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Bambaranut Protein Isolate: Effect of Incorporation on Nutrient Content and Sensory Properties of Enriched Indigenous Maize Noodle 'Kokoro'

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Abstract: Evaluation of proximate composition, amino acids and sensory attributes of maize noodle 'kokoro' enriched with Bambaranut protein isolate substitution was carried out. Dried coarse yellow maize and extracted protein isolate from Bambaranut were formulated into five different blends of 90:10, 80:20; 70:30, 60:40 and 50:50%, then 100% coarse maize granular form was used as control. Each type of blended materials was mixed with other ingredients such as onion, pepper, salt and whisk fresh egg uniformly. The mixtures were homogenized, molded into ring shapes through extruder and deep fried in hot vegetable oil. Samples prepared were subjected to proximate composition, amino acids and sensory properties evaluation while data obtained were analyzed statistically. Result showed that, the proximate composition of Bambaranut protein isolate were 8.61% moisture content, 78.11% protein, 0.68 fat, 2.82 ash, 0.08% crude fiber and nitrogen free extract was 9.70%. Proximate composition and amino acids content of enriched maize noodle and 100% maize noodle were different but significant ($p<0.05$). Moisture content of samples was slightly above <10% which ranged from 14.02-15.29%; fat content ranged from 13.81-14.38%. There was gradual increase on the protein and ash content of the enriched maize noodle samples when Bambaranut protein substitution increased from 10-50% in this blends. Protein increased from 15.06-32.44% while ash content changed from 3.82-3.94%. The crude fiber and carbohydrate decreased slightly from 2.51% crude fiber and 55.39% carbohydrate of control sample to 2.18% crude fiber and 3.77% carbohydrate of maize noodle sample E substituted with 50% Bambaranut protein isolate. Protein content, the amino acids content increases significantly ($p<0.05$) in the enriched noodle samples as the substitution of Bambaranut protein isolate increased (10-50%). The limiting amino acid lysine in maize increased from 1.66-34.08 mg/100 g protein, also threonine increased from 3.11-21.09 mg/100 g protein, valine changed from 4.61-22.51 mg/100 g protein, methionine 0.64-2.44 mg/100 g protein, isoleucine 4.0-20.66 mg/100 g protein, leucine 15.28-95.01 mg/100 g protein, phenylalanine 6.60-33.13 mg/100 g protein, tryptophan 0.68-4.53 mg/100 g protein, histidine 3.46-26.58 mg/100 g protein, arginine 5.33-40.06 mg/100 g protein, aspartic acid 10.14-81.23 mg/100 g protein, serine 4.68-21.01 mg/100 g protein, glutamic acid 15.49-106.96 mg/100 g protein, proline 2.06-15.66 mg/100 g protein, glycine 2.93-13.20 mg/100 g protein, alanine 2.11-12.01 mg/100 g protein and tyrosine increased from 3.99-18.39 mg/100 g protein. Mean sensory scores of the samples differred but significant ($p<0.05$) on the samples. Mean scores for overall acceptability dropped slightly from 7.35-6.75 when the Bambaranut protein isolate increased.

Key words: Maize noodle, substitution, Bambaranut protein isolate, enrichment, amino acids, 'kokoro'

INTRODUCTION

Maize is prepared and consumed in many ways especially in developing countries more importantly where processed foods are beyond the reach of low-income earners (Lasekan and Akintola, 2002). Food uses of maize vary from region to region and from one ethnic group to the other. In Nigeria and some West Africa countries indigenous foods from maize include maize noodle 'kokoro'.

