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Original Article

Physicochemical and microbiological characterization of infantile flour produced based local products

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ABSTRACT

Today, more than 40% of children in developing countries are affected by chronic malnutrition. In Benin, prevalence of chronic malnutrition is estimated at29%. In order to fight against malnutrition and achieve food security of infants, this study aimed to develop and characterize flour for children in weaning age based available low cost local products: maize sorghum and soy. The infant flour produced and named "MASOSO" (maize, sorghum and soya) is safe, accessible to as many children and has good nutritional and energetic value. The study of its nutritional value shows rates of 16% protein, 4% fat and 63% carbohydrate with an energy value of 366 kcal. Compared to a standard infant flour imported we note that the nutrient and energy are adequate and comply with standards set by WHO. Similarly, microbiological analysis on this infant flour shows that it is free of any pathogen and without risk to the infant body. This infant flour can be used to complement breast milk during the weaning period. Thus, it will be possible to effectively fight against diseases related to weaning such as marasmus, kwashiorkor and beriberi regularly observed in Africa.

Keywords: infantile flour, local products, nutriments contents, energy value, safe.

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INTRODUCTION

Food is essential to the main functions of life of all individual, a fortiori in children because it ensures his growth. The type of food varies according to several factors: age, sex, health status, physical activity ... Thus the infant feeding is different from that of an adult. Similarly, breast milk, main source of all nutritional requirements for children from birth to 6 months age[1-3] becomes insufficient to cover the whole of his energy and protein needs [4]. This is the so-called weaning period, which extends from 6 months to 1 year or 2 years, during which it is necessary to bring new foods to supplement breast milk intake. These new foods given to children during the weaning period are called complementary foods, and must bring in balanced proportions the major nutriments which are: protein, fat and carbohydrates [5-7]. Weaning is the period of child life where various signs of protein-energy malnutrition appear [8-10]. In Africa, during weaning, mothers usually feed their children with traditional foods made from flours or mixture of local flours coming from cereals and tubers. These foods are high in carbohydrates but low in proteins and unable to meet all nutritional needs of the child[11].In several countries of West Africa where a demographic and health survey was conducted, one child under three years of age out of three suffers from early growth retardation[12]. Today, more than 40% of children in developing countries are affected by chronic malnutrition. In Benin, prevalence of this malnutrition is estimated at29%[13]. Data from the World Health Organization (WHO) on growth of children show that 42% of children fewer than five years in developing countries are delayed in size and 9% of them suffer from wasting. Four children out of ten, approximately 250 million children are in a severe state of malnutrition which may affect their physical and intellectual development and, at long term, their ability to take part to the development of their country. The main cause of this malnutrition is a global deficit of energy intake. In order to make our contribution to improving the quality of infant foods during the weaning period, we were interested to study the physicochemical and microbiological characterization of infantile flour prepared from local products readily accessible and available in Benin. Infant flour is a food that is given as slurry to children from four to six months age in addition to breast milk. It must be specially designed to meet their nutritional needs, taking into account the contributions of breast milk and the daily frequency of meals [14]. This study aims to offer to low-income households an infant meal obtained from local raw materials with levels of nutrients and energy meets the recommended standards.

MATERIEL AND METHODS

Materials and methods of production: The raw material used is mainly composed of maize, sorghum and soybeans, which justifies the appellation (MASOSO) given to the flour produced. The infant flour "MASOSO" was formulated from food ingredients available, products and consumed in Benin. Maize and sorghum were carbohydrate sources associated with soya acting as the main protein source. Lipids were obtained from the soya. These ingredients were combined in precise doses. The flowchart of the flour formulation was simplified such that it is reproducible at household level. Thus, the process used to produce MASOSO has implemented various technological unit operations easy to implement. These operations are performed in sequence or simultaneously according to the figure 1.

