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NUTRITIONAL AND SENSORY EVALUATION OF FOOD FORMULATIONS FROM MALTED AND FERMENTED MAIZE (*Zea mays* L.) FORTIFIED WITH DEFATTED SESAME (*Sesamun indicum* L.) FLOUR

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ABSTRACT

Malting and fermentation were investigated as simple technologies for improving the nutritional and organoleptic properties of maize/sesame food formulations. Various maize flour samples were blended with defatted sesame flour, by material balancing, to give four food formulations consisting of unmalted maize + defatted sesame flour (UMS), malted maize + defatted sesame (MMS), unmalted, fermented maize + defatted sesame flour (UFMS) and malted fermented maize + defatted sesame flour (MFMS), which all contained 16g protein and 9g fat/100g food. Four diets were formulated (by material balancing with a basal diet) from the food formulations in addition to casein (milk protein), and Nutrend (a commercial complementary food produced from maize and soybeans) to give 10g protein/ 100g of each test diets, which were used for feeding trials with Wister albino rats. The protein efficiency ratio (PER), net protein ratio (NPR), apparent digestibility (AD) and amino acid profile as well as organoleptic properties of the gruels prepared from the food formulations were evaluated. The PER values of malted and fermented products (2.16 for MMS and 2.06 for MFMS) were significantly higher ($p<0.05$) than those of unmalted products (1.86 for UMS and 1.59 for UFMS). The NPR and AD values followed a similar trend with 3.82 and 70.50% for UMS, 4.40 and 72.10% for MMS, 4.21 and 70.00% for UFMS and 4.47 and 71.50% for MFMS respectively. Malting and fermentation significantly ($p<0.05$) increased lysine content from 2.16g/16gN (UFMS) to 5.46g/16gN (MFMS) and tryptophan from 1.08g/16gN (UFMS) to 1.35g/16gN (MFMS). There was significant ($p < 0.05$) difference in colour, taste and aroma for all the food formulations. Mean sensory scores ranged from 7.07 – 8.33 for UMS, 7.34 – 8.45 for MMS, 7.04 – 7.73 for UFMS and 6.82 – 7.74 for MFMS on a 9 – point hedonic scale. The unfermented products gave better acceptability than the fermented products in all the attributes; while the UFMS and MFMS (fermented products) did not show any significant difference in acceptability. The malted maize/sesame (MMS) blend therefore gave the best result with the highest acceptability and is therefore recommended for use as a complementary food.

Key words: Malting, Fermentation, Formulations, Complementary, Sesame

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INTRODUCTION

The need for nutritious foods to feed young growing children and help avoid protein/energy malnutrition is now being met through commercially produced foods prepared by extrusion or roller-drying and other high technology processes. Foods thus prepared are excellent products and meet the nutritional requirements of young children in both developed and developing countries. However, the products as marketed are too expensive for the target groups, who need them.

In many developing countries, traditional weaning foods are prepared mainly from cereals like maize and sorghum [1], which are usually poor in protein quantity and quality. This, coupled with the high cost and viscous nature of commercially available complementary foods, as well as the poor hygiene of food handlers are major constraints in providing children with adequate nutrients [2]. It is, therefore, desirable to study ways and means of developing less costly but equally nutritious complementary foods that may be within the reach of the wider population, using locally available staple cereals/ legumes and simple/ adaptable technologies.

A lot of work has been done on the formulation and development of nutritious complementary foods from locally and readily available raw materials using malting and fermentation technologies, which are simple traditional processing methods that have been reported to be effective in reducing bulk/viscosity of gruels [3, 4]. Such works involving the use of cereals blended with legumes notably: soybeans, cowpea and groundnuts, have achieved remarkable success [5, 6, 7, 8]. However, information on the effect of malting and fermentation on maize/ sesame food formulations is scanty.

Maize and sesame, the cereal and oilseed of choice in this study have the potential of giving a nutritious complementary food when blended. Malting and fermentation could improve the availability and quality of their proteins as well as reduce anti-nutritional factors that may affect the utilization of their nutrients and the health of consumers [8]. The objective of this study was, therefore, to assess the nutritional and sensory quality of food formulations from malted and fermented maize fortified with defatted sesame flour.