Noodles are long thin piece of staple food made from a mixture of flour, water and eggs, they are form of staple food (Taneya *et al*., 2014). Maize noodle "kokoro" is an indigenous snack produced from thick coarse corn paste with added seasoning ingredients, consumed by both adult and children. People that consume maize noodle "kokoro" frequently or in large quantity are faced basically with a large intake of carbohydrate. The low protein content in "kokoro" is evident with a shortage of tryptophan and lysine together with its low niacin content

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which may contribute further towards the incidence of pellagra in maize-consuming areas (Lasekan and Akintola, 2002). There are lots of factors that could affect the popularity and widespread of maize noodle beyond its locality this includes low protein, poor packaging and distribution style. In developing countries low protein intake has been majorly attributed to the increasing high cost of traditional sources of animal protein (Osho, 2003). Friedman (1996) high lighted the importance of protein component in the diet, needed for human survival. Its basic function in human nutrition is to supply adequate amount of needed amino acids. However, the availability of amino acids varies with protein sources, processing treatments and interaction of other components of the diet (Fagbemi *et al.*, 2004).

It is an established fact that most leguminous plant seeds are rich in nutrients such as digestible protein with a good array of amino acids and minerals (Fagbemi *et al.*, 2004). Complementary request for utilization of these legumes is encouraged by the fact that it is regarded as the cheapest source of proteins, especially in the diets of low-income erners in West Africa (Fagbemi *et al.*, 2004). Bambaranut (*Voandzeia subterranea* Thouars) is one of the most grown legumes next to cowpea and soybean in Nigeria that it has been established to be of high protein content (Okafor *et al.*, 2014). In spite of, the high nutrients in Bambaranut the use as cheap source of protein in food formulation is still below its potentials when compared to much attentions given to soybean.

However, developing countries like, Nigeria is seriously experiencing rapid process of rural urban migration which could create food insecurity if adequate measures are not put in place. Therefore, improvement on nutritional content of indigenous snacks such as maize noodle 'kokoro' through utilization of vast number of indigenous crops could be a mean of not only alleviating poverty but prevention of malnutrition and food insecurity. This research aimed toward evaluation of the potential of Bambaranut protein isolate as a means of enrichment of nutritional value of indigenous maize noodle 'kokoro'.

MATERIALS AND METHODS

Materials such as dried maize and Bambaranut were purchased from Ama-Hausa market, Owerri. Ingredients which include onion, salt, vegetable oil, fresh eggs and pepper were purchased from Eke-ukwu, Imo State.

Preparation of maize paste: Method described by Oloyo (1999) was modified for the preparation of maize paste. About 2 kg of dried maize was cleaned by winnowing to remove foreign particles and damaged grains and washed in portable water at 1:2 w/v. The maize grains were pret treated with warm water at 75°C for 30 min. The partially cooked grains were further washed and cooled in water prior to milling (attrition mill) into thick coarse maize paste. Maize paste was allowed to stand under ambient temperature 33±3°C for 8 h, dried into coarse maize particles and packaged in air-tight high density polyethylene bag for further use.

Preparation of traditional Bambaranut protein isolate: The method described by Peisker (2001) was modified for the preparation of traditional protein isolate from Bambaranut (Fig. 1). About 2 kg Bambaranut seeds were sorted by winnowing to remove Foreign particles and visual screening off damaged seeds. The cleaned seeds were soaked in portable water of 0.1% sodium metabisulphite ($NaHSO_3$) for 12 h and dehulled manually to remove the seed coats. Dehulled Bambaranut seeds

