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Quality Evaluation of Instant Breakfast Meals Fabricated from Maize, Sorghum Soybean and Yam Bean (*Sphenostylis stenocarpa*)

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Abstract: Prevailing shortage of livestock products and low income earning have compelled large population in developing nations to resort to plants as the chief source of proteins. This study aimed at producing instant breakfast meals from common plant sources with a view to making them acceptable to low income earners. Instant breakfast diets were fabricated from cereals (sorghum and maize) and soy bean and African yam bean (Edible legumes). The unsupplemented meal was obtained from ratio one to one of sorghum to maize and was named Masor with protein content of about 9% Masor supplemented with 10% soy bean and 35% yam bean flours showed increased protein value to 13.3 and 14.8% , respectively. Dry matter contents of the diets were very similar (88%-91%). Their carbohydrates were 81% for Masor and 76% for supplemented diets. All diets were low ash, low fat and low fibre (about 3.5%-3.8%). The pH values of the diets were about 5.0 for supplemented and 5.6 for unsupplemented. The water holding capacities of Masor and Masor unsupplemented diets were significantly ($p<0.05$) lower than the supplements. The bulk densities of products ranged from 2.35-2.44. Supplementation slightly reduced the pH of products Quaker oats and unsupplemented Masor were not significantly ($p>0.05$) different. Both Masor-supplemented diets were significantly ($p<0.05$) poorer than Quaker oats and unsupplemented Masor in colour, aroma, taste and texture. The yam bean supplemented Masor was significantly ($p<0.05$) poorer than soy bean supplemented Masor except in texture. Inspite of the differences, yam bean supplemented diet was still acceptable except for its dull colour apparently taken to have stemmed from the colour of raw yam bean. All the raw and dietary products were microbiologically stable and hence were adjudged to be good quality products. In conclusion the current results gave prominence to the adoption of the fabricated meal as a food breakfast meal with good consumer satisfaction and readily available at affordable prices.

Key words: Breakfast · Maize · Sorghum · Soybean · Yambean

INTRODUCTION

Dietary proteins for human beings are derived from two major sources, namely animal and plant materials. Meats, together with sea foods, provide essential amino acids needed in our diets. The plant protein products, in contrast to livestock products, are lacking essential amino acids. Developed counties consume higher livestock products than developing countries. The total meat production in developing nations, estimated to have risen from 69 million tonnes in 1990 and projected to reach 143 million tonnes in 2010, accounts for almost half of livestock production [1, 2]. In spite of these increasing levels of livestock production in most developing countries, including Nigeria, the proportion of meat and milk in the diets of average consumer remains highly low, being 15g / person / day instead of 1g/kg/body weight [3]. The shortage of livestock products in developing countries is a consequence of human over population growing almost as fast as that of livestock (in Africa, it grows faster), low income earning, unemployment, meat scarcity in many places and its comparatively high cost [3].

The above mentioned prevailing condition compels the large population of developing nations to have recourse to dependence on protein containing plants as the chief sources of protein. The two major groups of such vegetable materials are cereals and legumes, especially the pulses. Although both commodities are energy rich, each cannot furnish human body with essential amino acids in adequate amount as the meat products would. For instance the pulses contain very

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high level of lysine known to be highly deficient in cereals. Conversely the cereals have high sulphur amino acids which are deficient in legumes. Both cereals and legumes, constituting the most important staple crops grown for their edible seeds, have been very important in the diets of many population groups around the world. They may be processed into products serving primarily as an insurance against post harvest losses, but secondarily as a means of making them easily available out-of-season to meet human nutritional needs in terms of balanced amino acids.

Sorghum guinness, most commonly grown in the Northern state of Nigeria, provides high energy predominantly derived from starch of 68–73% [4, 5]. Some factors against the full utilization of this raw material are: presence of polyphenolic compounds, high gelatinization temperature of its starch and high viscosity of its cooked products. Maize, next to wheat, is one of the most widely distributed of the world's food plants. Although it is a major food and raw material for industrial manufacture, maize is inferior to other cereals in nutritional values. Diets in which maize predominates often result in niacin deficiency disease known as pellagra [6].

The importance of soy bean in alleviating malnutrition has almost been over stretched. Its high oil content has been a limiting factor in its use as an adjunct in cereal-based diets and bakery products. Soy bean's anti-nutritional factors have been known to be drastically reduced by processing and hence its utilization as a cheap protein source has also been highly acknowledged worldwide.

