Direct RESEARCH JOURNALS

Vol.4 (9), pp. 259-264, September 2016
ISSN 2354-4147
Article Number: DRJA53173619
Copyright © 2016
Author(s) retain the copyright of this article
Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/aboutjournal/drjafs

Research Paper

Evaluation of tiger nut (*Cyperus esculentus*), soya bean (*Glycine max*) and acha (*Digitaria exilis*) on the functional properties as weaning food

***[1]Bassey. S. O., [2]Ambo, E. E., [2]Inah, G. M. and [1]Ekpo, G. I.**

[1]Department of Biochemistry (Human Nutrition and Dietetic Unit), University of Calabar, Calabar, Cross River State, Nigeria.
[2]Department of Hospitality and Tourism, Cross River University of Technology, Cross River State, Nigeria.

*Corresponding author E-mail: starbassey2006@yahoo.com

Received 7 July 2016; Accepted 29 July, 2016

Micronutrient deficiency in infants is one of the major problems for most developing countries in Africa. Hence, the need for a weaning formula is of great importance as part of the interventions for the prevention of child under-nutrition and survival. The objective was to formulate and evaluate the functional quality of composite weaning food based on tiger nut (*Cyperus esculentus*), soya bean (*Glycine max*) and acha (*Digitaria exilis*) seeds as a substitute for the traditional weaning food. These seeds were processed into flour and six weaning formulates: TSA_1 (20:30:50), TSA_2 (20:50:30), TSA_3 (10:50:40), TSA_4 (30:40:30), TSA_5 (10:30:60) and TSA_6 (50:30:20). Commercial weaning food (Infacare) was used as control. Effect of these seeds or flours on the functional properties of the formulated blends were evaluated. Wet ability values ranged from 3.12 ±0.04 to 30.125 ±0.097. Swelling power values, bulk density value, measure of dispensability values reduced with percentage increase in ranged from 3.13 ±0.05 to 3.6 ±0.05. The % solubility values ranged from 20.36 ±1.240 to 24.46 ±1.2 with sample TSA_6 having the highest value and sample TSA_1 with the least value. The peak viscosity values ranged from -0.48 ±0.065 to -4.13 ±0.875; setback values were not significantly different from the control. The % increase in malted acha with decrease in tiger nut and soya beans correspondingly resulted in product with more fortified functional properties, and substitutes for the local complementary foods to low income homes in the country.

Key words: Acha, blends, functional properties, porridge, soya bean, tiger nut, weaning food

INTRODUCTION

Micronutrient deficiency otherwise referred to hidden hunger, is one of the major problems for most developing countries in Africa (Alderman and Sebastian, 2009). An infant between 6 and 12 months old with a weight if 8.5 needs about 98 kcal/kg or about 843 kcal of required daily food intake to obtain such body weight. Normally for such requirement to be met, 1.3 liters of breast milk with 67 kcal/100ml should be available as child caloric needs, making most nursing mothers resort to the use of traditionally produced weaning foods (Alderman and Sebastian, 2009). Weaning food are foods which gradually replaces breast feeding and act as a source of nurturing of infants. In this part of Africa, weaning foods are usually in the form of cereal gruels which are suspensions of cooked maize, rice or sorghum that are very much unlike the milk-based one which are expensive (Onuoha *et al.*, 2014). Sequel to this, home fortification of complementary food for children, aged 6 to 23 months and timely introduction of adequate, safe and appropriate complementary feeding has been recommended as part of the interventions for the prevention of child under nutrition and survival. Malnutrition and poverty poses a major challenge to low-income families in developing nations and the twin issues are very critical for a growing infant. Commercially processed weaning foods are expensive for these categories of families (Bhutta *et al.*, 2008).

Tiger nut (*Cyperus esculentus*) contains oil and milk. It is a refreshing vegetable which can be traditionally prepared into simple soft drink, mostly consumed during Ramadan fasting and other festivities in Nigeria with a mild, pleasant nutty flavor plus a superior texture to other vegetable (Bassey *et al.*, 2016).