MATERIALS AND METHODS

Source of materials and preliminary treatments

About 3.0 kg of white maize (TZW, 2005 harvest) was obtained from the Agronomy Department, University of Agriculture, Makurdi while 4.0kg of white sesame (variety E8, 2005 harvest), was obtained from the seed store of the National Cereals Research Institute, College of Agriculture, Yandev, Gboko. Corn starch, corn oil, 'Nutrend' (a maize –soyabean based infant food made by Nestle Foods, Nigeria PLC, Lagos) were purchased from a local supermarket in Makurdi. 'Vitalyte' (a multi-vitamin powder containing vitamins $B_{1:}$ 2.5mg, B_2: 2.5mg; nicotinamide: 10mg; vitamin D: 250 IU; produced by Evans Medical Plc, Lagos, Nigeria) were purchased from a local drug store in Makurdi while casein standard was obtained from the Department of

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Zoology, University of Jos. Rice husks were obtained from Olam Nigeria Ltd. Granulated sugar was purchased from a local supermarket in Makurdi. Wister albino rats (24 No. 3 week old males) were purchased from the National Institute for Trypanosomiasis Research (NITR) Vom, Jos, Plateau State. Most chemicals used for analyses were purchased from local stores in Nigeria and were of Analar grade (British Drug House chemicals, Poole England).

After manual sorting and winnowing to remove stones, debris and defective seeds, the clean maize and sesame seeds were packaged in 10L and 5L plastic buckets, respectively and the buckets then tightly covered with lids. The rice husks were dried in an air draft electric oven (Genlab Widnes, U.K. model T12H) at 100^{o}C to a constant weight, followed by milling and sieving through a 0.20mm mesh. The husks were then packaged in low density polyethylene bags and sealed with an electric impulse sealer (TEW Heating Equipment, Clamco Corp. Cleveland, Ohio, model 210-8). All materials were stored in a household refrigerator and utilized for product formulation within 2 weeks.

Preparation of unmalted and malted maize flours

Malting was carried out using the method described by Ariahu *et al.* [9] as shown in Fig. 1. Four hundred grams of raw maize grains were washed in 5% (w/v) sodium chloride (NaCl) solution to disinfect the grains. The grains were then soaked in tap water at room temperature (30 $\pm$ 2^{0}C) using a ratio of 1:3 (w/v grain : water), in a plastic bucket. The steep water was changed every 4 hours for a total steeping time of 12 hours, followed by draining in a plastic basket and the grains were spread in a single layer on a moistened jute bag and allowed to germinate at room temperature (30 $\pm$ 2^{0}C) for 72 hours, while spraying with water at intervals of 12 hrs. The non - germinated and germinated grains were removed at 0, and 72 hours respectively and dried in an air draft oven (Genlab Widnes,U.K, model T12H) at 100^{0}C to constant weight. The dried seeds were split in a disc attrition mill (Asiko A11, Addis, Nigeria) using a nip of about 3mm, to detach testa and rootlets from cotyledons which were removed by winnowing. The cotyledons were then milled into flour using a bench top hammer mill (Brook Crompton, Series 2000, England) to pass through a sieve of 0.2mm particle size. The resultant unmalted maize (UM) and malted maize (MM) flours were then packaged in low density dark - coloured polyethylene bags, stored in 500ml plastic containers with airtight lids at room temperature (30 $\pm$2^{0}C) and utilized for product formulation and analysis within 24 hours.