African yam bean, a non-conventional pulse has been brought into some focus by several previous workers [4, 7, 8]. It is known to have a good culinary and nutritive value.

This study, therefore, aimed at producing instant breakfast meals from maize, sorghum, soy bean and yam bean with a view to making them acceptable as income earners.

MATERIALS AND METHODS

Sources of Materials: Yellow maize, red sorghum and soy bean were purchased at King's market, in Ado-Ekiti, western Nigeria, while the African yam bean was obtained from Omuo Ekiti in Nigeria.

Raw Sample Preparation: All the raw materials were cleaned by removing extraneous matter prior to their subjection to different processing treatments.

Sorghum was subjected to lye peeling for five minutes using hot alkali solution of 0.05M NaoH. The grains were generously washed with clean water while their hulls were removed by water floatation. Phenolic compounds, predominantly found in the testa, were removed by lye peeling. Dehulled sorghum was dried, milled, sieved and packaged. Clean maize grains were de-braned, de-germed, similarly milled, sieved and packaged. Maize and sorghum flours were mixed in equal amounts (1kg each) and stored in screw capped bottled containers as MASOR (unfortified product name). Clean, non-defective yam bean (1.5kg) was germinated for 48h, cooked for 30min on a kerosene stove, decorticated mechanically using mortar and pestle, sun dried, sieved and stored until use. Soy bean was roasted at 160°C for 30min [8]. With mortar and pestle the product hull was separated from the cotyledon and winnowed. De-hulled grain was pulverized, sieved and packaged as roasted soy flour.

Products Developed Included: Masor 1:1 (Maize: sorghum combination), Masor + RSB 9:1 (Masor: roasted soybean flour) and Masor + GCYB 7:3 (Masor: to germinated, cooked yam bean flour).

Fortification of Masor with RSB and GCYB flours was each at the maximum substitution level, determined by a preliminary study. Trials were run to determine the maximum levels of substitution with RSB and GCYB that would produce satisfactory meals using ratios 9: 1, 4: 1, 7: 3, 6.5: 3.5 and 3: 2. Formulation beyond 10 and 35% substitution with RSB and GCYB, respectively produced unacceptable breakfast meals and therefore untolerable. Therefore, the Masor supplemented with 10% RSB and 35% GCYB were organoleptically compared with unsupplemented Masor and Quaker oats.

Analytical Methods: Proximate analysis of raw and finished products was carried out by the methods of Association of Official Analytical Chemists [9]. Crude protein was estimated by multiplying crude nitrogen by 6.25 while carbohydrate was determined by difference.

Method of Preparation: About 3-4 dessert spoon heaps of each meal were pasted with cold water. Water brought to boiling was added with initial vigorous stirring followed by intermittent stirring for about 4mins, to obtain desirable consistency. Sugar or honey to taste, a pinch of salt may be added to the meal paste before addition of hot water.

Physico – Chemical Analysis: Water holding capacities of raw materials and their diets were carried out by the method of Solsuski and McCurdy [10]. Water holding capacity was calculated as gram of water held per 100 gram sample. pH of sample was determined by the method of Bartolome *et al*. [11]. Bulk density was estimated by the method of Okezie and Bello [12].

Mineral Determination: Mineral contents of raw materials and diets were determined by A.O.A.C. [9]. Phosphorus was estimated by the Vanado – Molybdate colorimetric method.

Sensory Evaluation: Newly developed breakfast meals, compared to Quaker oat (a standard), were assessed by a ten member taste panel, using 5 hedonic rating as follows: Excellent (5) Good (4) Fairly good (3) Fair Poor (2) Very Poor (1). The panel members were trained to differentiate colour, taste, aroma and texture intensities. Scores were statistically analysed using analysis of variance (ANOVA) and by multiple range test using SPSS package.

Microbiological evaluation of sample was carried out as described by Collins and Lyne [13]. Total viable bacterial, mould and coliform counts were estimated by multiplying the means of the total colonies by the dilution factors.

Identification of Bacteria and Fungi in Breakfast Meals

Identification of Bacteria: Resident bacterial were isolated and identified by the use of Bergey's manual of determinative bacteriology [14].

Identification of Fungi: Fungi were identified by the method of Onions *et al*. [15].