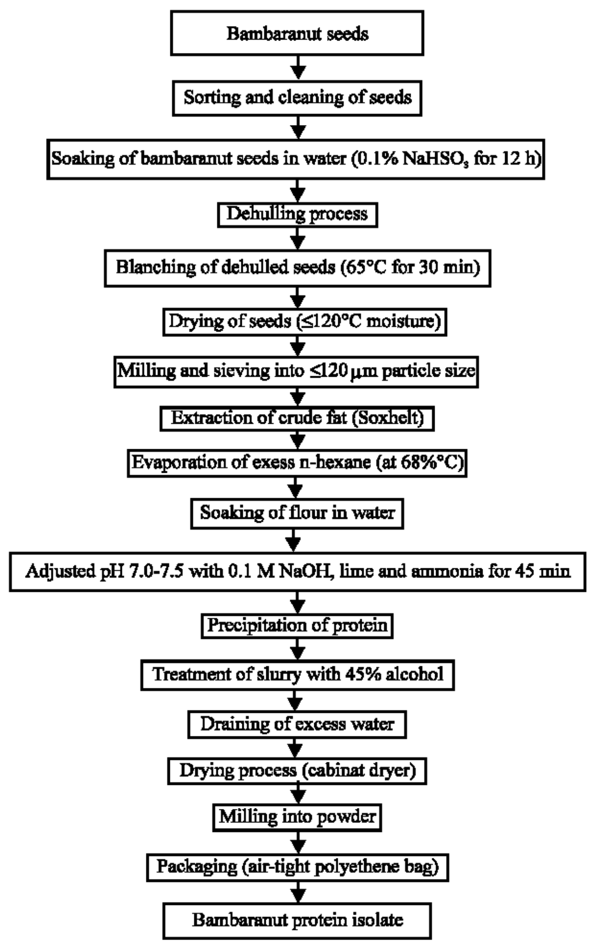

Fig. 1: Flow chart for the preparation protein isolate from Bambaranut

were blanched at 65°C for 30 min then allowed to drain off excess water and the seeds were dried in a cabinet dryer until ≤12°C moisture was obtained. The Bambaranut seeds were milled and sieved through 120 μm aperture sized sieve to obtained Bambaranut flour. Crude fat was removed from Bambaranut flour using soxhlet extraction method with-exane as solvent. Excess n-hexane in the flour was evaporated at 68°C. The flour was added into hot water Bambaranut 65-70°C containing 0.1 N NaOH, lime and ammonia (pH 7.0-7.5) while stirring continuously for 45 min. After 45 min of reaction, the mixture was centrifuged at 1100 rpm for 20 min. The protein was precipitated at pH 4.5 using 1 N HCl. The precipitate was washed with excess water and the pH adjusted 7.5 with 0.1 N NaOH and lime. Resultant slurry was treated with 45% aqueous alcohol. Excess water was drained off and dried using cabinet dryer (85°C until ≤10% moisture was achieved) cooled and milled into powder and packaged in air-tight high density polyethylene bag for further use.

Blending composite flour and preparation of maize noodle 'kokoro': About 5 composite flour samples were prepared from maize coarse particle material and Bambaranut protein isolate using varied proportions which included 90:10, 80:20, 70:30, 60:40 and 50:50%. A control sample was prepared from 100% coarse maize granular particles.

Procedure described by Maliki (1999) was used for the production of maize noodle 'kokoro'. A 400 g of each flour type was made into paste (water was added into the flour drop wise while stirring continuously until desire sticky paste was achieved). Other ingredients such as 0.1% grounded onion, 0.1 pepper, 2% of whisk fresh eggs and pinches of salt to taste were added into the paste. The paste mixture was homogenized in Ken Wood mixer (Model kW 500) and loaded into an extruder in order to form ring noodle shapes 3 mm thickness. The molded paste was deep fried in vegetable oil at 170°C for 10-15 min, cooled and packaged for further evaluation. Figure 2 showed the flow chart for the preparation of noodle 'kokoro'.

Chemical analysis and sensory evaluation: The methods described by AOAC (2004) were used to determine moisture content, protein, fat, ash and crude fiber of Bambaranut protein isolate and maize noodle samples. Total carbohydrate was determined by difference. Amino acids composition of noodle samples were determined using methods described by Spackman *et al*. (1958) as cited by Onuegbu *et al*. (2011). Sensory attributes colour, taste, aroma, texture and overall acceptability of the maize noodle was evaluated using the method described by Iwe (2002). Data obtained various analysis were subjected to statistical analysis using statistical package for social science Version 20.0 Inc. USA.