Soya bean (*Glyane max*) is a species of legume, native to East Asia, widely grown for its edible beans which have numerous uses (Onuoha *et al.*, 2014). It product such as texture vegetable protein (TVP) are ingredients in many meat and dairy analogue protein. Soya beans oil contain a lot of phytic acid, alpha linolenic acids and isoflavones with much significant to health and industrial use (Riaz, 2006).

Acha (*Digitaria exilis*) is a cereal grain crop grown abundantly in the northern regions of Nigeria also known as hungry rice. It reduces the viscosity of high viscous foods significantly and used to produce porridges. When acha is malted a technology commonly practiced by rural dwellers, it can result in the production of more enzymes like amylases which dextrinifies starch to simple sugar (Jideani, 1999).

This research work is aimed at assessing the functional properties and potentials of the blends of tiger nut (*Cyperus esculentus*), soya bean (*Glycine max*) and acha (*Digitaria exilis*) flours for formulation of weaning foods. This would allow for the production of low viscous foods that an infant can consume in significant quantities to supply needed nutrient and energy for infant growth.

MATERIALS AND METHODS

Sources and processing of the ingredient

The tiger nut (*Cyperus esculentus*) soya bean (*Glycine max*) and acha (*Digitaria exilis*) were bought from Watt market, Calabar, Nigeria and taken for processing in the recipe laboratory of Hospitality and Tourism of Cross River University of Technology, Cross River State, Nigeria. The grains were cleaned and washed in tap water and steeped in water for 8 h and then spread evenly (1.8 cm depth) on a bench top and covered with a moist jute bag for 72 h with constant watering to maintain its moisture content. The method described by Marero *et al.* (1988) was used in malting the acha. The resulting green malt which was then dried in an oven dryer at 60°C for 20 h and then de-sprouted and conditioned; while there tiger nuts were washed, de-stoned and sun-air-dried separately. The soya bean were sorted, roasted at 163°C for 20 min, it was also de-branded and milled into past with attribution machine and sun-air-dried.

Weaning food formulation

The following 6 formulations were made as follows: 20:30:50,20:50:30,10:50:40,30:40:30,10:30:60,50:30:20 for Tiger nut: Soya bean and acha (TSA) respectively. It was then milled using a disc attrition mill (Hunt No. 45 A premier mill, Hunt and Co, UK) into flour of the % composition to an average particle size of less than 0.3 mm. The flour were then sieved through a fine mesh (0.5um) to obtain the composite meal (weaning formula) using method described by Opara *et al*. (2012).

Method of Analysis

Evaluation of physical and functional properties

Bulk density (g/ml)

The method described by AOAC (2005) was adopted. 10 ml capacity graduates measuring cylinder was pre-weighed. The cylinder was then filled gently with the sample to the 10 ml marks. Bulk density was then filled gently with the sample of the 10 ml mark. Bulk density (g/ml) formulae is weight of sample (g) all over volume of sample (ml).

Bulk density (g/ml) = Weight of sample (g)/Volume of sample (ml)

Swelling (g)

One g of the flour sample was mixed with 10ml distilled water in a centrifuge tube and heated at 80°C for 30min with continually shaken during the heating period. The slurry was cooled to room temperature and then, the suspension was centrifuged at 1000 x g for 15 min. The supernatant was decanted and weight of the paste taken. The swelling was calculated as; Weight of paste (g)/Weight of dry flour (g) (Leach *et al.*, 1959).

Wet ability of formulae

The method described by AOAC, (2005) and Onwuka, (2005) was used. One g of sample was added into a 25

Table 1. Functional properties of the weaning formulae.

