Journal of Engineering and Applied Sciences 3 (6): 471-475, 2008
ISSN: 1816-949X

Chemical and Functional Properties of Complementary Food from Malted and Unmalted Acha (*Digitaria exilis*), Soybean (*Glycine max*) and Defatted Sesame Seeds (*Sesamun indicuml.*)

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Abstract: Acha (*Digitaria exilis*), soybean (*Glycine max*) and sesame (*Sesamun indicum* L.) seeds were cleaned separately of dirt and extraneous materials. The acha grains were malted by steeping, germinating (72 h), drying (60°C, 20 h), dehulling, milling and sieving. Soybean and sesame seeds were processed into flours using standardized methods. Complementary food blends were formulated at various ratios from malted and unmalted acha, full fat soybean and defatted sesame flours. The formulations thus produced were assessed for chemical and functional properties. The results showed that the blends containing the malted acha had better functional properties with respect to the viscosity, water absorption capacity and bulk density. The viscosity was particularly low (< 2.550 Cps) which will enhance consumption by the intending infants. The inclusion of sesame flour boosted the level of protein of the blends.

Key words: Acha, malting, complementary food, functional, viscosity

INTRODUCTION

The use of traditional staples such as cereal as a source of complementary food to infants that are weaned from milk is well recognized (Fashakin and Ogunsola, 1982; Gopaldas *et al*., 1988; Onofiok and Nnanyelugo, 1998; Ikujenlola, 2004). However, there is an inherent problem associated with the utilization of these staple foods as complementary food and this lies in the inability of the staples to satisfactorily supply all the necessary nutritional requirements of the fast growing infants. Plant proteins are incomplete in that, it lack in one or two essential amino acid which the infant require for optimum growth and wellbeing. Cereals like maize, wheat, barley, acha (hungry rice), millet and sorghum are lacking in lysine as the first limiting amino acid and tryptophan as the second limiting amino acids and these essential amino acids can not be synthesized at reasonable quantity by the body (Bressani and Elias, 1974; FAO, 1992). Legumes like soybean, cowpea, green gram and chick pea are deficient in sulphur bearing amino acids such as methionine and cystine. Coupled with this problem is the problem of processing of the traditional weaning food which often lead to leaching or depletion of protein from the resulting gruel. Adeyemi (1989) reported that fermented maize contained less than 0.5% protein after processing to Ogi. In addition, other significant problem associated with traditional complementary food and commercially available weaning food is the high dietary bulk which often prevents the growing infants from consuming as much as possible of the gruel. High dietary bulk is responsible for high viscosity and thick gruels; this makes consumption difficult for children. The reports of Marero *et al*. (1988), Gopaldas *et al*. (1988), Kulkurnai *et al*. (1991), Obatolu and Cole (2000) and Sajilata *et al*. (2002) showed that various method have been adopted in combating the problem of high dietary bulk, one of the simplest methods being malting. The principle is that during malting process certain enzymes called amylase is activated which dextrinified starch to simple sugars which does not swell when cooked.

The utilization of acha (*Digitaria exilis*) in this study was informed by its availability in the northern parts of Nigeria and the fact that not too many information as regards its utilization in complementary food has been explored especially it complementary effect with soybean and sesame flours which are known to be very high in good quality protein and oils (Kaga *et al*., 2003). Therefore, this study is designed to produce high nutrient density low dietary bulk complementary food from acha, soybean and sesame seeds using malting technology.

MATERIALS AND METHODS

The acha (*Digitaria exilis*) used was purchased from the Jos Market, Jos Nigeria. While soybean and sesame seeds were bought from Owo central market, Owo, Nigeria.

