Original Research Article

PHYSICOCHEMICAL AND NUTRITIVE PROPERTIES EVALUATION OF FIVE INFANT FLOURS PRODUCED IN KORHOGO IN NORTHERN IVORY COAST AFTER CONSERVATION

ABSTRACT

Objective of this study is to evaluate the physicochemical and nutritional properties of 5 infant flours produced by the ONG Tasnim located in Korhogo in the north of Ivory Coast. The flours were stored for 2 months. Each month samples are taken for the various analyzes according to the AOAC. The results obtained showed that humidity (3.21 – 5.92% to 3.48 – 7.78%), proteins (11.42 – 25.37% to 21.43 – 33.29%) and acidity (0.73 – 1.10% to 0.83 – 2.20%) increase during storage unlike carbohydrates (51.53 – 66.37% to 47.25 – 58.49%), lipids (10.80 – 20.50% to 4.70 – 13.70%) and energy value (422.76 – 481.02 Kcal/100g to 382.98 – 431.22 Kcal /100g) which are decreasing. These results suggest that the formulations should be stored for a period not exceeding 1 month in order to effectively contribute to the fight against malnutrition in low-income households.

Keywords: Formulation, infant flour, conservation, nutritive, physicochemical

1. INTRODUCTION

Infant flours are generally food supplements that are given after cooking or in the form of porridge to young children from the age of six months in addition to breast milk. They must be specially designed to cover nutritional needs, taking into account breast milk intake and the daily frequency of meals [1]. The complementary feeding period represents a delicate transition period due to the immaturity of the child's digestive system [2]. In Ivory Coast, the consumption of infant flour is very high [3]. Those existing on the market are generally imported and high-cost products inaccessible to low-income households [4].

As a result, infant flour products made from local cereals are present on the markets in instant or cooked form [5]**.** The quality of these local infant flours used during the period of food diversification is therefore of great importance. Unfortunately, the processing and storage processes of these local flours are not completely controlled, often causing conservation difficulties.

[6] noted that during the manufacturing stages objective limits to the quality, safety and standardization of finished artisanal products existed because many operations are manual, materials are approximately sanitized, frequently used dirty water and inconvenient storage conditions. According to [7], lizards, pets and insects (flies, crickets) can carry many pathogens in food. Thus, recent studies in Africa have shown the presence of salmonella and entero-pathogens in certain infant foods [8].

Fortunately, these microbiological contaminations can be corrected with effective thermal treatments (cooking, roasting) or sufficient reduction of the water content [9]. The objective of this study is to evaluate the physicochemical and nutritional properties of five infant flours produced by the ONG Tasnim located in Korhogo during its conservation.

2. MATERIAL AND METHODS

2.1 Material

2.1.1 Biological material

The biological material consists of 5 different infant flours produced by the ONG Tasnim at a rate of 3 samples of 100g per formulation. These flours have been formulated with millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*), maize (*Zea mays*), soy (*Glycine max*), beans (*Phaseolus vulgaris*) and peanuts (*Arachis hypogaea*).

F1 (sorghum + bean) F2 (maize + peanut) F3 (sorghum + soy) F4 (maize + bean) F5 (millet + soy)

Fig. 1. Infant flour for different formulations

2.1.1 Chemicals

Reagents [(phenolphthalein, sodium hydroxide, hexane, sulfuric acid, methyl red and bromocresol green] were purchased from Sigma-Aldrich (Germany). All chemicals used in this study were of analytical grade.

2.2Methods

2.2.1 Flour treatments

After production, the formulations were packaged in plastic pots. A sample of each formulation was used immediately for the different analyses. The other samples were stored at room temperature (28 - 30°C) in a warehouse for 2 months. Each month samples are taken for the various analyses.

Table 1. Proportions of ingredients for different formulations

Ingredients	F1	F2	F3	F4	F5
Millet (Kg)					40
Maize (Kg)		50		50	
Sorghum (Kg)	25		25		
Soy (Kg)			50		50
Bean (Kg)	25			25	
Peanut (Kg)		40			

2.2.2Physicochemical analysis

Moisture, ash, pH and acidity were determined using [10]**.** The moisture content was determined by the difference of weight before and after drying flour (10 g) in an oven (Memmert, Germany) at 105°C until constant weight. Ash fraction was determined by the incineration of flour (5 g) in a muffle furnace (Pyrolabo, France) at 550°C for 12 h. pH was determined as follow: 10 g of crushed pulp was homogenized with 100 mL of distilled water and then filtered through Whatman No. 4 filter paper. The pH value was recorded after the electrode of pH-meter was immersed into the filtered solution. For acidity 10 mL of filtrate or nectar have been titrated by NaOH 0.1N in the presence of phenophthalein.