RESULTS

Table 1 shows of the proximate composition of undefatted roasted soy bean, germinated, cooked yam-beans and the three breakfast meals. The dry matter composition of the raw materials and their breakfast meals ranged between about 89% in Masor and 93% in roasted soy bean. The protein contents of breakfast meals (11.43%-15.02%) were quite lower than that of the raw germinated cooked yam-beans (29.07%) and roasted dry beans (40.21%) with which Masor was fortified. The ash contents in products were quite low except in soy bean. Fibre contents of the breakfast meals were very similar (3.1%-3.8%). The breakfast meals were high energy products. Masor supplemented with vegetable proteins increased by 6.0% in GCYB and 4.3% in RSB.

Table 2 details the results of the physico-chemical properties of raw materials as well as those of fabricated breakfast meals. The pH of unfortified Masor was significantly ($p < 0.05$) higher than Masor fortified with RSB and GCYB. The water holding capacity of RSB and GCYB were significantly ($p<0.05$) higher than those of both unfortified and fortified Masor. The bulk density of raw materials and breakfast meals ranged from 2.55 to 2.74.

Table 3 shows the mineral contents of the raw materials and their breakfast meals. Fortification of Masor with RSB and GCYB shows apparent increase in the concentrations of Ca, K, Fe and Zn.

Table 4 shows the sensory evaluation of unsupplemented and supplemented breakfast meals compared with a standard meal. In all sensory properties Masor fortified with GCYB was significantly ($p<0.05$) poorer than unfortified Masor. The most critical sensory property of Masor fortified with GCYB is the colour with sensory score of 1.7 which is below acceptable minimum level (2.5 score).

Table 1: Proximate composition of raw food materials and their breakfast meals (on dmb)

	Composition (%)					
Sample	Dm	Crude fat	Crude protein	Ash	Fibre	Carbohydrate
Roasted Soy bean (RSB)	93.60±5.50	17.54±1.62	40.21±3.15	2.44±0.10	3.72±0.60	36.09±3.24
Germinated, cooked Yam- bean (GCYB)	90.80±4.62	3.30±0.72	29.07±2.05	1.10±0.03	3.52±0.45	63.01±2.81
Masor (combined maize and sorghum)	89.20±4.20	4.71±0.80	09.20±1.43	1.57±0.16	3.14±0.50	81.0±6.82
Masor + RSB	89.90±4.1	5.65±0.46	13.53±1.83	1.61±0.06	3.82±0.62	76.39±5.66
Masor +GCYB	91.80±5.10	3.71±0.36	15.02±2.30	1.36±0.05	3.49±0.52	76.42±5.50

Values are means of triplicate determinations ± SE

Table 2: Physico-chemical properties of raw materials and their formulated meals

Sample	pH	WHC	Bulk density (BD)
RSB	5.33^{ab}	198.20 ± 1.25^{b}	2.23 ± 0.04
GCYB	5.15^{ab}	205.85 ± 4.42^{a}	2.74 ± 0.10
Masor	5.64^{a}	75.50 ± 1.42^{c}	2.46 ± 0.02
Masor+RSB	4.95^{b}	93.06 ± 2.62^{c}	2.45 ± 0.10
Masor+GCYB	4.88^{b}	96.70 ± 2.74^{c}	2.60 ± 0.05

Values are means ± SE of Triplicate Determinations. Values differently superscripted along vertical columns are significantly ($p<0.05$) different

Table 3: Mineral composition of raw materials and their compounded diets

	Composition (mg/kg)			
Sample	Ca	K	Fe	Zn
RSB	113 ± 7.26	60.58 ± 5.24	10.09 ± 1.46	1.29 ± 0.30
GCYB	138 ± 10.40	21.15 ± 1.48	7.70 ± 1.20	1.11 ± 0.20
Masor	120 ± 9.64	50.58 ± 4.57	9.13 ± 2.40	1.22 ± 0.20
Masor+RSB	134 ± 11.27^{ab}	68.65 ± 6.20^{ab}	9.65 ± 1.52^{ab}	1.54 ± 0.30^{ab}
Masor+GCYB	156 ± 13.32^{ab}	70.19 ± 6.82^{ab}	13.46 ± 1.74^{ab}	1.64 ± 0.40^{ab}

Values are mineral concentrations of raw materials and diets ± SD

Means superscripted along the vertical columns are significantly ($P < 0.05$) different

Table 4: Sensory evaluation of formulated breakfast meals compared with standard sensory scores