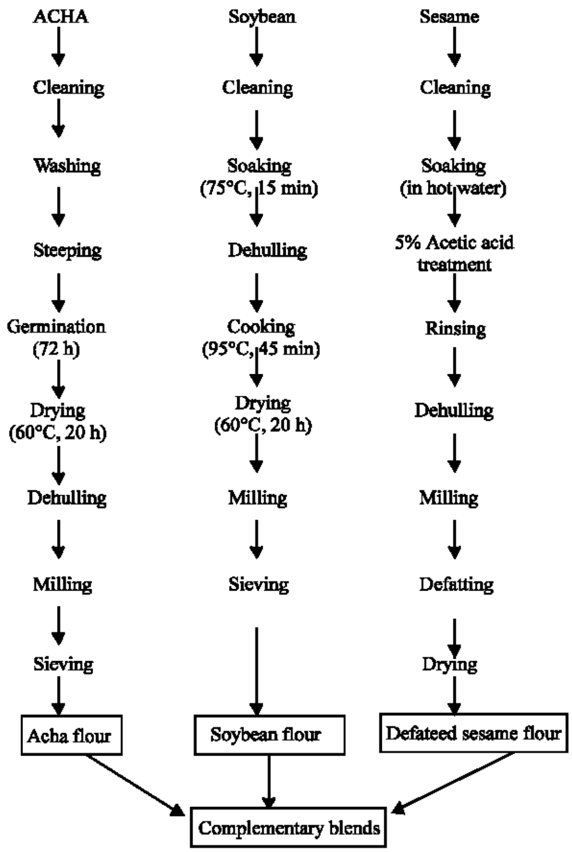

Fig. 1: Flow chart of the unit operations involved in the production of various flours of acha, soybean and sesame seeds

Production of alted acha flour: The method described by Marero *et al*. (1988) was adopted in the production of malted acha. The grains were cleaned in tap water and steeped in water (1:3) for 8 h it was spread evenly (1.5 cm depth) in a germinating chamber for 72 h with constant watering to maintain its moisture content. The resulting green malt was dried in cabinet dryer at 60°C for 20 h, this was later desprouted, conditioned, dehulled, milled and sieved (Fig. 1).

The Soybean and Sesame flours were produced according to the methods of Obayanju and Ikujenlola (2002) and Kulkarni *et al*. (1991), respectively. Figure 1 gives the flow chart of the unit operations involved in the various flours production. The unmalted acha flour was produced according to the method of Obayanju and Ikujenlola (2002).

Proximate composition determinations: The proximate composition of the blends (protein, fat, ash, crude fibre and moisture) were determined by using the standard methods of AOAC (1990). Carbohydrate was determined by difference and energy value was determined by calculation using the relationship described by Osborne and Voogt (1978) (1g of protein, carbohydrate and fat are multiplied by factors 4, 4 and 9 kcal, respectively).

Table 1: Various complementary blends

Sample	Acha	Soybean	Sesame
Unmalted A	100	-	-
Unmalted B	70	30	-
Unmalted C	70	20	10
Malted A	100	-	-
Malted B	70	30	-
Malted C	70	20	10

Functional properties determinations: The functional characteristics of the blends were assessed by determining the values for these parameters; bulk density, water absorption capacity, oil absorption capacity and viscosity.

The water holding capacity was determined using the method of Quinn and Paton (1979). The oil absorption capacity was determined by the method of Sosulki *et al.* (1976). The method described by Ikujenlola and Fashakin (2005) was used in the determination of the viscosity of the blends.

Formulations of the blends: The flours (acha, soybean and sesame) were formulated into various blends using the various ratios in Table 1.

RESULTS AND DISCUSSION

Chemical compositions: The chemical compositions of the formulated blends were as presented in Table 2. The major components of the blends are protein, fat and carbohydrate. The protein of acha flour was 7.23%, the value was 7.68% for the malted acha flour. The protein content of the malted complementary blend ranged between 16.23-21.08%, while a range of 13.25-17.90% protein was the levels for unmalted blends. The inclusion of sesame increased the level of protein in the samples (unamlted Sample C and malted sample C). The report of Kaga *et al*. (2003) showed that sesame has between 24.90 and 46.70% protein. The presence of soybean and sesame guarantee good quality protein in terms of the essential amino acids. Legume and oil seeds are reportedly high in protein of good quality essential amino acids (Robellen *et al.* 1988). The fat content of the malted blends ranged between 8.15 and 12.10% while the unmalted blends ranged between 7.20 and 13.30%. Flours of high fat content supply high energy however, food containing high fat is susceptible to both hydrolytic and oxidative/enzymatic rancidity which is responsible for off flavour and this affect both the general acceptability and

Table 2: Proximate composition of the blends (%/100g)

Sample	Fat	Protein	Ash	Crude fibre	Moisture	Carbohydrate (By difference)	Energy (Kcal)
Malted A	3.45	7.68	3.45	2.75	8.50	74.17	358.45
Malted B	13.15	16.23	4.10	2.20	7.65	56.67	409.95
Malted C	18.10	21.68	4.00	2.05	8.25	45.92	433.30
Unmalted A	3.95	7.23	4.25	2.50	9.00	73.07	356.75
Unmalted B	12.20	13.25	3.90	2.15	8.75	59.75	401.80
Unmalted C	15.35	17.90	4.20	3.50	7.50	51.55	415.95
Control	9.00	16.00	2.00	5.00	4.00	64.00	401.00