2.2.3 Nutritive analysis

Proteins were determined through the Kjeldhal method [11]. It consisted of mineralizing 1 g of flour then distilling the mineralization and finally titrating the distillate with 0.1 N sulfuric acid. Lipid content was determined by Soxhlet extraction using hexane as solvent. Carbohydrates content and calorific value were calculated and expressed on dry matter basis using the following formulas [12] **:**
Carbohydrates = 100 – (% moisture + % proteins + % lipids + % ash).
Calorific value = (% proteins x 4) + (% carbohydrates x 4) + (% lipids x 9).

2.2.4 Statistical analysis

The data were analyzed using descriptive statistics. Thus, the means and standard deviations were calculated using Excel 2016. Furthermore, the STATISTICA software version 7 was used to study the relationships between the variables through the analysis of variance (ANOVA) by the turkey test (HSD).

3. RESULTS AND DISCUSSION

3.1 Physicochemical properties

Table (2) presents the physicochemical parameters of the different formulations depending on the storage time. The humidity of the different formulations varies from 3.21 to 5.92% before storage. Formulation F2 has the lowest content while formulation F4 has the highest content. During storage, a slight increase is recorded in all formulations. After 2 months of storage, the moisture content of the formulations ranges between 6.46% for F5 and 7.78% for F1. These results are in agreement with those of [13] in flours composed of rice and cowpea (6.50 to 7.50%); rice and soya (9 to 9.50%) and rice + cowpea and peanut (7 to 7.2%) for 2 months of storage. The different moisture contents of the different formulations could be due to the use of different ingredients as well as roasting during the production of flours leading to a reduction in humidity [14]. After 2 months of storage, the moisture contents are higher than the standard of 5% recommended by the [15]. These low humidity contents limit the proliferation of microorganisms and therefore extend the shelf life beyond 2 months [15]. Ashes represent all the mineral elements present in a food. The ash contents of formulations F3 and F5 are statically identical and different from the others. After 2 months of storage, the ash contents vary from 1.70 to 2.60%. Our values are much higher than those of [16] in weaning flours sold in the Abidjan district. This difference could be due to the ingredients used for the different formulations. Formulations F1, F2, F3 and F5 have values close to the recommended standard which is 2.90% [15]. The pH values of the different formulations are statically identical before storage and vary from 6.29 to 6.61. After 2 months of storage they decrease with values between 5.65 and 5.97. These values are inversely correlated with increasing acidity. These results are consistent with those of [17] who showed that the physicochemical parameters of infant flour, namely water content and tritratable acidity, increase during the storage period. This decrease could be due to the oxidation of fatty acids or to amylase activity leading to the hydrolysis of starch facilitating the production of acid during fermentation [9,18].

Table 2. Physicochemcal properties of different formulation

	Moisture %	Ash %	pH	Acidity %
F1				
0 Month	5.51 ± 0.29e	2.30 ± 0.10b	6.29±0.01 ab	1.10 ± 0.10d
1 Month	6.01 ± 0.13d	2.38 ± 0.04b	6.11±0.06 c	1.47 ± 0.11c
2 Months	7.78 ± 0.12a	2.35 ± 0.11b	5.65±0.01 e	2.15 ± 0.10a
F2				
0 Month	3.21 ± 0.08i	2.16 ± 0.05c	6.43±0.01a	0.87 ± 0.03e
1 Month	3.48 ± 0.02h	2.10 ± 0.10c	6.14±0.04c	1.40 ± 0.00c
2 Months	7.24 ± 0.10a	2.08 ± 0.09c	5.64±0.02e	2.20 ± 0.09a
F3				
0 Month	4,79 ± 0.05g	2.68 ± 0.02a	6.47±0.04a	0.85 ± 0.05e
1 Month	5.15 ± 0.05f	2.56 ± 0.10a	6.18±0.02c	1.40 ± 0.05c
2 Months	7.44 ± 0.12a	2.52 ± 0.05a	5.82±0.02d	1.98 ± 0.13b
F4				
0 Month	5.92 ± 0.14d	1.78 ± 0.05d	6.61±0.04a	0.77 ± 0.13e
1 Month	6.16 ± 0.08d	1.70 ± 0.11d	6.36±0.08a	0.83 ± 0.02
2 Months	6.81 ± 0.10b	1.70 ± 0.05d	5.97±0,01d	1.97 ± 0.12b
F5				
0 Month	4.64 ± 0.16g	2.66 ± 0.05a	6.48±0,02a	0.73 ± 0.12e
1 Month	4.91 ± 0.08g	2.62 ± 0.02a	6.14±0.05c	1.43 ± 0.03c
2 Months	6.46 ± 0.04c	2.60 ± 0.06a	5.86±0,01d	2.00 ± 0.12b

Data are represented as Means ± SD (n = 3). Means in the colonn with no common letter differ significantly (p<0.05) for different formulation