Materials and methods of analyses: Standard and valid methods from the international literature were used for the laboratory analyses. More specifically, the following laboratory methods were applied and all laboratory analyses were carried out in duplicate or triplicate:

Physicochemical analyses

Determination of water content: the water content was determined by the oven method [15].

Determination of nitrogen: The determination of nitrogen was carried out using the Kjeldahl method [15]. Protein was calculated by multiplying the total nitrogen value by FAO/WHO nitrogen conversion factors [16].

Determination of total lipids: Total lipids of the samples were determined by the Soxhlet method after acid hydrolysis [16, 17, 18].

Calculation of carbohydrates: Carbohydrates were calculated by difference. The values reported correspond to available carbohydrates and were calculated based on analytical values.

Determination of dietary fiber: The determination of dietary fiber was carried out by the Englyst's method [19].

Measurements of energy value: The available energy value of the flour was calculated following the determination of the gross energy value. Content of each component (g) is multiplied by its average caloric value: Protein (4kcal/g), fat (9 kcal/g) and Carbohydrates (4kcal/g).

Determination of inorganic components: Atomic absorption spectrometry with flame and with graphite oven was applied [15].

Determination of ions (Fe, K, Ca, Mg) and vitamins: These assays were carried out using atomic absorption spectrophotometry method; the samples were prepared in acid using ash. The ash was solubilized using 2mL de HCl 1:1 and 2 drops of HNO 12 M. After the solubilization, the solution was filtered in to volumetric flask of 50ml and distilled water was used to fill the flask. Samples were taken from this and a suppresser was added (lanthanium chloride) for calcium and magnesium determination and sodium chloride for potassium determination [16].Vitamin content was performed by reversed-phase HPLC method, a well-suited technique for vitamin analysis according to Adebiyi et *al*. [20].

Microbiological analyses: Microbiological analyses were performed according to Joseph's method [21].The total aerobic flora was counted on PCA (Plat Count Agar) after 72 h at 30°C according to ISO 4831 method, the yeasts and moulds on OGA (Oxytetracycline Glucose Agar) after 5 days at 25°C following the ISO 7954 method, mean coliform in BLBVB (Bubble Belie Lactose with the brilliant Green) after 48 hours at 30°C, Staphylococci on Baird Parker plate after 48 h at 37°C and Streptococcus by sowing of 1 mL of the first suspension (and diluted solutions) in 10 mL Rothe medium respectively according to ISO4832 and ISO 6888 methods. After 24 h (or 48 h) of incubation at 37°C, any tube presenting a bacterial disorder is considered positive.

RESULTS

Table1 shows the chemical composition and energy value of locally produced flour (MASOSO) compared with imported flour and standard flour of Sanogo et *al*. [22]. The energy density of the flour (366 kcal/100g) as well as its proteins (11%) and fat (6%)contents were not significantly different from the standard values suggested by Sanogo et *al*. [22]. The water content of the flour was 9% and its crude fiber content was5%. The table2 presents the results of ion determination and vitamin content of flour produced. The minerals content of the flour was found to be greater than the recommended value; but its vitamin content is consistent with the standard recommended. All this is an important advantage for consumer health. Total aeroby mesophile flora of the flour was significantly lower than the recommended values. No yeasts, moulds or pathogens *(Escherichia coli, Staphilococus aureus)* were found in the flour (table 3).

