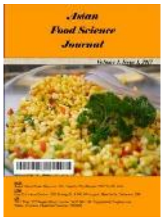

Asian Food Science Journal

6(3): 1-7, 2019; Article no.AFSJ.45712

Determination of the Moisture and Mineral Contents in Selected Infant Flour Sold at Ouagadougou, Burkina Faso

Mètuor-Dabiré Amana[1,2*], Konate Kiessoun[2], Adama Djeneba[2], Zongo S. Véronique[1] and Simpore Jacques[1]

[1]Laboratoire de Biologie et de Génétique Moléculaire (LABIOGENE), Université OuagaI Pr Joseph KI-ZERBO (UOI-PJKZ), B.P.: 03 B.P. 7021 Ouagadougou 03, Télex 5270, Burkina Faso.
[2]Université de Dedougou (UDDG), B.P: 176 Dédougou, Burkina Faso.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2019/45712
Editor(s):
(1) Dr. Ho Lee Hoon, Department of Food Industry, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin (UniSZA), 22200 Besut, Terengganu, Malaysia.
Reviewers:
(1) A. Adedokun Olufemi, Federal University of Technology, Nigeria.
(2) Ahmed Emam, High Pharaohs Institute of Tourism and Hotels, Ministry of Higher Education, Egypt.
(3) Nupo Sunday Sedodo, Moshood Abiola Polytechnic Ojere, Nigeria.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/28038

Original Research Article

Received 26 September 2018
Accepted 09 December 2018
Published 01 January 2019

ABSTRACT

Child malnutrition is one of the major causes of public health and social welfare problems in developing countries. It is manifested by micronutrient deficiency. Indeed, nutritional deficits are particularly severe in children from 6 to 24 months, when their nutritional needs exceed what they can get from breast milk. To help improve the nutritional quality of locally produced infant flours in Burkina Faso, we assessed the mineral content and determined the water content (moisture content) of 10 infant flours.

The principle of moisture determination is to dry a sample at a temperature between 103 and 105 degrees Celsius until a constant result is obtained. The principle of mineral determination is based on flame atomic absorption. The main flours studied are: corn, soy, millet, sorghum and wheat flour. The highest humidity is 14.09%, while the lowest is 3.23%. The concentration of minerals is unevenly distributed in our samples. Thus the concentration of iron varies between 1.30 mg / 100 g to 7.64 mg / 100 g, zinc between 0.04 to 0.50 mg / 100 g, potassium between 0.03 and 67.52 mg / 100 g, sodium between 14.24 mg / 100 g to 222.69 mg / 100 g, magnesium between 27.66 and

**Corresponding author: Email: ametuordabire@yahoo.fr;*

114 mg / 100 g, and the calcium varies between 4.29 and 538.43 mg / 100 g. Results were compared to codex standards and it appears that the concentration of minerals did not meet the standards in some samples. No samples met zinc and potassium standards. In addition, we evaluated the proportion of the main minerals in each sample. Calcium is the most common mineral in most samples against the weakly occurring zinc. The results of this work will enable the necessary organizations to make appropriate arrangements so that the flours that will end up in the shops and foodstuffs meet the international standards for the benefit of the population.

Keywords: Infant flour; malnutrition; minerals; moisture content; Burkina Faso.

1. INTRODUCTION

Malnutrition is defined as a pathological condition resulting from the deficiency, excess or imbalance of one or more nutrients, whether this condition is clinically manifest or detectable only by biological, anthropometric or physiological analyzes [1].

Child malnutrition is one of the major causes of public health and social welfare problems in developing countries. It is manifested by micronutrient deficiency. Deficiencies of iron, vitamin, and zinc are the most deadly deficient diseases in children and pregnant women in developing countries. Malnutrition is implicated in half of child deaths [2], and imposes lifelong consequences for survivors [3].

