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Physicochemical and nutritional evaluation of sweet potato based complementary mix

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Abstract

Sweet potato (*Ipomea batatas*) based complementary food was formulated from locally available foods by using different processing technologies like tray drying, roasting and sprouting. Three supplements were developed from locally available least expensive food items. Three different formulations were prepared from black rice, green gram, sweet potato, sesame seed; pumpkin seed, groundnut by incorporating them in varied composition and analysed for their nutrient and functional properties by following standard procedures. The moisture content of the sweet potato based complementary mix was 6.97%. The protein content of the complementary food blends are within the RDA values (13-14g) for infants as recommended by Nutrition Research Council (1989). Crude fat content was 2.29% followed by ash 2.74%, crude fibre 2.10%. The calcium and iron content of the complementary food was 530mg/100gm dry weight and 8.7 mg/100gm dry weight respectively. The bulk density of the sweet potato based complementary food mix was 0.71g/ml followed by water holding capacity 9.80g/100g. The viscosities of the formulation from 10%, 20% and 30% slurry concentration with spindle-4 ranged from 1.0 ± 0.02 - 1.6 ± 0.06 mPa.s, 12.2 ± 0.16 - 12.4 ± 0.21 mPa.s and 28.5 ± 1.13 - 39.7 ± 1.17 mPa.s respectively. The present study showed that the sweet potato based complementary food mix formulated from locally available food commodities (black rice, green gram, sesame seed, pumpkin seed and groundnut) met the nutritional needs of the children between 6 months to 2 years of age. Also, the present study established that the processing methods (sprouting) carried out had a positive influence on the nutritive values of the formulated diets.

Keywords: Physicochemical, complementary mix, sweet potato.

Introduction

One of the major public health problem among infants in developing countries is malnutrition which can be related to the composition of the complementary foods introduced after the breastfeeding period (Sanoussi *et al.*, 2013) [8]. The Food and Agriculture Organization (FAO) reported that about 2.0 billion people globally are suffering from chronic malnutrition, which is manifested in diseases like kwashiorkor, marasmus, and other related malnutrition problems. Of this population, about 1.2 billion are from the developing countries of Asia, Africa, and Latin America, where the most prevalent cause of death in infants after weaning is protein-energy malnutrition. Protein-energy malnutrition continues to be a major public health problem among children throughout the developing world (Barbin *et al.*, 2003; FAO, 2004) [5]. Poverty and poor feeding practices are considered the major factors responsible for this nutritional problem (Sachs *et al.*, 2005) [7]. Childhood malnutrition caused by the consumption of weaning foods of low nutrient density is common in developing countries (Black *et al.*, 2008) [2].

In many developing countries, commercially available weaning foods are too expensive for the average family, so nursing mothers often depend on traditional weaning foods that are low in nutritive value (Onofio *et al.*, 1998) [6]. The need for improvement of the nutritional quality of traditional complementary foods cannot be overemphasized. Under the present socioeconomic conditions in developing countries, the best means of enhancing the nutritional status of the people is by encouraging increased use of inexpensive and available foods. This can be achieved by supplementation of the popular cereal based complementary foods with legumes (pulses), oilseeds, roots and tubers like sweet potato.

Complementary foods based on either root or tuber crops have been shown to be significantly lower in phytate (by 3% to 20%) than cereal- and legume-based foods (Abu-Reidah *et al.*, 2014) [1]. A level of 0.01 g/100 g of phytate has been found in sweet potato. The inhibitory effect of phytate has been shown to be dose-dependent; hence the use of sweet potato to process complementary food is likely to result in a product that would be low in phytate. Sweet potato contains inulin in addition to starch as a carbohydrate reserve. Inulin is a soluble, fermentable, nonstarch carbohydrate containing fructose as monomers. When inulin was added to bread or liquid food in a human feeding trial, it was associated with increased calcium bioavailability. Fructose, as well as imparting sweetness to food, could possibly improve iron bioavailability. Human infants were found to consume fructose and sucrose (table sugar) in similar quantities, which indicates that the infants liked the sweetness of fructose; hence the presence of fructose in food would increase food intake without the need to add sweeteners. Daily fructose intake of 50 g or less, or approximately 10% of total food energy, has been recommended as not deleterious. Therefore, in the present investigation, complementary food formulations containing cream-fleshed sweet potato has been developed and their physicochemical and nutritional characteristics has been evaluated.