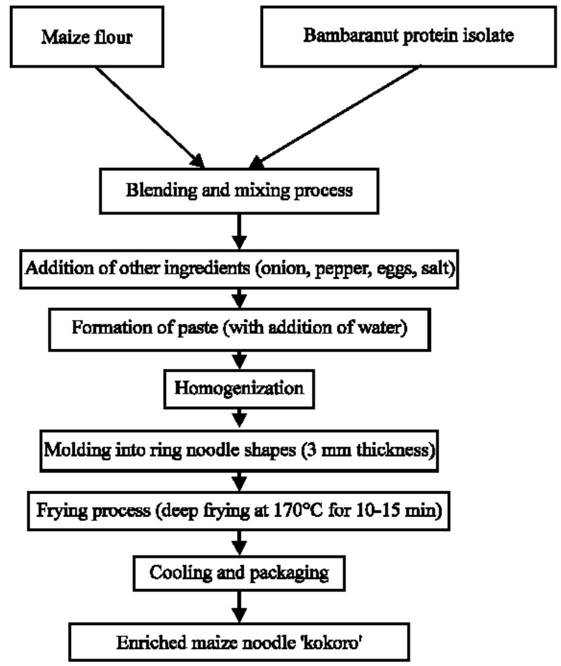

Fig. 2: Flow chart for preparation of enriched maize noodle 'kokoro'

RESULTS AND DISCUSSION

Proximate composition of Bambaranut Protein Isolates (BPI): Table 1 shows the proximate composition of Bambaranut protein isolate extract. Moisture content 8.1% of sample was below <10% (Sanni *et al*., 2005) recommended for dried foodstuff also, closely related to 8.88% moisture of cowpea protein concentrate. Moisture content is one of the quality parameter that is used to determine the shelf-life of foodstuffs and moisture found in this research suggests longer shelf-life stability. Protein content of 78.11% of the Bambaranut isolate found in this research was slightly >85.82% of cowpea protein concentrate 90% of soybean protein isolate (Peisker, 2001) but higher than 42-50% in soybean meal and 65% soybean protein concentrate of alcoholic extract (Peisker, 2001), 67.9-77.30% in beach pea (Chavan *et al*., 2001) and 65.90% in chickpea (Mwasaru *et al*., 1999). The variation on the protein content of Bambaranut protein isolated found in this research and those reported in literature could be attributed to the effect of methods of extraction, type and species of legume used. However,

Table 1: Mean values of proximate composition (%) of Bambaranut protein isolate

Samples	Moisture	Protein	Fat	Ash	Crude fiber	Nitrogen free extract
Bambaranut protein isolate	8.61	78.11	0.68	2.82	0.08	9.70

indicates its potential as source of vegetable protein in diet and food formulation. Fat content of the Bambaranut protein isolate was 0.68% this was below 1% fat reported for soybean protein isolate (Peisker, 2001). Ash content 2.82% of the Bambaranut protein isolates was <1.79% of cowpea protein isolates but lower than 5.0% reported for soybean protein isolate (Peisker, 2001). Onyeka stated that ash content of food is a measure of minerals of important in human nutrition. This indication shows that amount of ash content found in this could supply adequate mineral elements in human diet or in food formulation. Crude fiber content 0.08% was low, generally most of the extracted protein isolates from legume, nut and seeds contains little or no crude fiber. This is because most were lost due to solubility during extraction (Peisker, 2001). Nitrogen free extract of 9.70% was found on the Bambaranut protein isolate.

Proximate composition of enriched "kokoro" noodle: The results of the proximate compositions of noodle samples were shown in Table 2. There was differences on the proximate composition of enriched maize noodle and control samples but significant ($p<0.05$). Moisture content of the samples was within 14.02-15.29%. The values of moisture content of samples within this range were above <10% recommended moisture content for long shelf-life stability for dried foodstuffs (Sanni *et al*., 2005). Also, moisture content found in this research could support microbial growth under normal storage condition during long storage of the samples.