3.2Nutritive properties

Figure (2) shows the evolution of protein and lipid contents during storage. The protein contents (Figure 2A) are statically different from one formulation to another. They increase with prolonged storage time with contents between 11.42 and 33.29%. Our results are different from those of [19] and [20] who recorded protein stability during the storage of powdered milk and infant flour in Benin. This slight increase in proteins in the different formulations could be due to the action of proteolytic germs producing enzymes during protein degradation. After 2 months of storage, the protein contents of our different formulations (21.43 to 33.29%) are higher than the standard recommended by [21] which is between 11 and 21%. The high levels of the formulations are due to the use of legumes as an ingredient. The different formulations could be used to combat protein-energy malnutrition in developing countries [22].
Lipids contents (Figure 2B) of the different formulations are statically different and vary from 10.8 to 20.50%. These values are higher than those of [23] and [16] in infant flours based on cassava and soy (10%) and in infant flours (1.02 to 6.93%) sold in the Abidjan district. These high values of formulations F2, F3 and F5 are due to the use of peanut and soy as ingredients. The lipid contents of the formulations comply with the recommended standards which are greater than 8% [5]. After 2 months of storage, the lipid contents drop compared to the work of [20]. This drop could be due to the hydrolysis and oxidation of lipids linked to the presence of oxygen during conditioning. This could produce unpleasant odors in flours due to lipids becoming rancid. To avoid lipid oxidation it would be desirable to incorporate antioxidant substances into the formulations.

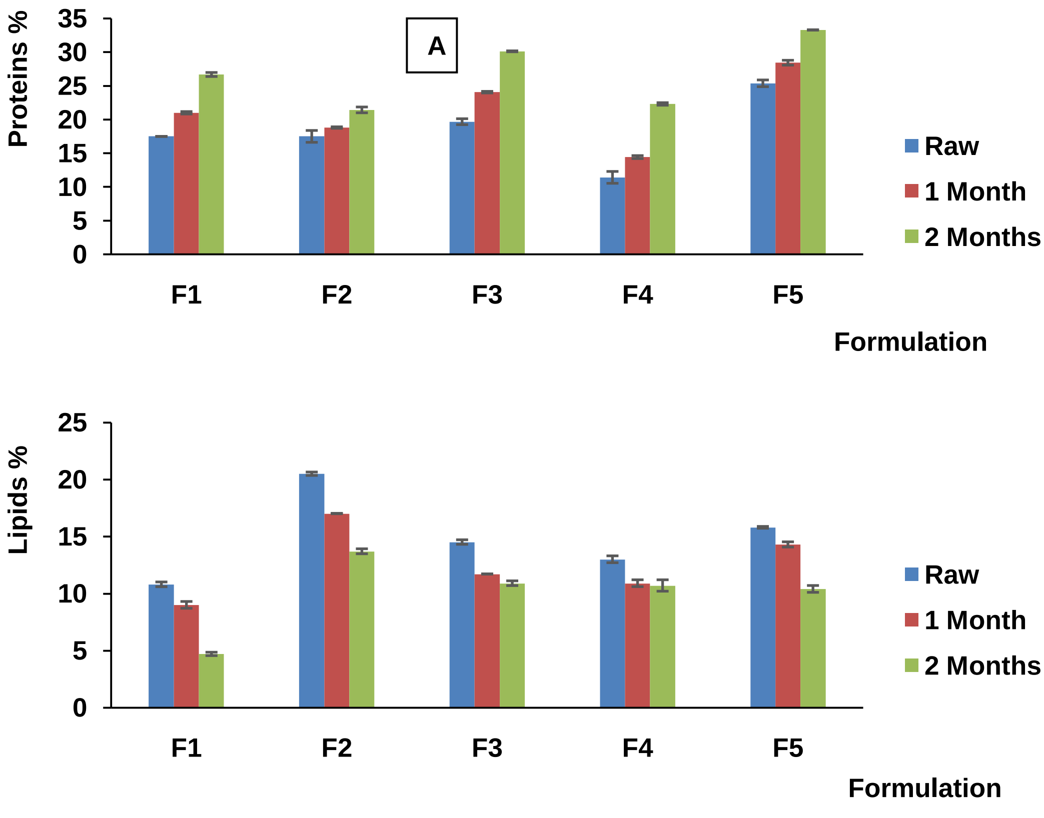
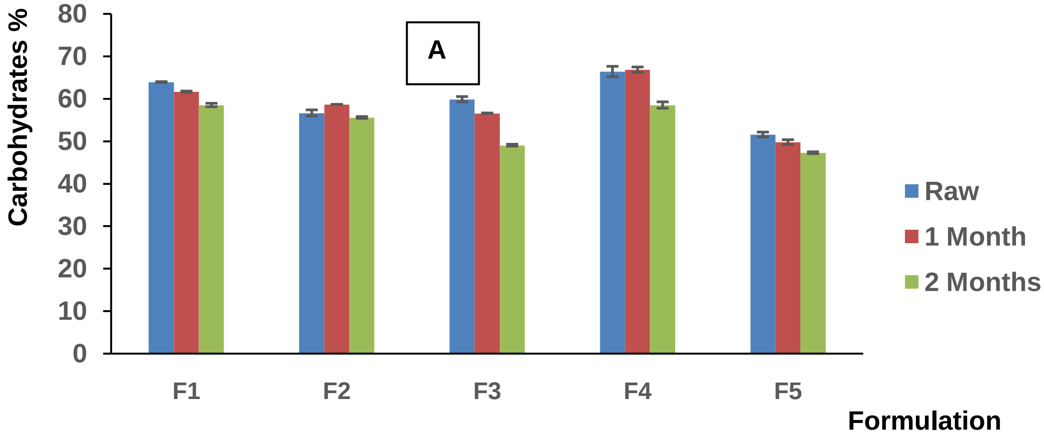