Preparation of fermented maize flours

Fermented maize doughs were obtained by accelerated natural lactic acid fermentation using the method described by Ariahu *et al.* [10] as shown in Fig. 1. In this process 120.0g each of unmalted (UM) and malted (MM) maize flours were mixed with 80ml of distilled water and subjected to natural fermentation in a covered 500ml glass beaker at room temperature (30 $\pm$ 2^{0}C) for 24 hours. At the end of this period, 50% of the fermented mixture was used as starter culture for a new fermentation cycle. During this process, the pH and titratable acidity (an index of lactic acid bacteria activity) were monitored. The fermentation process was continued until the pH of the medium stabilized and remained constant. The fermented concentrates were dried at 80^0C in a fan driven electric oven (Genlab Widnes, U.K, model T12 H) to constant weight and milled in a disc attrition mill (Asiko A11, Addis Nigeria) to a particle size of 0.2mm. The unmalted fermented maize (UFM) and malted fermented maize (MFM) flours were then packaged in low density dark - coloured polyethylene bags, stored in 500ml plastic containers with airtight lids at room temperature (30 $\pm 2^0$C) and utilized for product formulation and analysis within 24 hours.

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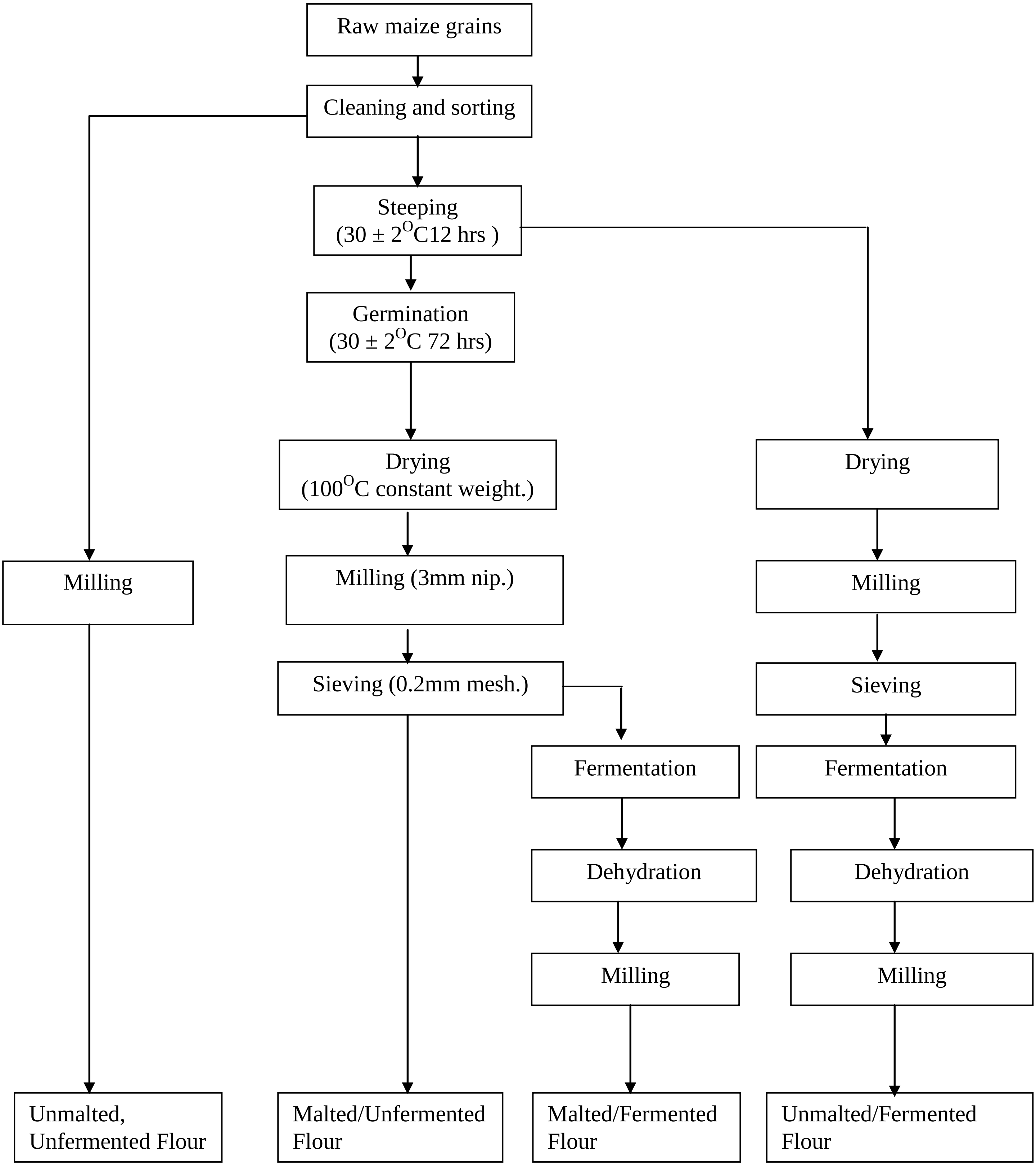