Treatment	Bulk density (g/ml)	Water absorption capacity (g/100g)	Measurement of dispensability %	Wet ability (mm)	Swelling power (g/f)	% solubility
TSA_1	6.696 ± 0.360^{b}	5.40 ± 0.533^{a}	89.35 ± 2.6^{a}	7.44 ± 0.074^{b}	3.13 ± 0.05^{a}	20.36 ± 1.240^{b}
TSA_2	5.727 ± 0.245^{a}	8.90 ± 0.239^{ab}	81.58 ± 3.15^{a}	19.193 ± 0.715^{d}	3.6 ± 004^{a}	23.18 ± 0.72^{ab}
TSA_3	876 ± 0.093^{a}	7.66 ± 0.301^{ab}	74.07 ± 0.78^{ab}	8.79 ± 1.97^{c}	3.42 ± 0.02^{a}	22.96 ± 0.22^{ab}
TSA_4	727 ± 0.230^{c}	7.8 ± 0.331^{b}	83.88 ± 3.98^{ab}	12.91 ± 0.67^{d}	3.6 ± 0.04^{a}	23.26 ± 0.68^{ab}
TSA_5	688 ± 0.12^{b}	4.8 ± 0.712^{b}	72.54 ± 4.37^{b}	3.12 ± 0.4^{a}	3.23 ± 0.05^{a}	20.58 ± 1.23^{b}
TSA_6	6.953 ± 0.021^{c}	9.23 ± 0.1^{b}	70.38 ± 3.64^{b}	30.125 ± 0.097^{c}	3.6 ± 0.03^{a}	24.46 ± 1.2^{ab}
Control	5.48 ± 0.05^{a}	1.96 ± 0.19^{b}	40^{c}	3.92 ± 0.051^{a}	27.24 ± 0.05^{a}	

*Means of three determination. Values not followed by the same letter in the same row are significantly different ($P<0.05$).

** Infacare used as control

TSA_1- 20% tiger nut, 30% soya bean; 50% malted acha
TSA_2- 20% tiger nut, 50% soya bean, 30% malted acha
TSA_3- 20% tiger nut, 50% soya bean, 40% malted acha
TSA_4- 30% tiger nut, 40% soya bean, 30% malted acha
TSA_5- 10% tiger nut, 30% soya bean, 60% malted acha
TSA_6- 50% tiger nut, 30% soya bean, 20% malted acha

ml graduated cylinder with a diameter of 1 cm was used by placing a finger over the open end of the cylinder then later inverted and clamped at a height of 10 cm from the surface of a 600 ml beaker containing 500 ml of distilled water. The finger was removed and the time required for the sample to become completely wet recorded as wet ability.

Water absorption capacity (WAC)

One gram of the sample was weighed in a conical graduated centrifuge tube. It was then mixed thoroughly with mixing of 10 ml distilled water using warring whirl mixer for 30 sec. The sample was allowed to stand for 30 min at room temperature and then centrifuged at 5000 xg for 30 min. The volume of free water (supernatant) was then read directly from the graduated centrifuged tube. The % of absorbed water was calculated according to Sosulki *et al.* (1976).

Dispensability of formulae

The methods described by Balami *et al.* (2004) and Onwuka, (2005) were adopted. 50 ml of distilled water was added to 3 g of the sample and stirred for one min at room temperature. The mixtures were filtered through dried cheese cloth of known weight then rinsed in a beaker with 50 ml of distilled water and poured through the cheese cloth. The sieve and the residue were dried in a hot air oven at 100°C for 10 min. The dispensability was expressed as the % of the solids dissolved.

Pasting properties

Pasting properties was done by mixing 3 g each of flour samples with 25 ml distilled water in the canister of a rapid visco analyzer (RVA 4500, Perten manufacture, U.S.A) and monitored. The following parameters were observed; peak viscosity, pasting temperature, setback viscosity, breakdown viscosity, final viscosity and time to reach the peak viscosity.

Statistical analysis

Data collected were subjected to analysis of variance (anova) using statistically analytical system (SAS) software, version 8. Mean separations were done using Fischer LSD at 0.05% probability.

RESULTS AND DISCUSSION

Table 1 shows the results of functional properties of the formulae of the weaning food and Infacare (as control). Bulk density values (g/L) ranged from 5.727±0.245 to6.953±0.021 with formula TSA_6 Having the highest value. Functional characteristics such as bulk density, water absorption, swelling