DISCUSSION

Also as shown in results of this work, the infant food, which is developed in this study based on local raw materials, is found to be physico-chemical and microbiological satisfactory. Each of unit operations involved in producing process contributes to the quality of the finished product. Extrusion cooking is a useful process for the production of instant in-fant flours, as it allows gelatinisation and partial dextrinisation of starch, as well as reduction of the activity of some antinutritional factors [23]. The triage-winnowing removes the damaged product (moldy grains) and impurities (stones, plant debris etc.). The drying-cooling operation leads to expanded products called crackers. The mineral content of MASOSO offers many benefits to infants. A meta-analysis showed that zinc supplementation caused a significant increase in height in children who were stunted and a significant increase in weight in children whose serum zinc was low. It was also shown that zinc supplementation decreased the incidence of diarrhea and pneumonia in children of preschool age[24]. The iron supplementation increases significantly the haemoglobin and ferritin concentrations of blood in children less than 24 months [25]. MASOSO is found to be easily digestible (5% of fibre) and contain appreciable amounts of protein (11%) and energy value (366kcal/100g DM), which rendered the product to be valuable and suitable to satisfy the criteria of infants foods that was recommended by FAO/WHO in1976; FAO in1979 and Valencia *et al*. in1988 [26-28]. It has been reported that proteins content for infant flours produced in Africa fluctuate from 8.2% to 21.3% [29]. It was the case for this study. According to current standards, recommended protein content of a complementary food is 2g for a child aged 6 to 9 months with average milk consumption of 666mland 3g for a child aged 9 to 11 months with average milk consumption of 611ml [30]. The protein density of MASOSO was 11%, which means the protein needs of infants will be largely met upon consumption of MASOSO. According to AGBO and ZANNOU TCHOKO [31, 32], the advantage of soy incorporation in infant gruel is justified by the fact that soy contains balanced proportions of proteins of good biological value containing all essential amino acids, vitamins and minerals. It's very high in fat gives it a significant calorific value. Since animal proteins are scarce and quite expensive in poor countries, the incorporation of vegetable protein, particularly soy protein should be encouraged because they are inexpensive and available than other animal proteins. The Ph of MASOSO infantile flour was 6.3 and according to the literature, the amylase activity has been reported to be effective at pH above 4 [33]. The infant flour proposed therefore offers appropriate condition for amylases contained in added maize. The energy density of MASOSO was the same range as flours commonly produced in Africa: Bitamin in Niger, Musalac in Burundi and Misola in Burkina Faso [34-38].

However, the flour had a lower energy density than *Vitafort* produced in Congo. This difference in energy density maybe explained by the use of BAN 800 MG, an enzyme produced by NOVO industry SA used as ingredients in the production of *Vitafort* [39].

CONCLUSION

This study led us to propose to African's household, generally at low monthly income, infantile flour for children in weaning-age, from available and accessible local products. The infant flour characterized in this study offers potential benefits that can help improve nutritional status of weaning-age children. The microbiological analyzes performed on this flour reveal that it contains no yeasts, moulds or pathogens *(Escherichia coli,* Sta*philococus aureus)* and therefore has no adverse effect on consumer health.