Figure 1: Flow Chart for Production of the Different Maize Flours
Source: Ariahu *et al*. [5,6]

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Preparation of defatted sesame flour

Sesame seeds were dehulled using the method of Ramachandra [10] as shown in Fig. 2. In this process the sesame seeds were cleaned and sorted by soaking in water and removing the seeds that floated on top. The good seeds were then boiled in 0.6% sodium hydroxide (NaOH) solution for 1minute after which they were washed with excess cold water. Thereafter, the raptured seed coats were separated by scrubbing between the palms and air dried to get rid of excess water. The dehulled seeds were then defatted by the screw press method described by Fasina [11] as modified by Igyor *et al.* [12]. Sesame seeds (1.0 kg) were coarsely ground in a kitchen blender (Phillips, Holland model HR 1702), wrapped in a muslin cloth and placed in a screw press (Edwards and Jones, Meir, England). The handle of the screw press was turned until it reached maximum pressure (20 psi). The press was held at this pressure during which time the oil dripped into a holding tray and was collected. By varying the extraction time at intervals of 10, 20, 30 and 40 minutes (at maximum pressure) samples were collected for fat analysis until a fat content of 14-15% in the cake was obtained (from the original 42.60% fat content of the sesame seeds). The defatted sesame cake was dried at 80^0C to constant weight in an air draft electric oven (Genlab Widnes, U.K model T12H), after which it was milled to a particle size of 0.2mm.The flour was then packaged in a low density dark - coloured polyethylene bag, stored in a 500ml plastic container with airtight lid at room temperature (30 $\underline{+}2^0$C) and utilized for product formulation and analysis within 24 hours.

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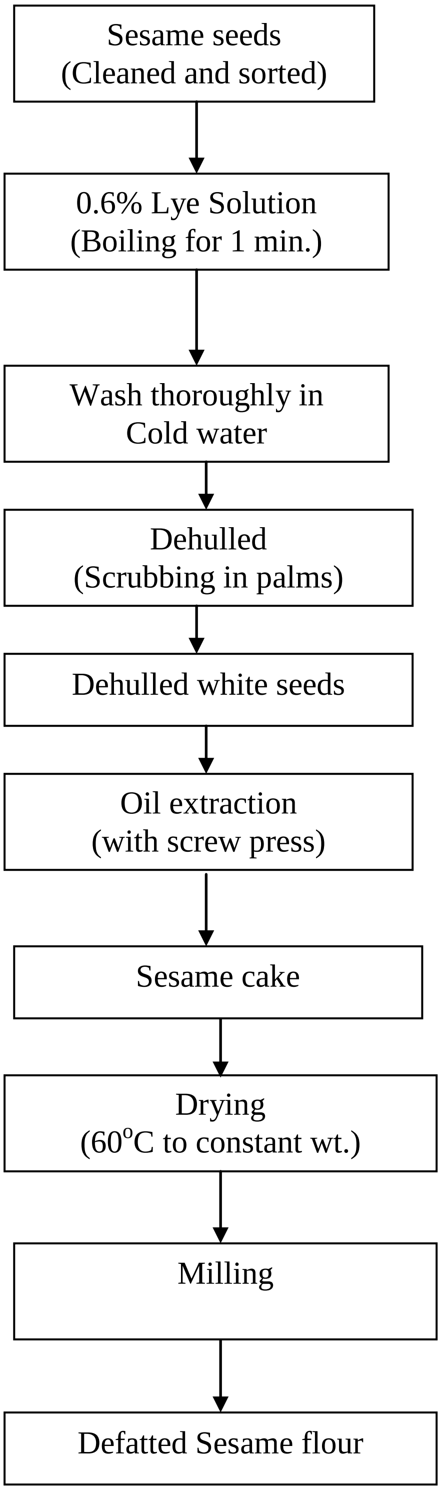