Table 2. Pasting characteristics of the weaning formulae.±

Sample	Peak viscosity	Trough	B/D	FV	SB	Pt	P/Temp
TSA_1	$0.48{\pm}0.05^{c}$	6.12 ± 0.04^{a}	$5.14{\pm}0.101^{d}$	$3.28{\pm}0.45^{b}$	$2.17{\pm}0.10^{b}$	$4.01{\pm}0.0^{b}$	$50.16{\pm}0.01^{a}$
TSA_2	$1.46{\pm}0.20^{bc}$	$5.16{\pm}0.15^{a}$	$3.96{\pm}0.04^{c}$	$2.13{\pm}0.045^{b}$	$2.05{\pm}0.08^{b}$	$4.16{\pm}0.0^{b}$	$50.41{\pm}0.075^{a}$
TSA_3	4.13± 0.875a	$6.03{\pm}0.51^{a}$	$2.46{\pm}0.21^{b}$	$4.20{\pm}0.25^{a}$	$2.33{\pm}0.05^{b}$	$4.09{\pm}0.02^{b}$	$50.2{\pm}0.05^{a}$
TSA_4	$1.9{\pm}0.25^{b}$	4.0±0.21b	$2.11{\pm}0.08^{ab}$	1.21 ± 0.03^{c}	$2.42{\pm}0.0^{b}$	$3.66{\pm}0.02^{b}$	$50.24{\pm}0.0^{a}$
TSA_5	$1.345{\pm}0.035^{b}$	$5.11{\pm}0.04^{ab}$	$3.48{\pm}0.13^{c}$	$2.21{\pm}0.01b^{c}$	$2.89{\pm}0.21^{c}$	$4.25{\pm}0.1^{b}$	$50.25{\pm}0.05^{a}$
TSA_6	$3.19{\pm}0.0389^{a}$	$5.64{\pm}0.04^{a}$	$1.69{\pm}165^{a}$	3.36 ± 0.09^{b}	$2.93{\pm}0.45^{b}$	$3.80{\pm}0.0^{c}$	$50.18{\pm}0.25^{a}$
Control	$4.09{\pm}0.0889^{a}$	$5.78{\pm}0.301^{a}$	$1.67{\pm}0.165^{a}$	4.2 ± 0.21^{a}	$1.54{\pm}0.04^{a}$	$2.82{\pm}0.5^{a}$	

*Means of three determination. Values not followed by the same letter in the same row are significantly different (P<0.05).
B/D – break down; FV-Final viscosity; SB-Setback; Pt = peak time P/Temp– Pasting Temperature; * Control = Infacare
TSA_1- 20% tiger nut, 30% soya bean; 50% malted acha
TSA_2- 20% tiger nut, 50% soya bean, 30% malted acha
TSA_3- 20% tiger nut, 50% soya bean, 40% malted acha
TSA_4- 30% tiger nut, 40% soya bean, 30% malted acha
TSA_5- 10% tiger nut, 30% soya bean, 60% malted acha
TSA_6- 50% tiger nut, 30% soya bean, 20% malted acha

power and pasting properties of the food materials are very important for the growing children (Otegbayo *et al.,* 2009).

This invariably influences the frequency of feeding and quantity of the diet consumed by the infant who are also important in determining the extent to which an individual will meet his or her energy and nutrient requirements (Otegbayo *et al.,* 2009). Bulk density decreased with increasing % addition of malted acha. However, the Bulk Density (BD) is a reflection of the load the sample can carry if allowed to rest directly on one another. The lower the bulk density value, the higher the amount of flour particles that can stay together thereby increases the energy content derivable from such diets (Onimawo and Egbekun, 1998). However, no significance difference between sample TSA_2, TSA_3, and the control (p< 0.05). This trend agrees with Onuoha *et al.*(2014), that the reaction of malting vitally affects the water absorption capacities in addition to the viscosities of flours. The advantage of low bulk density presence in complementary diets is the gruel or porridge form from this diet will have a dietary bulk that is low. This is as a result of the higher the bulk limit, the lower the caloric and nutrient intake per child feed. This is based on the fact that infants are sometimes unable to consume enough to satisfy their energy/nutrient requirement with less viscosity, plasticity and elasticity present.

According to Opara *et al.* (2012), bulk density is very important in packaging requirement and handling material of complementary diet. Water absorption capacity values ranged from 4.8 ± 0.712 to 9.23 ± 0.1 g/100 g indicating the increase in values with increase in % addition of malted acha. WAC is the ability of a product to associate with water under a condition where water is limiting (Omueti *et al.,* 2009). There was a progressive reduction in WAC values as the level of acha flour decreased. However, there was no significant difference at P< 0.05 for all the samples.