Nutritional deficits are particularly severe in children 6 to 24 months, at a time when their nutritional requirements exceed what they can obtain from breast milk [3]. During this critical period, children need supplement foods that are exceptionally concentrated in nutrients, hence the introduction of infant flours into their diet.

The provision of high nutritional supplement foods, especially for children, is proving difficult in low-income countries [3]. In addition, the lack of diversity in food raw materials (cereals) is one of the major causes of iron and zinc deficiencies, especially for children in the supplementary feeding period who are moving from exclusive breastfeeding to diet food [3]. The Infant flours are little used or do not always meet the nutritional needs of children in Burkina Faso given the low content of micronutrients in cereals [4]. FAO and WHO advocate that complementary foods should be made from locally available, accessible and nutritionally adequate foods to meet the nutritional needs of the child.

In this work, we evaluated the mineral content and determined the water content (moisture content) of these infant flours in order to take corrective measures on the quality of the flours and improve nutritional quality of the flours produced locally in Burkina Faso.

2. MATERIALS AND METHODS

2.1 Framework of Study

The study on infant flours was conducted by the national laboratory of public health (LNSP) located in Karpala in the city of Ouagadougou. It is a public health institution (EPS) with legal personality and financial autonomy. It was established by Decree No. 99 / PRES / PM / PMS of 1999, placed under the technical supervision of the Ministry of Health and Finance. The main objective of this establishment is to be a reference for toxicological, physicochemical, microbiological and biomedical analyzes, health quality control, expertise in medical biology, nutrition, pharmacy, water, the environment and all areas related to public health and safety.

2.2 Plant Material

- Sampling

Ten samples of infant flours were purchased from several feeds in the city of Ouagadougou between June and July 2016 and were the subject of our study.

Randomly sampled, these samples have been stored with their packaging in a dry place in the laboratory so that they do not take moisture because the flour is very sensitive to humidity.

2.3 Analysis Method

2.3.1 Determination of moisture content

- Operating mode

- Test sample

Weigh quickly the sample to 01 mg near 05 g for testing in a previously dried and tared capsule.

- Drying

Introduce the open capsule containing the sample in the oven and let it stay for 02 h of time counted from the time when the temperature in the oven is 103 plus or minus 02°C. Remove the capsule from the oven, placed it in the desiccator. As soon as the capsule is cooled to the temperature of the laboratory, it is weighed to 01mg near, then repeated heating and thinking under the same conditions with successive stays in the oven for 1h until the mass loss of two successive weighings do not exceed 02 mg.

- ➢ Expression of results
- ➢ Calculation mode and formula

The water content (W), expressed as a percentage of product mass, is given by the following formula:

W = ((M1-M2) / PE) x100 (%) or W = ((M1-M2) / (M1-M0)) x100 (%)

M0: Mass in g of the crystallizer,
M1: Mass in g of the crystallizer and the test sample (PE),
M2: Mass in g of the crystallizer and the test sample after drying.
EP: Test taking

2.3.2 Determination of the mineral content

- ➢ Operating mode

- The mineralization

The sample thus mineralized was dissolved with nitric acid. The mineralized material thus obtained was transferred to a 50 ml tube and then supplemented to 50 ml with 0.5 N nitric acid. The iron, zinc, calcium, sodium, magnesium and potassium contents were determined by flame atomic absorption spectrometry.

- Calibration curve

Calibration curves were performed with standard solutions of iron, zinc, calcium, magnesium, sodium, calcium and potassium.

Expression of results

C = ((mPE X Clue X Vf) / 1000) X100.

C = content of iron, zinc, magnesium, sodium, potassium, or calcium
Clue = Concentration read in mg / L
mPE = Mass of the test sample in gram
Vf = Final mineralized volume

3. RESULTS AND DISCUSSION

3.1 Nature of Samples

Agricultural production in Burkina Faso is rich and varied. This variety allows processors to select cereals based on their nutritional value to produce infant flours that meet international standards. Table 1 shows the composition of the various infant flours that were the subject of our study.