Figure 2: Flow Chart for Production of Sesame Flour
Source: Ramachandra [10]

Food products formulation

Four different food formulations were made by blending the different maize flours with the defatted sesame flour to obtain 16g protein and 9g fat/100g food as is obtained in Nutrend- a maize/ sesame complementary food manufactured by Nestle, Nigeria Plc Lagos; which was chosen as a reference in this study because it is a popular, cheap and easily available non-milk based infant food formulation. This was achieved by material balancing from their respective proximate compositions [13]. The four formulations were: unmalted maize + defatted sesame (UMS), malted maize + defatted sesame (MMS), unmalted fermented maize + defatted sesame (UFMS) and malted fermented maize + defatted sesame (MFMS). These were packaged in low density dark- coloured polyethylene bags and stored in 500ml plastic containers with air tight lids in a household refrigerator from where samples were taken for diet formulation.

Diet formulation

Four diets were formulated by material balancing [13] from the food formulations above (UMS), (MMS) (UFMS) and (MFMS), by substituting approximately 62.50g of the food products with formulated basal (nitrogen-free) diet, to give 10g protein/100g of each test diets. The basal diet consisted of corn starch: 80g/100g, corn oil: 10g/100g, common table salt: 4g/100g, sugar: 1g/100g, vitamin premix: 1g/100g and non-nutritive fibre (rice husk): 4g/100. The diets were packaged in low density dark- coloured polyethylene bags and stored in 500ml plastic containers with air tight lids at room temperature from where samples were taken along with casein (milk protein), and Nutrend for feeding the rats.

Feeding trials

Feeding studies were conducted using 21 weanling male albino rats (Wistar strain), that were clinically healthy (age 21-28 days), using a modification of the method described by Rasaco [14]. A complete randomized design (CRD) was used in which the rats were initially weighed to the nearest 0.1g at the start of each feeding trial and allocated into the seven cages based on weight equivalent with 3 rats per cage. The cages were placed on cardboard to permit collection of faeces. The six diets formulated above along with the basal diet were evaluated. The rats were offered 10g of food (which was increased to 30g by day 14) and water *ad-libitum* for 28 days. The total food intake of the rats was determined by recording the food left after daily intake. Daily weight gain was obtained by weighing all the rats individually. Protein consumption was calculated from the food intake. All faeces collected (day 10-28) were stored in the refrigerator until the end of feeding, when they were pooled together, dried, weighed and milled into fine powder.

Preparation of gruels

Gruels were prepared from the food formulations using the method described by Uvere *et al.* [3]. A 5.0% (w/v) solution of each of the food formulations were used to prepare slurries. Gruels were then prepared by boiling the slurries for 10 minutes. All the gruels were cooled to $40^{o} – 42^{o}$C and used for determination of viscosity.

Determination of protein quality

Protein quality indices were determined using standard methods. The nitrogen content of the faeces was determined by the standard Kjeldhal method [15]. From the values of Mean Daily Feed Intake (MFDI) and Mean Daily Weight Gain (MDWG) obtained, Protein Efficiency Ratio (PER), Net Protein Retention (NPR) were estimated by the method of Pellet and Young [16]; Apparent Digestibility (AD) and Feed Conversion Efficiency (FCE) were calculated using approved formulae.

Essential amino acid composition

Qualitative assessment of the essential amino acid composition of the food formulations was carried out using the automatic Technicon Sequential Multi-sample Amino acid Analyser (TSM, model DANA 0209). Amino acid scores were then calculated from FAO reference values of each amino acid.