This indicates that the samples react in manner or attraction in water, which means the lower the water absorption capacity, the lower the formulae water binding capacity which is desirable for making thin gruels with high caloric/nutrient density per unit volume which is in agreement with the finding of Onuoha *et al.* (2014) and Opara *et al.* (2012). The dispensability values ranged from to 38 ± 3.64 to 89.35 ± 2.6 % which implies that there is a reduction in value with % increase in addiction of malted acha.

The dispersibility of a mixture in water indicates its reconstitutability. The higher the dispensability the better and more preferred. The comparatively high dispensability values is based on the easily digested carbohydrate, low sucrose and starch content, enzymatically hydrolyzed proteins and particles size distribution (Bassey *et al*., 2016).

Wet ability values ranged from 3.12±0.04 to 30.125± 0.097 mm. Wet ability is time dependent and when malted acha decreases, wet ability decreases. The decrease in the wet ability could be due to disruption of the nature of molecule in the malted sample which resulted to low interfacial tension between the particles and the liquid (Onuoha *et al*., 2014). Swelling power values ranged from 3.13 ± 0.05 to 3.6 ± 0.05g/l. The swell power value of the formulae is relatively high compare to the favorability of the control, showing no significant difference between all the formulas and the control. Swelling causes changes in hydrodynamic properties of the food, thus impacting characteristics such as body, thickening and increase in viscosity to foods. The SI is an important parameter since it determines the consistency of the diet. Flours with high SI value indicates high water absorption capacity and will therefore hold large volume of water during cooking into gruels, to yield voluminous low energy and nutrient food (Ambo *et al*., 2015).

According to FAO/UN/WHO (2003), appropriate complementary diet is one which produce a gruel or porridge that is neither too thick for the infant to consume nor so thin that energy and nutrient density are reduced., it implies that the formulae will produce viscous gruel that compares with the control which is commercial infant food.

The % solubility values ranged from 20.36±1.240 to 24.46±1.2 with sample TSA_6 having the highest value and sample TSA with the least value (Table 1). There was significant difference at $P < 0.05$ for the values of sample TSA_6 and TSA_1. This could be as a result of the increasing percentage addition of tiger nuts and soya bean which are rich in simple sugar (Oladele and Aina, 2007). % solubility is an index which measures the amount of reducing sugars or solubility of sugar present in the foods indicates the capacity of the food to be eaten.

The pasting characteristic of the weaning formulae is presented in (Table 2). The peak viscosity values ranged from -0.48±0.065 to -4.13 ± 0.875; break down values ranged from 1.69 ± 0.165 to 5.14 ± 0.101; final viscosity values ranged from -1.21± 0.03 to -4.20 ± 0.25; setback values ranged from 2.05 ± 0.08 to 2.93 ± 0.045 where not significantly different from the control. There was no significant difference in the peak time for all the weaning formulas but there was significant different between the peak time for all weaning formulas and the control in terms of peak time for all weaning formula and the control in terms of peak temperature.

However, no significant difference was observed in the temperature required to form past for all the weaning formulas and the control. Pasting is the result of a combination of processes that follows gelatinization from granule rapture to subsequent polymer alignment due to mechanical shear during the heating and cooling of starches (Opara *et al*., 2012). The low peak viscosity and low final viscosity of the diet implies that the weaning food will produce a viscous paste that is low rather than a thick gel on cooking and cooling according to the observation made by Onuoha *et al*. (2014). This implies that the gruel will have a caloric density food which is high per volume (Opara *et al*., 2012). Setback value of the gruel indicates that the weaning diet on cooking will not be cohesively gruel whereas the low setback is an indication that the starch contents have a low nostalgic or synergy during icy cycles.

The pasting temperature is an indication of the minimum temperature to cook the sample. Based on this result, the temperature of pasting all weaning formula is comparable to that of the control.

