.D. Thesis, Université Ouaga I.

[12] AOAC (1990) Official Methods of Analysis. 15th Edition, Association of Official Analytical Chemists, 831-835.

[13] Merrill, A.L. and Watt, B.K. (1955) Energy Value of Foods: Basis and Derivation. ARS United States Department of Agriculture.

[14] Pinta, M. (1973) Méthodes de référence pour la détermination des éléments minéraux dans les végétaux. Détermination des éléments Ca, Mg, Fe, Mn, Zn et Cu par Absorption Atomique. *Oléagineux*, **28**, 87-92.

[15] Gall, M.L., Montagne, L., Jaguelin-Peyraud, Y., Pasquier, A. and Gaudré, D. (2011) Prédiction de la teneur en fibres totales et insolubles de matières premières courantes dans l'alimentation du porc à partir de leur composition chimique. 43'eme Journ'ees Recherche Porcine, 117-123.

[16] AOCS (1990) Official Methods and Recommended Practices (4th ed.). American Oil Chemists Society, 373-384.

[17] Soro, S., Konan, G., Koffi, E., Elleingand, E. and N'guessan, D. (2013) Formulation d'aliments infantiles a base de farines d'igname enrichies au soja. *African Journal of Food, Agriculture, Nutrition and Development*, **13**, 8313-8339. https://doi.org/10.18697/ajfand.60.12655

[18] Marie-Ève, S. (2005) Les fibres alimentaires et le pain de blé entier. Mémoire présenté à la Faculté des études supérieures de l'Université Laval dans le cadre du programme de maîtrise en sciences et technologie des aliments pour l'obtention du grade de maître ès sciences (M. Sc.). 116.

[19] Sullivan, D.M. and Carpenter, D.E. (1993) Methods of Analysis for Nutritional Labeling. AOAC International, 102.

[20] CAC/RCP (1998) Bulletin du réseau TAP. 48.

[21] Fanou Fogny, N., Madode, E.M.Y., Laleye, F.T.F., Amoussou-Lokossou, Y. and Kayode, A.P.P. (2018) Formulation de farine de fonio enrichie en ressources alimentaires locales pour l'alimentation complémentaire des jeunes enfants au Bénin. *International Journal of Biological and Chemical Sciences*, **11**, 2745-2755. https://doi.org/10.4314/ijbcs.v11i6.15

[22] Ponka, R., Nankap, E.L.T., Tambe, S.T. and Fokou, E. (2016) Composition nutritionnelle de quelques farines artisanales du cameroun. *International Journal of Innovation and Applied Studies*, **16**, 280-292.

[23] Yomadji, O. (1995) Fabrication des farines enrichies à partir de produits locaux du Tchad. Centre National de Nutrition et de Technologie Alimentaire N'Djaména, 7.

[24] FAO/WHO (2004) Vitamin and Mineral Requirements in Human Nutrition. World Health Organization, 303.

[25] Ukegbu, P.O. and Anyika, J.U. (2012) Chemical Analysis and Nutrient Adequacy of Maize Gruel(pap) Supplemented with Other Food Sources in Ngor-Okpala Iga, Imo State, Nigeria. *Journal of Biology, Agricultural and Healthcare*, **2**, 13-21.

[26] Sika, A.E., Kadji, B.R.L., Dje, K.M., Kone, F.T.M., Dabonne, S. and Koffi-Nevry, A.R. (2019) Qualité nutritionnelle, microbiologique et organoleptique de farines composées à base de maïs (*Zea mays*) et de safou (*Dacryodes edulis*) produites en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*, **13**, 325-337. https://doi.org/10.4314/ijbcs.v13i1.26

[27] Traoré, T. (2005) Élaboration et évaluation d'une stratégie d'amélioration de l'alimentation de complément des jeunes enfants au Burkina Faso. Master's Thesis, Université de Ouagadougou.

[28] Compaoré, W.R., Nikièma, P.A., Bassolé, H.I.N., Savadogo, A., Mouecoucou, J., Hounhouigan, and Traoré, S.A. (2011) Chemical Composition and Antioxidative Properties of Seeds of *Moringa oleifera* and Pulps of *Parkia biglobosa* and *Adansonia digitata* Commonly Used in Food Fortification in Burkina Faso. *Current Research Journal of Biological Science*, **3**, 64-72.

[29] Trèche, S. and Broin, M. (2003) Combattre la malnutrition avec les feuilles de Moringaoleifera, compte-rendu des essais de formulation d'une farine infantile incorporant de la poudre de feuilles de *Moringa oleifera*. 12. https://slideplayer.fr/slide/3700349/