The crude protein and ash contents of the enriched maize noodle samples increased when substituted Bambaranut protein isolate increased from 10-50%. However, the protein content increased from 15.06% of maize noodle substituted with 10% Bambaranut (sample A-32.44% of maize noodle substituted with 50% Bambaranut protein isolate (sample E). On the other hand ash content of the samples changed from 3.82% of sample A-3.94% of sample E. In both cases the values found on the enriched samples were <10.28% protein and 3.26% ash content of the control sample (100% maize noodle). The result obtained in this research agreed with the findings from previous researches (Ijarotimi and Keshinro, 2012; Oloyo, 1999). Fat content of the samples differed slightly from each other and significant ($p<0.05$). The mean values ranged within 13.81-14.38%. The slight differences on fat content may be attributed to the extent of deep frying operation adopted in this research. Crude fiber content of the samples decreased slightly from 2.48-2.18%. This effect occurred when the proportion of Bambaranut protein isolate substitution increased from 10-50%, respectively. Control sample had 2.51% crude fiber higher than mean values for crude fiber of the experimental samples. The result on carbohydrate content of the maize noodle samples decreased from 55.39% of control sample F 100% maize noodle to 31.77% of sample E made from 50:50% of maize and Bambaranut protein isolate. The differences on crude fiber and carbohydrate content of the maize noodle samples may be attributed to the compositional adjustment or interaction resulting from blending effect of maize and Bambaranut protein isolate. Consequently, indication from this result further supported the finding in Table 3 where there was significant improvement on the amino acids composition of indigenous maize noodle 'kokoro'.

Amino acids profile of enriched maize noodle 'kokoro': Amino acids profile of indigenous maize noodle 'kokoro' enriched with Bambaranut protein isolate was presented in Table 3. Essential amino acids found include lysine, threonine, valine, methionine, isoleucine, leucine, phenylalanine, tryptophan and histidine. The quantity of proportion of Bambaranut protein isolate increased from 10-50%. Lysine a limiting amino acid in cereal was 1.66 mg/100 g protein in 100% maize noodle (sample F) this level was increased steadily from 11.49 mg/100 g protein of maize noodle substituted with 10% Bambaranut protein isolate sample A-34.08 mg/100 g maize noodle substituted with 50% Bambaranut protein isolate (sample E). Similar trend of increment was found on other amino acids of the enriched and control maize noodle samples. Among the samples threonine increased from 3.11-21.09 mg/100 g protein, valine changed from 4.61-22.51 mg/100 g protein, methionine 0.64-2.44 mg/100 g protein, isoleucine 4.01-20.66 mg/100g protein, leucine 15.28-95.01 mg/100g protein, phenylalanine 6.60-33.13 mg/100 g protein, tryptophan 0.68-4.53 mg/100 g protein, histidine 3.46-26.58 mg/100 g protein, arginine 5.33-40.06 mg/100 g protein, aspartic acid 10.14-81.23 mg/100 g protein, serine 4.68-21.01 mg/100 g protein, glutamic acid 15.49-106.96 mg/100 g protein, proline 2.06-15.66 mg/100 g protein, glycine 2.93-13.20 mg/100 g protein, alanine 2.11-12.01 mg/100 g protein and tyrosine increased from 3.99-18.39 mg/100 g protein. The behavior of amino acids content of the maize noodle 'kokoro' samples was similar to finding

Table 2: Mean values of proximate composition of enriched maize noodle 'kokoro'

Samples	Moisture	Protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrate(%)
A	14.65[b]	15.06[e]	13.89[c]	3.82[c]	2.48[a]	50.01[b]
B	14.02[c]	18.43[d]	14.06[b]	3.86[b]	2.41[a]	47.22[c]
C	15.11[a]	23.61[c]	14.10[b]	3.88[b]	2.40[a]	40.90[d]
D	15.22[a]	26.29[b]	14.31[a]	3.89[b]	2.37[a]	37.92[e]
E	15.29[a]	32.44[a]	14.38[a]	3.94[a]	2.18[a]	31.77[f]
F	14.75[b]	10.28[f]	13.81[c]	3.26[b]	2.51[a]	55.39[a]
LSD (p<0.05)	0.149	0.759	0.152	0.108	0.382	0.695