Sample	Colour	Aroma	Taste	Texture	Overall Acceptability
Quaker oats	5.0^{a}	5.0^{a}	5.0^{a}	5.0^{a}	5.0^{a}
Masor	4.8 ± 0.1^{a}	4.2 ± 0.1^{b}	5.0^{a}	5.0^{a}	4.9 ± 0.01^{a}
Masor+RSB	4.0 ± 0.3^{b}	4.4 ± 0.2^{b}	4.4 ± 0.3^{b}	4.0 ± 0.3^{b}	4.2 ± 0.3^{b}
Masor+GCYB	1.7 ± 0.2^{c}	3.0 ± 0.1^{c}	3.3 ± 0.3	3.3 ± 0.2^{c}	$3.4+0.2^{c}$

Means differently superscripted along the vertical columns are significantly ($P < 0.05$) different

Table 5: Microbial Assay of raw materials and their formulated meals

		Count Bacteria		Count Mould		Count Coliform
Sample	Mean no	(Cfu/g)	Mean no	(Cfu/g)	Mean no	(Cfu/g)
RSB	2.0	$2.0\text{x}10^{4}$	3.4	$3.4\text{x}10^{-4}$	0	$<10^{4}$
GCYB	3.0	$3.0\ \text{x}10^{3}$	3.4	$3.4\text{x}10^{1}$	0	$<10^{3}$
Masor	3.2	$3.2\text{x}10^{-4}$	2.9	$2.9\ \text{x}10^{4}$	0	$<10^{4}$
MASOR+ RSB	2.8	$2.8\text{x}10^{-4}$	2.8	$2.8\ \text{x}10^{1}$	0	$<10^{4}$
Masor +GCYB	2.7	$2.7\text{x}10^{-4}$	3.5	$3.5\text{x}10^{-4}$	0	$<10^{4}$

Means of Cfu/g as indices of microbiological stability of the samples

Masor-maize, sorghum combination (unfortified)

RSB- Roasted Soy bean flour

GCYB- Germinated Cooked Yam Bean flour

Table 5 represents the microbial assay of raw and breakfast meal products. All the breakfast meals, unfortified or fortified have low levels of bacterial and mould growth. No coliform was detected.

DISCUSSION

The high dry matter, high energy, low ash and low fibre contents recorded for the fortified breakfast meals have satisfied the recommended minimum composition in accordance with the report of Bookwalter [16]. The low level of fibre in the meals may not affect the digestibility of Ca needed for skeleton /bone development in children. Higher lipid in soy bean fortified meal may cause lipid peroxidation if the meal is ill-packaged or ill-stored for example the use of packaging materials that can allow absorption of ultraviolet rays which facilitates oxidation of lipids. Supplementation of starch-based meals with vegetable protein guarantees amino acid balance in the breakfast meals. The meals, being rich, provide the energy requirement for body activities.

High water holding capacities (WHC) of the fortifiers (RCB and GCYB) compared to Masor is not surprising in that their pre-heat treatments involved gelatinization of their starch before their incorporation into Masor [17]. In contrast WHC of Masor was visibly lower because no pre-gelatinization was deliberately intended except, probably by the little inadvertent heating encountered during milling [17]. The similarity in the bulk densities of the products signifies that they may require identical packaging space. The less the bulk density, the more packaging space is required [17]. The increased level of minerals in the diets is noticeable due to the fortification with the plant proteins. It is not unlikely that the substantial mineral contents of the vegetable protein- containing raw materials were lost during pre-treatments including dehulling, lye peeling, soaking or leaching during cooking. In any situation where body mineral is threatened supplementation may be contemplated.

The difference in the aroma of the standard Quaker oats and Masor may be due to the botanical sources of the raw materials. The major constraint of Masor fortified with GCYM stemmed from the natural grey colour of its raw material transferred to the end product. Retention of this colour may be taken for a product identity since the remaining organoleptic properties attained had exceeded the minimum acceptable level of 2.5 sensory score. Incorporation of cereals and legumes into starchy meals has been reported to result in a higher protein quality than will, if administered separately [18].

Total viable bacterial and fungal counts were extremely low [2] to warrant any fear of infection. No coliform was detected in both fortified and unfortified breakfast meals. The consumption of the products may not be fraught with any danger of outbreak of food borne disease.

In conclusion, the result achieved in this study has given prominence to the adoption of Masor as a food breakfast meal. Just as Quaker Oats will give consumers satisfaction upon addition of milk so also will Masor as a breakfast meal. The fortified alternatives are also recommended for adoption on the basis of their complementary amino acids. These new products will be readily available at affordable prices. Quaker oats is a cereal which is subject to many factors including increasing custom duties. The raw materials used in this study are readily available locally all year round and at affordable price. Therefore the sale of the commodities locally and their exportation to neighboring countries will substantially boost domestic and foreign earnings.

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