3.2 Physico-chemical Characteristics of Infant Flours

3.2.1 Moisture content

The moisture content of our samples varies between 3.2380% and 14.0943%. However, humidity values are normal according to the codex alimentarius which sets the standard at 15.5% maximum. All of our samples meet the standard for humidity; Kagambèga in a similar study in 2013 had found a moisture content of less than 15.5% in its samples with a minimum rate of 4.20% and a maximum of 7.07% [4].

Table 1. composition of infant flours

Code	Designation	Composition
E1	Cerealor	Corn, soy, peanut, sugar, milk powder, salt iodine, CMV and BAN
E2	Petit gourmet	White corn, soy, peanut, sesame, iodized salt, sugar, minerals, vitamins and amylazes
E3	Biuung zom	Mil, peanut, cowpea, soy, sugar, iodized salt
E4	Fanutri	Corn, soy, peanut, sugar, iodized salt, and Enzymes
E5	Natavie	Mil, sorghum, peanut, soy, sugar, powder monkey bread, iodized salt, calcium carbonate, RAN enzyme
E6	Vitazom	Corn, soy, peanut, cowpea, sugar, iodized salt
E7	Misola	Mil, soy, peanut, sugar, iodized salt, and
E8	Têega-Wendé	industrial amylase
E9	Vita casui	Little millet, monkey bread
E10	Vitaline	Mil, wheat, palm oil, cowpea, vitamins,

Table 2. Moisture content in the samples

Samples	Moisture content (%)
E1	4.158
E2	14.0943
E3	5.8576
E4	4.3982
E5	4.7381
E6	6.0563
E7	4.1791
E8	9.4162
E9	3.238
E10	5.089

3.2.2 Mineral characteristics

Fig. 1 shows the variation of the concentration of iron, zinc, potassium, sodium, magnesium and calcium in the samples.

Sample 7 contains more iron (7.6402 mg / 100 g) than the others; on the other hand, sample 9 contains less iron (1.3099 mg / 100 g). In the standards the iron content in flours is greater than 4 mg. Only samples E1, E2 and E7 have a normal iron content. A similar study conducted in Cameroon shows that iron content varies between 2.01 and 2.19 mg / 100 g in five flour samples [5]. The other 7 samples have a lower content than the normal iron content in the slurry.

Sample 8 contains more Zinc (0.5034 mg / 100 g) than the others, while Sample 4 contains less Zinc (0.0462 mg / 100 g). All samples have a zinc content of less than 0.8 mg / 100 g. These results differ from those found in five flours in Cameroon where the content varies between 1.59 and 2.27 mg / 100 g [5]. Moreover, an analysis of the maize porridges consumed in Nigeria gives a variation of 0.17 to 0.30 mg / 100 g comparable to our results [6]. Our samples as well as those analyzed in Nigeria do not meet Codex standards. Given the crucial role of zinc in strengthening the immune system, infant flours must meet the standard.

Sample 3 contains more potassium (67.5229 mg / 100 g) than other samples; while sample 8 contains less potassium (0.0299 mg / 100 g). The potassium content of all our samples is below 129 mg / 100 g which is the norm. Our results differ from those found in Cameroon (>250 mg / 100 g) (Roger. et al. 2016) and northwestern Nigeria in maize porridge (171.32 mg / 100 g) [7].

Sample 7 contains more sodium (222.6954 mg / 100 g); however, sample 2 contains less sodium (14.2443 mg / 100 g).

Sample 7 contains more magnesium (113.9972 mg / 100 g), compared to sample 10 which contains less magnesium (27.6634 mg / 100 g).

Sample 2 contains more calcium than other samples, while Sample 8 contains the least calcium (about 0 mg / 100 g). On the basis of Codex standards, only samples 1, 2, 3, and 5 meet calcium standards.