Conclusion

The % increase in malted acha with decrease in tiger nut and soya bean correspondingly resulted in product with fortified functional properties. The findings illustrated that the formulated diets, showed good properties that contrast auspiciously with that of the control and can be consumed in similar quantity too. The important determinants of the weaning formula are the permanence of feeding and the magnitude of the formulae consumed by the infant in order to meet the required energy and nutrient values. These weaning formulae help to reduce the prevalence of malnutrition and act as substitute for the local complementary foods to low income homes in the country.

Authors` declaration

We declare that this study is an original research by our research team and we agree to publish it in the Journal.

REFERENCES

Ambo EE, Bassey SO, Iyam MA, Inah GM, Uwalaka, SU (2015). Effect of Cypermetrin on the Haematological indices of African Catfish (Clarias gariepinus). J. Biop. Env. 2(1-2): 29-35.

Alderman H, Sebastian L (2009). Anemia in low income countries is unlikely to be addressed by economic development without additional progras. *Food. Nutr. bull*, *30(3):* 265-270

AOAC (2005). Association of Official Analytical Chemists official method of analysis. Vol. II 17th ed. Washington, DC, USA.

Balami YA, Bolaji PT, Hamza F, Bahago EJ, Komplafe G, Onyewu SC, Hassan A (2004). Practical manual on food technology,nutrition and dietetics for school and industries, 2nd Ed. National Science and Technology Forum, Kaduna, Nigeria, pp.49.

Bassey SO, Ambo EE, Umo FE, Inah GM, Agiopu FB (2016). Proximate composition and physicochemical properties of beverages from blends of soya beans (*Glycine max*) and tiger nut milk (*Cyperus esculentus*). Book of extended abstract of the 2nd southeast chapter regional food summit (ReFost) of Nigerian Institute of Food Science and Technology, Umuahia,2016.

Bhutta Z, Ahmed T, Black CS (2008). Maternal and child under nutrition 3: What works, interventions for maternal and child under nutrition and survival. *Lancet 371(9610)*: 417-440.

FAO/UN/WHO (2003). Assuring food safetyand quality: Guidelines for strengthening national food control system. FAO corporate documentary repository ISSN 0254-4725.

Jideani IA (1999). Traditional and possible uses of *Digitaria exilis* (Acha) and *Digitaria ibunna* (Iburu): *A review,Plant Foods Human nutr, 54*:363-374.

Leach HW, McCowen LD, Schoch TJ (1959). Structure of the starch granules. In; Swelling and solubility patterns of various starches. *Cereal Chem*, 36:534-544.

Marero LM, Payumo EM, Lirando EC, Larez WN, Gopez MD, Homa S (1988). Technology of weaning food formulation prepared from germinated cereals and legumes. J. Food Sci. 53 (13):1-6

Oladele AK, Aina JO (2007). Chemical composition and functional properties of flour produced from two varieties of tiger nut. Afr. J. Biotechnol, 6:2473-2476.

Onimawo IA, Egbekun KM (1998). Comprehensive Food Science and Nutrition. Rev. Ed.: Benin, Ambik Publishers.

Onuoha OG, Chibuzo E, Badau M (2014). Studies on the potential of malted *Digtaris exilis, Cyperus esculentus* and *Colocasia esculenta* flour blends as weaning food formulation. Nig. Food J, 32(2):40-47.

Onwuka GI (2005). Food analysis and instrumentation theory and practice. Naphthali prints, Lagos, pp.133-137.

Opara B, Uchechukwu IN, Omodamiro RM, Paul N (2012). Production and sensory evaluation of food blends from maize, plantain, soya beans as infant complementary food. J. Storage Prod. Postharv, Res, 3(6):75-79.

Otegbayo B, Omueti O, Jaiyeol O, Afolabi O (2009). Functional properties of complimentary diets developed from soyabean (Glycine max), groundnut (Arachis hypogea), and crayfish (Macrobrachium spp).

E.J.Env,Agr, Food.Chem, 8(8): 563-573
Riaz MN (2006). Soy applications in Food. Boca Raton, Florida. CRS Press.
Sosulki,S, Garret MD, Slunkard AE (1976). Functional Properties of ten legume flours. Inst. Food Sc.Tech. J, 9, 66-69.