Sensory evaluation

Sensory evaluation of gruels produced from the food formulations was performed by affective testing [17]. The panelists consisted of 20 women (mostly mothers) from the University of Agriculture, Makurdi; who were regular users of commercial complementary foods. A 9-point hedonic scale (1-deslike extremely, 9-like extremely) was used to rate the sensory attributes of colour, taste, aroma and overall acceptability of the products. Each attribute was evaluated separately on a daily basis between 10-11am. At each session, each panelist judged 5 samples, which were presented randomly, with fresh tap water used for mouth rinsing in between evaluations [18]. The gruels from the formulated products and Nutrend were prepared in distilled water and stored in insulated 2l food flasks (Eleganza Nigeria Plc; Lagos), from where they were served to the panelists. Fifty (50) ml of each gruel was served hot (70-80^{0}C) in 100ml colourless, transparent plastic cups, which were coded and colourless transparent spoons were supplied for eating the gruels.

Statistical analysis

All results were subjected to analysis of variance (ANOVA) using Minitab version 15.0 at 5% level of significance. Least significant differences (LSD) were used to compare the means.

RESULTS

Protein quality

Protein quality indices for the various maize/sesame food formulations as well as the control diets (Nutrend and casein) are presented in Table 1. The PER and NPR of the malted and fermented products were found to be significantly ($p<0.05$) higher, with PER values of 2.12 (MMS) and 2.06 (MFMS) as compared to 1.86 (UMS) and 1.59 (UFMS) and NPR values of 4.40 (MMS) and 4.47 (MFMS) as compared to 3.82 (UMS) and 4.21 (UFMS). The PER values for Nutrend were, however, significantly ($p<0.05$) higher than those of the food formulations at 2.25, while NPR values were significantly ($p<0.05$) lower at 3.53. A comparison of the PER and NPR values of the test diets with the corresponding ANRC (casein) resulted in the R-PER and R-NPR data also shown in Table 1; which ranged from 0.80 – 0.96 and 0.92 – 1.16, respectively. Apparent digestibility of the products ranged from 90.0% in UFMS to 95.90% in Nutrend, with the MMS product recording the highest AD of 92.10% among the maize/sesame food formulations.

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Essential amino acid composition/scores

The results of essential amino acid composition and scores of the food formulations are presented in Tables 2 and 3, respectively. Lysine and tryptophan increased dramatically with malting and fermentation with lysine values ranging from 3.05g/16gN for UMS to 5.46g/16gN for MFMS food formulations as compared to the FAO reference of 5.50g/16gN. Tryptophan values increased from 1.25g/16gN in UMS to 1.35g/16gN in MFMS as compared to FAO reference of 1.00g/16gN. This trend was reflected in the amino acid scores of the various amino acids (Table 3), with lysine and tryptophan recording scores of 68.73% and 130.00% for MMS, 99.27% and 135.00%, respectively for MFMS food formulations.

Sensory evaluation

The results of the sensory evaluation of gruels prepared from the food formulations are shown in Table 4. Out of 9, the colour scores ranged from 7.02 in UFMS to 7.84 for Nutrend; taste scores from 7.42 in UFMS to 8.25 in Nutrend. The MMS was characterized as having a slightly sweet taste, while the UFMS and MFMS had a sour taste. The aroma of the non-fermented samples was superior to those of fermented samples with those of MMS recording the best scores at 8.45. Acceptability scores ranged from 7.15 in UFMS to 8.04 in Nutrend, with MMS food scoring the best acceptability of 7.81 among the maize/sesame food formulations.