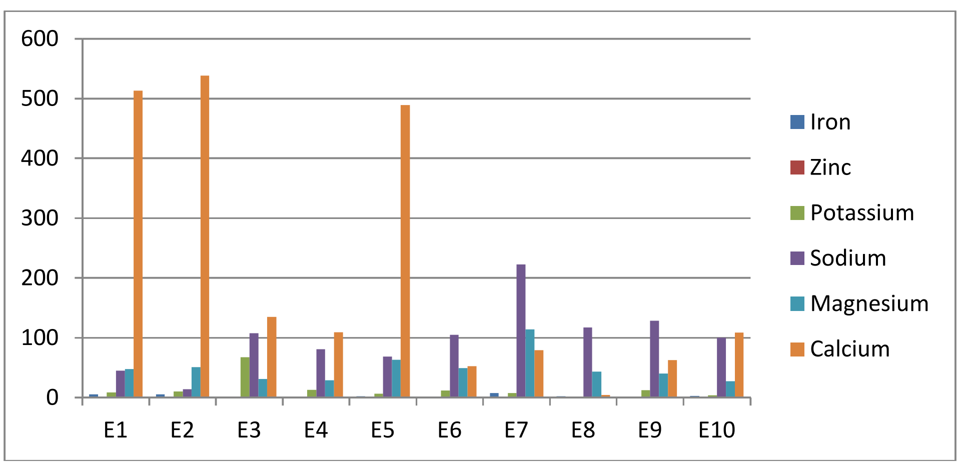

Fig. 1. Concentration of minerals in samples

Legend: Fe: iron; Zn: Zinc; K: potassium; Na: sodium; Mg: magnesium; Ca: calcium.
E1: sample1; E2: sample2; E3: sample3; E4: sample4; E5: sample5; E6: sample6; E7: sample7; E8: sample8; E9: sample9; E10; sample10

3.2.3 Proportion of minerals in the samples

Fig. 2 shows the proportions of Iron, Zinc, Potassium, Sodium, Magnesium and Calcium in the samples.

In sample 1, more than 80% of the measured minerals are calcium, while zinc is almost absent. The concentration of calcium meets the standards but that of zinc is far below the norm.

Calcium accounts for more than 86% of the minerals in Sample 2, and Zinc represents only 0.03% of the minerals measured. The concentration of calcium meets the standards but that of zinc is below the norm.

In sample 3, no element represents more than 50% of the minerals dosed. Calcium is still in the lead with about 39%, and Zinc has a proportion of less than 1% of minerals. Nevertheless, the concentration of calcium meets the standards.

In sample 4 we have calcium with the highest percentage (around 46%), compared with Zinc which is 0.02% of the measured minerals. Both minerals do not meet Codex standards.

Calcium represents more than 77% of the minerals in sample 5 and its concentration meets codex standards, whereas Zinc represents only 0.01% of the minerals dosed.

The results of these 5 samples are similar to those obtained in a study in Burkina Faso, where calcium was predominant and zinc was a minority [8]. However, in a study conducted in Cameroon, potassium was majority [9].

Of the minerals measured in Sample 6, sodium is strongly present at nearly 47%; its concentration meets codex standards, while Zinc represents only 0.09% of minerals. The calcium that was supposed to have the highest proportion of minerals has a concentration that does not meet the standards.

In the sample7, sodium is strongly present (51%), its concentration meets the standards of the codex, against Zinc with a proportion of 0.03%. The calcium that was supposed to have the highest proportion of minerals has a concentration that does not meet the standards.

Sodium represents nearly 70% of the minerals measured in Sample 8 and its concentration meets codex standards; while the least represented element is Potassium (0.02%) whose concentration does not meet the standards.

Sodium represents nearly 52% of the minerals dosed and its concentration meets the standards of the codex; while the least represented element is Zinc (0.19%) in sample 9. these results where sodium was predominant differ from those obtained in Cameroon where potassium was predominant [9].

In sample 10, no element represents more than 50% of the measured minerals. Calcium is the most represented element with 44%, but the concentration does not meet codex standards, Zinc which has a proportion of less than 1% of minerals.