Materials and Method

Sample collection and preparation

Raw ingredients used, namely, black rice, green gram, sesame

seeds, pumpkin seeds and amaranth leaves were procured from the local market. The Assam Mix complementary food, developed by the Department of Food Science and Nutrition was used as the basis for formulating the complementary food mix.

Experimental formulations

The grains were cleaned of dust and other extraneous materials and stored at room temperature in air tight containers. Roasting and malting of the grains were employed in the processing of different ingredients as these are traditional method commonly used in rural families. Roasting was used as it significantly reduces most of the anti-nutrients and improves the taste, flavour and nutritional quality of the products. Malting was practised because it increases the digestibility, lowers the paste viscosity and increases the nutrient density.

The black rice was washed and kept for drying at 60 °C for 6 hours. The black rice was then roasted in a pan, grinded and sieved through 0-1mm screen to obtain the black rice flour and stored in an air tight container in a refrigerator for further use. The green gram was malted by first soaking the pulse, then germinating, drying and finally powdering after removal of husk. The steps used in the preparation of the ingredients are shown below:

Fig 1: Flow sheet of sweet potato based complementary food mix production.

The blended food mix was mixed in three different proportions as given below:

Complementary mix	Ingredients	Amount (g)
Supplement 1	Black rice flour	70
	Green gram	20
	Sweet potato	3.3
	Sesame seed	3.3
	Pumpkin seed	3.3
	Total	100
Supplement 2	Black rice flour	65
	Green gram	20
	Sweet potato	5
	Sesame seed	5
	Pumpkin seed	5
	Total	100
Supplement 3	Black rice flour	60
	Green gram	20
	Sweet potato	6.6
	Sesame seed	6.6
	Pumpkin seed	6.6
	Total	100

Fig 1: Raw-ingredients

Fig 2: Formulations of the complementary mix

Testing and evaluation

Sensory characteristics

The sensory evaluation was carried out by a panel of 20 members comprising of trained and semi trained members. A 9 point Hedonic scale was used to evaluate the formulations. Results indicated high scores for colour, flavour, taste, and overall acceptability to the formulations containing the

highest amount of sweet potato. Therefore further tests were carried out on the formulation 3.

Analytical methods

The moisture, protein, fat, crude fibre and ash contents of the complementary food was determined using the standard methods described by AOAC International (33). Total carbohydrate was calculated as the difference between 100 and the sum of the percentages of moisture, crude protein, total fat and ash (34). Mineral contents were determined in a dilute solution of the ashed samples by running them at a particular wavelength using the atomic absorption spectrophotometer to quantify the various mineral elements present in the sample.

Bulk density

Bulk density was determined using the method suggested by Lewis (1987). The bulk density of the sample (g/ml) was measured by placing a known weight of the mix into a measuring cylinder, tapping the cylinder a fixed number of times and determining the resultant bulk volume:

$$\text{Bulk density} = \frac{\text{Weight of product}}{\text{Volume of product}}$$

Water holding capacity

The WHC of the sample was determined using the method of Onwuka (2005). A measured quantity (1g) of the sample was dispersed in 10ml of distilled water in a conical graduated centrifuge tube. The sample was thoroughly mixed for 30 seconds and allowed to stand at room temperature for 30 minutes before being centrifuged at 5,000*g for another 30 minutes. The volume of the supernatant was measured directly from the graduated centrifuge tube. The amount of the absorbed water was multiplied by the density of water (1g/ml) and results were expressed as g/100g.

Viscosity

Viscosity of the sample was determined as per modification method given by Hallic and Kelly (1959) by using Brookfield viscometer. Complementary food mixes were reconstituted with water at different solid concentrations (10, 20 and 30%) heated for 10 minutes in a boiling water bath, cooled to ambient temperature (27 °C) and the viscosity was measured in Brookfield viscometer using appropriate spindles depending on the slurry consistency. The spindle was determined by trial and error to get a % torque reading between 10% and 100%. The viscosity was measured in milli Pascal seconds (m.Pa.s).

Results and Discussion

Proximate composition of sweet potato based complementary food mix has been shown in Table 1.