DISCUSSION

Protein quality

Generally, malting and fermentation significantly improved PER and NPR of the foods. The PERS of MMS, MFMS and that of Nutrend were higher than the value of 2.1 recommended by the Protein Advisory Group (PAG) for complementary foods [19]; however, those of the UMS and UFMS were lower. Both PER and NPR are indices of protein quality. Protein Efficiency Ratio (PER) indicates the relationship between weight gain in the test animals and the corresponding protein intake, while NPR relates the weight changes in the animals fed the test diets to those fed the control diet. The higher AD, PER and NPR of germinated and fermented products could be due to enzymic degradation of protein and carbohydrate macromolecules into smaller units, thereby increasing the surface area of the substances for a facilitated digestion and subsequent absorption by the complementary animals. These observations were consistent with earlier reports of significant increases in PER in rats as a result of malting and fermentation of cereals and legumes [20, 21]. The lower quantity of fermented products consumed could be because the characteristic sour taste of the fermented products affected their intake by the experimental rats, thus affecting their PER and NPR values. It has been established that rats prefer a diet with some sweet taste and may consume higher quantities of such diets [22]. Thus, the unfermented food formulations were sweeter and, therefore, more consumed.

Essential amino acid composition/scores

Most of the essential amino acids increased in quantity with malting and fermentation. This could be due to the breakdown of complex polypeptides in the grain to simpler absorbable compounds (amino acids). This is in conformity with the findings of Wu [23], who also reported increased lysine content with malting and fermentation. This is of great nutritional significance since these are the main limiting amino acids in maize, which are of use to the growing infant. This finding is in agreement with earlier reports of Fernandez [24] and Mbugua [25], who reported increase in the levels of lysine, tryptophan and methionine in germinated and fermented cereals. Generally, amino acid scores for MMS food product were better than the others. For these food formulations, therefore, the purpose of complementation of maize with sesame has been fulfilled, since they can be used to adequately fulfil the amino acid needs of the growing infant.

Sensory evaluation

There was significant difference in colour, taste and aroma for all the food formulations; on the other hand, the UFMS and MFMS (fermented products) did not show any significant difference in acceptability. The unfermented products were better than the fermented products in all the attributes, while the values for Nutrend were significantly higher than all the food formulations. Nutrend was significantly ($p < 0.05$) preferred followed by the MMS and UMS formulations in that order. It was also interesting to note that, in spite of the much lower sensory scores, the fermented products (UFMS and MFMS) were still acceptable to panellists. This could be due to the fact that fermented (sour) gruels are common in local diets.

CONCLUSION

Malting and fermentation technologies can be employed to produce acceptable and improved protein quality food products from maize and defatted sesame, which could be used as complementary foods. Malting and fermentation increased nutrient quantity, quality and availability due to hydrolysis of complex food reserves to simpler absorbable molecules. There was a significant increase in the quantity of lysine and tryptophan thus complementing the essential amino acids that are limiting in maize.

There were significant differences in colour, taste and aroma for all the food formulations. The unfermented products gave better acceptability than the fermented products in all the attributes; the UFMS and MFMS (fermented products), however, did not show any significant difference in acceptability. The malted maize/defatted sesame food formulation gave the highest acceptability and is, therefore, recommended for use as a complementary food.

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Table 1: Effect of malting and fermentation on the protein quality indices of the maize/sesame food formulations

Parameter		UMS	MMS	UFMS	MFMS	NUTREND	CASEIN	LSD*
	PER	1.86[e]	2.12[c]	1.59[f]	2.06[d]	2.25[b]	2.35[a]	0.03
C –	PER	1.99[e]	2.26[c]	1.69[f]	2.19[d]	2.39[b]	2.50[a]	0.04
R -	PER	0.80[e]	0.90[c]	0.68[f]	0.88[d]	0.96[b]	1.00[a]	0.03
	NPR	3.82[e]	4.40[b]	4.21[c]	4.47[a]	3.53[f]	3.84[d]	0.05
C –	NPR	3.99[e]	4.62[b]	4.41[c]	4.68[a]	3.96[f]	4.02[d]	0.07
R -	NPR	0.99[c]	1.15[a]	1.10[b]	1.16[a]	0.92[d]	1.00[c]	0.06
	AD (%)	70.50[e]	72.10[c]	70.00[f]	71.50[d]	85.90[b]	97.30[a]	0.05
	MDFI (g)	7.29[d]	7.44[c]	6.49[f]	7.07[e]	13.28[a]	11.41[b]	0.08
	MDWG (g)	1.38[e]	1.57[c]	1.04[f]	1.46[d]	3.00[a]	2.69[b]	0.03
	FCE	5.28[b]	4.74[d]	6.24[a]	4.84[c]	4.44[e]	4.24[f]	0.05