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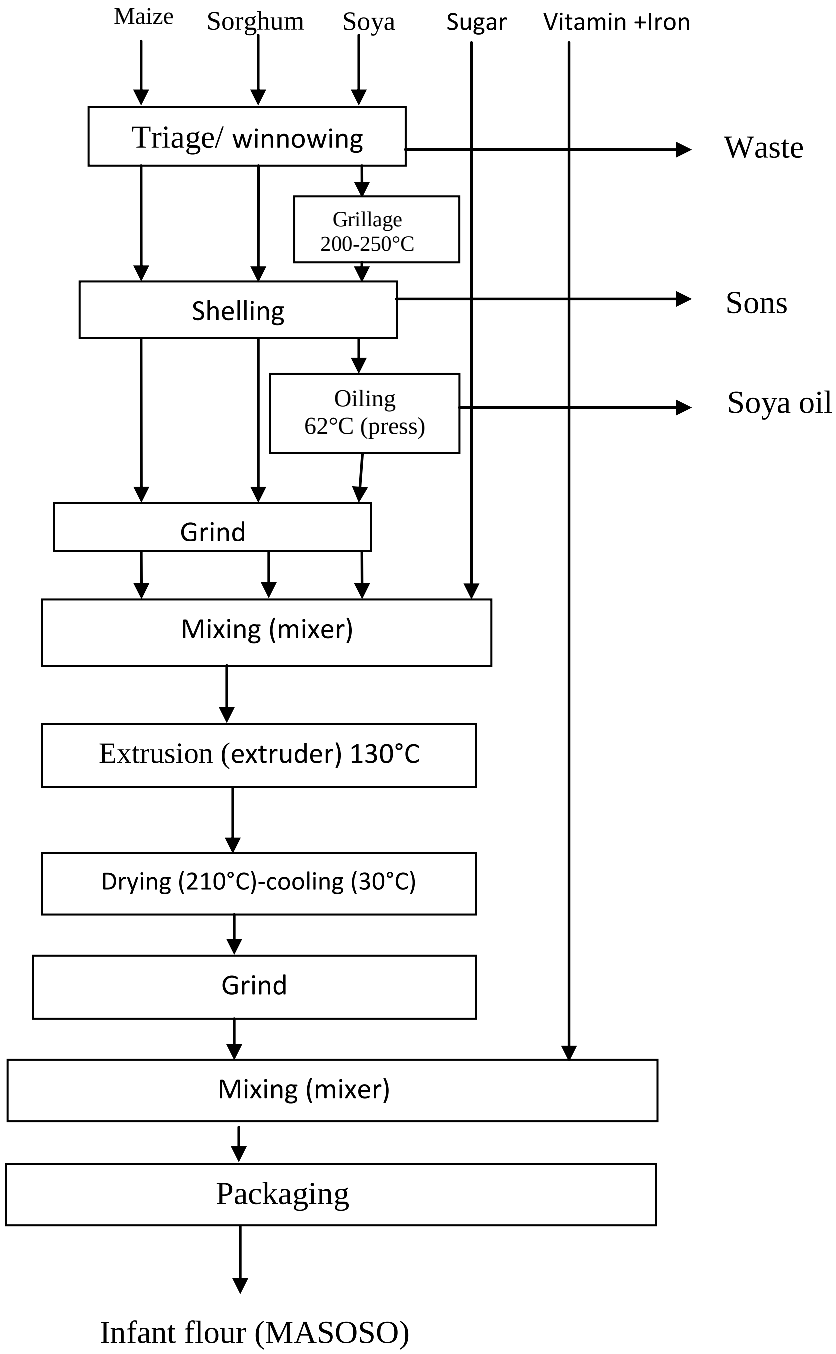

Figure1: Technological diagram of production of MASOSO

TABLE1: Nutritional characteristics of MASOSO compared with imported and standard flours

	MASOSO	Imported flour	Standard flour
Nutritional characteristics	In g for 100g DM		
Water content	9	8.8	5
Protein	11	7.5	13
Fat	6	2.1	7
Carbohydrate	67	76.8	68
Ash	2	2.3	2
Crude fibre	5	2.2	5
Ph	6.3	-	-
Nitrogen	1.5	1.5	-
Caloric value			
kcal/100g DM	366	396	400
kJ/100g DM	1530	1655	1672

DM: Dry Mater

TABLE2: Ion and vitamin content of the flour made compared with imported and standard flours

		MASOSO	Imported flour	Standard flour
Minerals (µg/100g)	Fe	6	8	> 4
	Mg	61		> 19
	K	178		>129
	Ca	140		> 125
Vitamins (mg /100g)	E	3.1	2	
	C	27	20	> 2.3
	B_1	0.09	0.7	> 0.03
	PP	3.2	3.5	

TABLE3: Microbiological characteristics of the infant flour compared with standard

microbiological characteristics (log CFU/g)	MASOSO	Standards
Total aeroby mesophil germs	3.39	< 5
Total coliforms	-	< 3
Faecal coliforms	-	< 2
Escherichia coli	-	< 1
Yeasts and moulds	-	< 3
Staphilococus aureus	-	< 1

CFU = colony Forming Unit;
(-) = absence of germs

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