Table 1: Proximate composition of sweet potato based complementary food mix

Parameters	Sweet potato based complementary food mix
Moisture (%)	6.97±0.25
Crude protein (%)	17.74±0.37
Crude fat (%)	2.29±0.16
Ash (%)	2.74±0.21
Crude fibre (%)	2.10±0.02
Total carbohydrate (%)	91.23±0.12
Calcium (mg/100gm dry weight)	530.16±0.26
Iron (mg/100gm dry weight)	8.7±0.17

From table 1., it has been observed that the moisture content of the sweet potato based complementary mix was 6.97%. Moisture content and water activity are key factors affecting the storage, shelf life, and safety of foods. The moisture content of the blend was within RDA values (5-10%) for moisture content of complementary foods (NRC, 1989). The low moisture content of the blend (<10%) will ensure their shelf-life stability. The protein content of the complementary mix was 17.74%. The values of the protein content observed in this study was within the range as reported by other researchers. The lower value of protein observed in this study could be attributed to the effects of heat treatment after soaking and germination as reported by Uppal and Basins (2012). Khalil *et al.*, (1986) also reported the decrease in protein content after cooking of field pea, moth pea and pigeon pea. The protein content of the complementary food blends are within the RDA values (13-14g) for infants as recommended by Nutrition Research Council (1989). The crude fat content was 2.29%. The low fat content might be due to the malting loss incurred as a result of dry matter loss, mainly due to growth and respiration of the embryo and the enzymatic activity in grains as reported by Abiodun (2002). Uppal and Bains (2012) also reported the reduction in fat content of germinated chickpea and cowpea. Low crude fibre content (2.10%) of the studied complementary blend could be due to the reason that the fibre in the hull was removed during processing. Genc *et al.*, (2005) reported that the cereal hull contains about 64% of the total fibre. The ash content which is an index of mineral content in food samples was 2.74% and this falls within the RDA values (not less than 2% and not more than 5%) for infants upto 1 year of age as recommended by NRC (1989). The total carbohydrate content of the sweet potato based complementary food mix was 91.23%. Hence the developed complementary food can meet the energy requirement of the infant. The calcium and iron content of the complementary food was 530mg/100gm dry weight and 8.7 mg/100gm dry weight respectively.

Table 2: Functional properties of the sweet potato based complementary food mix

Functional properties	Sweet potato based complementary food mix		
Bulk density (g/ml)	0.71±0.00		
Water holding capacity (g/100g)	9.80±0.18		
Viscosity (m.Pa.s)	10%	20%	30%
	1.0±0.02-1.6±0.06	12.2±0.16-12.4±0.21	28.5±1.13-39.7±1.17

Table.2, revealed that the bulk density of the sweet potato based complementary food mix was 0.71g/ml followed by water holding capacity 9.80g/100g. The water holding capacity of the flours influence the amount of water available. During mixing, the free water can migrate towards water binding sites and thus increase the viscosity of the products. Also protein and starch have the tendency to bind water. Therefore, the low protein content of the complementary mix may possibly affected the water holding capacity. The cold paste viscosities of formulated complementary food mix from 10, 20, 30% slurry concentration respectively are reported in table.2. The viscosities of the formulation from 10% slurry concentration with spindle-4 ranged from 1.0±0.02-1.6±0.06 mPa.s. The viscosities of the formulation from 20% slurry concentration with spindle-4 ranged from 12.2±0.16-12.4±0.21 mPa.s. The viscosities of the formulation from 30%

slurry concentration with spindle-4 ranged from 28.5±1.13-39.7±1.17 mPa.s. Thus it has been observed that the viscosity of the cooked paste of formulated weaning mixes increased with slurry concentration. In a study conducted by Ikujenlola and Fashakin (2005), it was reported that the viscosity of the germinated blends were significantly reduced compared with ungerminated blends. Germination increases the amylase activity and degrade the starch granules which reduce the water binding capacity of granules thereby reducing the viscosity.

Summary and Conclusion

The present study showed that the sweet potato based complementary food mix formulated from locally available food commodities (black rice, green gram, sesame seed, pumpkin seed and groundnut) met the nutritional needs of the children between 6 months to 2 years of age. However further investigations on fortification with appropriate macronutrients or micronutrients- dense food stuff should be carried out. Also, the present study established that the processing methods (sprouting) carried out had a positive influence on the nutritive values of the formulated diets. It is recommended that infants fed on this formula should be of atleast 6 months, as the formulation is intended to act as supplement to breast milk and as a transition meal from breast milk to family diet and not as a substitute to breast milk.

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