Mean values different letters in the same column are significant (p<0.05), LSD = Least Significant Difference, sample A = Enriched maize noodle contained 10% Bambaranut protein isolate; Sample B = Enriched maize noodle contained 20% Bambaranut protein isolate; Sample C = Enriched maize noodle contained 30% Bambaranut protein isolate; Sample D = Enriched maize noodle contained 40% Bambaranut protein isolate; Sample E = Enriched maize noodle contained 50% Bambaranut protein isolate; Sample F = 100% maize noodle

Table 3: Amino acids (mg/100 g protein) of enriched maize noodle 'kokoro'

Amino acids	A	B	C	D	E	F	LSD (p<0.05)
Lysine	11.49[e]	13.56[d]	18.31[c]	26.09[b]	34.08[a]	1.66[f]	0.0563
Threonine	6.16[e]	10.48[d]	15.09[c]	18.22[b]	21.09[a]	3.11[f]	0.0286
Valine	7.43[e]	9.68[d]	13.46[c]	17.16[b]	22.51[a]	4.61[f]	0.0028
Methionine	1.08[e]	1.87[d]	1.96[c]	2.09[b]	2.44[a]	0.64[f]	0.1850
Isoleucine	8.46[e]	11.02[d]	16.26[c]	19.38[b]	20.66[a]	4.01[f]	0.5590
Leucine	36.01[e]	45.77[d]	58.21[c]	70.11[b]	95.01[a]	15.28[f]	0.8260
Phenylalanine	12.36[e]	16.84[d]	20.22[c]	27.14[b]	33.13[a]	6.60[f]	0.4590
Tryptophan	0.96[e]	1.49[d]	2.60[c]	2.94[b]	4.53[a]	0.68[f]	0.0336
Histidine	10.28[e]	15.11[d]	21.08[c]	24.78[b]	26.58[a]	3.46[f]	0.0418
Arginine	14.16[e]	18.96[d]	23.11[c]	28.31[b]	40.06[a]	5.33[f]	2.6800
Aspartic acid	28.49[e]	32.66[d]	51.03[c]	64.91[b]	81.23[a]	10.14[f]	4.6100
Serine	13.94[e]	14.36[d]	16.11[c]	19.10[b]	21.01[a]	4.68[f]	0.7740
Glutamic acid	40.63[e]	58.45[d]	73.26[c]	86.43[b]	106.96[a]	15.49[f]	11.4580
Proline	8.16[e]	11.06[d]	12.84[c]	13.58[b]	15.66[a]	2.06[f]	0.8660
Glycine	5.34[e]	6.77[d]	8.09[c]	11.55[b]	13.2[a]	2.93[f]	0.2280
Alanine	4.85[e]	6.26[d]	7.49[c]	9.29[b]	12.01[a]	2.11[f]	0.0664
Tyrosine	5.69[e]	8.40[d]	11.18[c]	15.09[b]	18.36[a]	3.99[f]	0.8860

Values different letters in the same column are significant (p<0.05), LSD = Least Significant Difference, Sample A = Enriched maize noodle contained 10% Bambaranut protein isolate; Sample B = Enriched maize noodle contained 20% Bambaranut protein isolate; Sample C = Enriched maize noodle contained 30% Bambaranut protein isolate; Sample D = Enriched maize noodle contained 40% Bambaranut protein isolate; Sample E = Enriched maize noodle contained 50% Bambaranut protein isolate; Sample F = 100% maize noodle

Table 4: Mean sensory scores of enriched maize noodle 'kokoro'