Fig. 2.Protein (A) and lipid (B) contents of the different formulations depending on the storage time

Figure (3) shows the evolution of carbohydrates and energy value during storage. The carbohydrate contents (Figure 3A) of the different formulations are statically different. The contents of formulations F1 (63.89%), F3 (59.85%) and F4 (66.37%) comply with the recommendation of the [24] for infant flours (64±4%), unlike formulations F2 (56.63%) and F5 (51.53%). Our results are similar to those of [25] in infant flours (52.99 to 67.20%) produced by artisanal units in Burkina Faso. After 2 months of storage, the carbohydrate contents decreased, varying from 49.02 to 58.49%. This decrease in carbohydrates could be due to a possible fermentation of them by residual amylophilic germs [26]. It would be desirable to extend the roasting time to avoid the action of residual germs. The energy values (Figure 3B) of the different formulations are statically different. These values vary from 422.79 to 481.02 Kcal/100g.

These values are much higher than those of [16] which oscillate between 351.41 and 390.37 Kcal/100g in infant flour sold in the Abidjan district. The high energy value of our formulations is due to the rich lipid content of ingredients such as peanut and soy. These formulations could largely cover the energy needs of children. After 2 months of storage, we recorded a drop in the energy value of our formulations. This decrease would be due to the degradation of lipids and carbohydrates during storage. Despite this reduction, the energy value of our formulations is higher than the standard recommended by [15] which is estimated at 400 Kcal/100g.



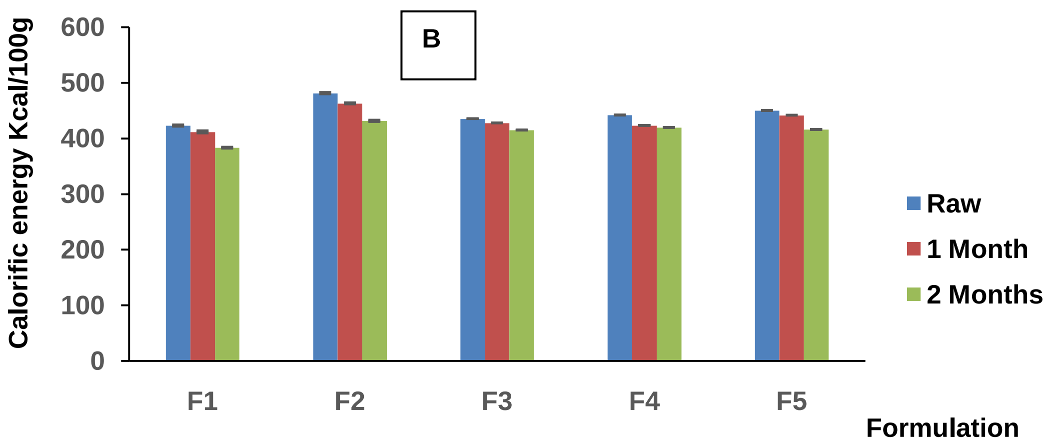


Fig. 3.Evolution of carbohydrates (A) and calorific energy (B) of the different formulations as a function of time

4. CONCLUSION

This study was carried out to evaluate the effect of conservation on the physicochemical and nutritional properties of 5 formulations produced by the NGO Tasnim in Korhogo in the north of Ivory Coast. The study showed a decrease in lipids, carbohydrates and energy value during storage in contrast to proteins, humidity and acidity. To contribute to food safety, it would be desirable to keep the different formulations for a period not exceeding 1 month. For storage beyond 1 month, it would be desirable to improve the roasting to minimize variations. We plan to evaluate the microbiological aspect of the formulations for a better appreciation of the effect of conservation on the nutritional properties.

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