Table 3: Functional properties of complementary blends

Sample	Malted A	Malted B	Malted C	Unmalted A	Unmalted B	Unmalted C	Control
Bulk density (g mL^{-1})	0.65	0.50	0.51	0.75	0.70	0.65	0.60
Water absorption capacity (%)	110	115	113	125	125	150	140
Swelling capacity (%)	115	110	120	130	145	165	145
Oil absorption capacity (%)	135	130	135	120	120	125	130

Table 4: Consistency of the blends

Dry matter	Malted A	Malted B	Malted C	Unmalted A	Unmalted B	Unmalted C	Control
10%	Free flowing	Free flowing	Free flowing	Free flowing	Free flowing	Free flowing	Freeflowing
15%	Free flowing	Free flowing	Free flowing	Spoonful	Spoonful	Spoonful	Spoonful
20%	Free flowing	Free flowing	Free flowing	Paste like	Paste like	Paste like/Viscous	Spoonful

storage stability of the products. The moisture contents of the products were all below 10% these values are lower enough to allow for good storage if packaged properly. These results compared favourably with the commercial weaning food sold in Nigeria.

Functional properties: The bulk density of the malted samples as shown in Table 3 were lower compared to the unmalted samples and the control. During malting the activated amylase enzyme dextrinified starch. Desikachar (1980) reported that malting process is useful in the preparation of low bulk weaning foods. Low bulk density food is desired where packaging is a serious problem. Water absorption and swelling capacities of the malted samples were lower than the values for the unmalted samples. The water absorption capacity relate to the amount of water available for gelatinization. Malting according to Marero *et al.* (1988), Kulkarni *et al.* (1991) and Mensah and Tomkins (2003) lowers water absorption capacity of malted flour, lower water capacity would be desirable for producing a thinner gruels or porridges for children. Gruels of low water capacity will allow for increase total solid.

Viscosity of food is one of the important determinants of food acceptability to both mothers and young children. Viscosity is the measure of the resistance to fluid to flow. Food is visco-elastic in nature. Weaning or complementary food of high viscosity is usually unacceptable to growing infants as it makes feeding difficult and causes suffocation. The malted blends gave a better viscosity (<2,250 cps) than the unmalted and the control samples (>10,550 cps) (Fig. 2). The consistencies (Table 4) of the malted blends were soft and free flowing

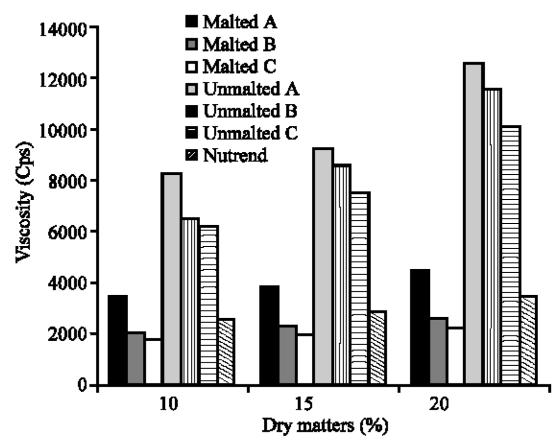

Fig. 2: Viscosities of the various blends

compared to the high viscous and thick consistency of the unmalted. The low paste viscosity of the malted samples was informed by the activity of the amylase enzyme which breaks down the starch molecule of the grain to dextrin and eventually to maltose and glucose. These sugars always have low viscosities. With low viscosity infant can easily consume as much as possible of the food and more solid can be added to the mixture; this will no doubt increase the nutrient density of the gruels which is highly beneficial to the infants. The reports of Desikarchar (1980), Marero *et al.* (1988), Kulkarni *et al.* (1991), Uvere *et al.* (2002), Sajilata *et al.* (2002) and Ikujenlola and Fashakin (2005) showed that malting process is valuable in reducing the viscosity of infants' gruels and increase the total solid of such gruels and thereby increase the nutrient density of such food.

The oil absorption capacities of the malted samples were higher than the unmalted complementary blends. This observation agreed with the reports of Narayana and Narasinga (1984) and Ikujenlola (2004). This observation is at variance with the report of Obatulo and Cole (2000).

CONCLUSION

The fortification of acha (hungry rice) with soybean and sesame has led to the production of a complementary blends of high nutritive food which will guarantee good and healthy living for infants and the problem of protein energy malnutrition can be reduced with these formulations. The adoption of malting technology also added advantage to the functional properties especially the viscosity and water absorption capacity which were reduced this ensure the production of gruels of low hot paste viscosity which will encourage more and easy consumption of the blends, moreover, large quantity of solid can be added to improve the nutritive value. In addition, the inclusion of sesame flour to the blend led to the increase in the level of high quality protein. Mothers and caregivers living in areas where acha, sesame and soybean are grown can adopt the malting technology in the production of infant food of high nutritive value.

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