Samples	Colour	Aroma	Taste	Texture	Overall acceptability
A	8.23[a]	8.50[a]	7.92[a]	8.10[ab]	7.35[b]
B	8.20[a]	8.48[a]	8.20[a]	7.90[b]	7.40[a]
C	8.25[a]	8.40[a]	8.10[a]	7.65[c]	7.45[a]
D	8.11[a]	8.35[a]	8.10[a]	7.52[d]	6.80[d]
E	8.10[a]	8.30[a]	8.0[a]	7.28[e]	6.75[d]
F	8.25[a]	8.50[a]	7.90[a]	8.15[a]	7.10[c]
LSD (p<0.05)	0.564	0.372	0.618	0.152	0.10

Mean scores different letters in the same column are significant (p<0.05), LSD = Least significant difference; Sample A = Enriched maize noodle contained 10% Bambaranut protein isolate; Sample B = Enriched maize noodle contained 20% Bambaranut protein isolate; Sample C = Enriched maize noodle contained 30% Bambaranut protein isolate; Sample D = Enriched maize noodle contained 40% Bambaranut protein isolate; sample E = Enriched maize noodle contained 50% Bambaranut protein isolate; sample F = 100% maize noodle

by Ijarotimi and Keshinro (2012) who reported increased concentration of amino acids content of diet formulated from blends of pop corn, Bambaranut and locust bean. Also, the concentration of amino acids in enriched maize noodle samples were higher than values reported for quality protein maize and common maize meal (Sumbo and Victor, 2014) and as well as FAO/WHO (1991) recommended pattern of essential amino acids. This implies that Recommended Daily Allowance (RDA) these amino acids were adequately met with enrichment process in this research.

Sensory evaluation of maize noodle 'kokoro': Table 4 showed the mean scores for sensory attributes of maize noodle 'okokoro' enriched with substitution of Bambaranut protein isolate. There was significant different (p<0.05) on the mean scores of texture and overall acceptability of maize noodle samples. The mean scores for colour, aroma and taste of experimental and control samples varies slightly but not significant (p>0.05). Mean scores for colour of samples decreases gradually from 8.25-100% maize noodle (control sample F) to 8.10 of maize noodle substituted with 50% Bambaranut protein isolate (sample E). For aroma and texture attributes of the samples, the mean scores changed slightly from 8.50-8.30 and 8.15-7.28, respectively when Bambaranut protein isolate substitution increased from 10-50%. On the contrary, the mean scores for taste increased from 7.90 of control sample F-8.20 of maize noodle substituted with 20% of Bambaranut protein isolate and subsequently decreased to 8.0 of maize noodle substituted with 50%

Bambaranut protein isolate (sample E). This observation on taste is unique among the attributes of the maize noodle that need to be noted. Because this affects the overall acceptability of the product. Similar trend was observed on the overall acceptability where the mean scores of the samples increased from 7.10 of control sample F-7.45 of maize noodle substituted with 30% Bambaranut protein isolate, then decreased to 6.75 when Bambaranut protein isolate increased to 50% (sample E) in the blend. Indication from this result suggest that Bambaranut protein isolate should be carefully substituted to level that will not affect the overall acceptability of maize noodle 'kokoro' in spite of nutritional advantages recorded in Table 2.

CONCLUSION

From the findings of the research, the enrichment of indigenous maize noodle 'kokoro with addition of Bambaranut protein isolate improved the proximate composition and amino acids content. Protein and ash contents increased gradually when the substituted Bambaranut protein isolate increased from 10-50%. However, the protein and ash content increased up to 32.44-3.94%, respective <10.28% protein and 3.26% ash content of control maize noodle. The higher ash content found in enriched maize noodle samples further implies that the presence of Bambaranut protein isolate improved the minerals of indigenous maize noodle.

RECOMMENDATIONS

Furthermore, effect of Bambaranut protein isolate was noticed on amino acids content, most importantly with increased concentration of lysine a limiting amino acid in maize and other essential and non essential amino acids of the maize noodle samples. In term of sensory attributes of maize noodle, substitution of Bambaranut protein isolate at varied proportion caused significant difference on the samples. Therefore, the results obtained in this research revealed the potential of under-utilized Bambaranut as a source of vegetable protein in diet and food formulation.

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