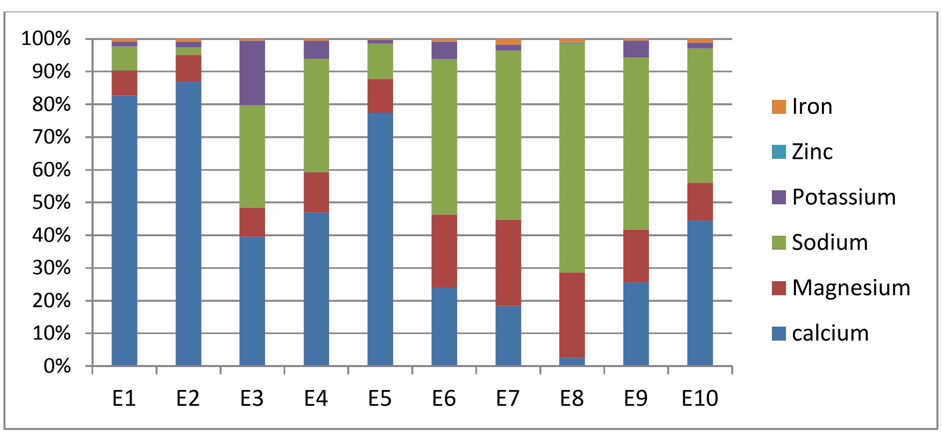

Fig. 2. Proportions of minerals in samples

Legend: E1: sample1; E2: sample2; E3: sample3; E4: sample4; E5: sample5; E6: sample6; E7: sample7; E8: sample8; E9: sample9; E10; sample10

The iron content of samples ranged between 1.3099 to 7.6402mg/100g. This trend is the same with what Roger et al. 2016 observed in a similar study conducted in Cameroon on five flour samples. Samples E_1, E_2 and E_7 values are within the standard of 4mg recommended by standard.

The mineral content in our samples differs from that found in other non-cereal flours. Thus, the levels are much lower than those found in the dried caterpillar powder (*Imbrasia oyemensis*) in the center-west of Côte d'Ivoire where the calcium, sodium, magnesium, potassium, iron and zinc contents are respectively 307, 511, 208, 610, 70, and 11 mg / 100 g [10]. This difference could be explained by the fact that Chenille powder is a raw powder derived from a very nutritious insect according to the studies.

Depending on the species, caterpillars are rich in minerals such as potassium, calcium, magnesium, zinc, phosphorus and iron as well as various vitamins. Research shows that 100 grams of insects cover more than 100 percent of the recommended daily intake of minerals and vitamins [10].

Because of its high nutritional value, caterpillar meal is in some areas incorporated into the gruel given to children in order to counter malnutrition, "according to Mr. Vantome, contrary to what many may think, caterpillars are not considered an emergency food but are an integral part of the diet in many regions, depending on seasonal availability consumed like delicacies, he added [11].

4. CONCLUSION

At the end of this work, which was aimed at checking the macroelements standards and the water content, our results were satisfactory. Indeed, we analyzed ten infantile flours made in Burkina Faso among which we determined the concentrations of calcium, iron, magnesium, potassium, zinc, and sodium. These reminder elements are not produced by the body and are nevertheless essential for survival. They must be brought from the outside through the food. Thus no sample met the zinc and potassium standards. Only three samples met the calcium standards, 7 samples met the sodium standards, all samples met the magnesium standards and the moisture content was respected. No flour among our samples was perfect in terms of mineral content. The pregnant woman and the child of more than 6 months constitute the vulnerable population and must benefit from these elements through a food diversification, but also an increase in the frequency of the food intake.

The results of this work will enable to make the appropriate arrangements so that the flours that will end up in the shops and foodstuffs meet the national standards for the benefit of the population. They will also allow decision-makers and the population to know the value of these infant flours that are widely used today in the fight against malnutrition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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