Means with the same superscripts within the same row are not significantly different ($p>0.05$)

Key:
UMS – Unmalted maize + defatted Sesame
UFMS – Unmalted, fermented maize + defatted Sesame
NUTREND – Commercial weaning food (Control)
CASEIN – Milk Protein diet
C – NPR- Corrected NPR
R – PER – PER relative to ANRC-Casein (2.5)
AD - Apparent Digestibility
MDWG - Mean Daily Weight Gain
MMS – malted Maize + defatted sesame
MFMS – Malted, fermented maize + defatted sesame
PER – Protein Efficiency Ratio
NPR –Net Protein Retention
C – PER- Corrected PER
R – NPR – NPR relative to ANRC-Casein (4.02)
MDFI- Mean Daily Feed Intake
FCE – Feed Conversion Efficiency

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Table 2: Essential Amino Acid (EAA) composition of the maize/sesame food formulations (g/16gN)

EAA	UM	MMS	UFMS	MFMS	FAO Reference
Lysine	3.05	3.78	2.16	5.46	5.50
Histidine	2.65	3.41	2.02	2.71	-
Arginine	6.47	7.68	4.49	5.35	-
Threonine	3.61	3.86	2.65	3.20	4.00
Valine	3.72	3.76	2.28	3.38	5.00
Methionine	1.85	2.39	1.56	1.04	3.50
Isoleucine	3.96	4.05	2.66	3.65	4.70
Leucine	9.64	10.95	6.69	6.28	7.00
Tryptophan	1.25	1.30	1.08	1.35	1.00
Phenylalanine	4.28	6.25	3.26	4.71	6.00

Key:

UMS – Unmalted maize + defatted sesame
MMS – Malted maize + sesame
UFMS – Unmalted, fermented maize + defatted
MFMS – Malted, fermented maize + defatted sesame

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Table 3: Amino Acids scores of Essential Amino Acids (EAAs) of the maize/sesame food formulations (%)

EAA	UMS	MMS	UFMS	MFMS
Lysine	55.45	68.73	39.27	99.27
Histidine	-	-	-	-
Arginine	-	-	-	-
Threonine	90.25	96.50	66.25	80.00
Valine	74.40	75.20	45.60	67.60
Methionine	52.86	68.29	29.71	44.57
Isoleucine	84.26	86.17	56.60	77.66
Leucine	137.71	156.43	95.57	89.72
Tryptophan	125.00	130.00	108.00	135.00
Phenylalanine	71.33	104.17	54.33	78.50

Key:

UMS – Unmalted maize + defatted sesame
MMS – Malted maize + sesame
UFMS – Unmalted, fermented maize + defatted
MFMS – Malted, fermented maize + defatted sesame

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Table 4: Sensory scores for gruels prepared from the various maize/sesame food formulations compared to Nutrend

Attributes	UMS	MMS	UFMS	MFMS	NUTREND	LSD*
Colour	7.21^{c}	7.53^{b}	7.02^{d}	7.04^{d}	7.84^{a}	0.04
Taste	7.83^{c}	8.05^{b}	7.42^{d}	7.44^{d}	8.25^{a}	0.05
Aroma	8.33^{c}	8.45^{b}	7.55^{d}	7.56^{d}	8.52^{a}	0.02
Acceptability	7.63^{c}	7.81^{b}	7.15^{d}	7.16^{d}	8.04^{a}	0.03

Means with the same superscripts within the same row are not significantly different (p>0.05)

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Key:

UMS – Unmalted maize + defatted sesame
MMS – Malted maize + defatted sesame
LSD- Least significant difference

UFMS – Unmalted, fermented maize + defatted sesame
MFMS – Malted, fermented maize + defatted sesame.
NUTREND – Maize/soyabean commercial complementary food

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