Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension
Volume 16 Number 1 (January 2017) pp. 26 - 30
ISSN 1119-7455

CHEMICAL COMPOSITION AND SENSORY ACCEPTABILITY OF PARTIALLY GELATINISED PASTA PRODUCED FROM BLENDS OF WHEAT, BAMBARA NUT AND CASSAVA FLOURS

[1*]James, S., [2]Nwokocha, L., [3]James, Y., [1]Abdulsalam, R.A., [4]Amuga, S.J., [1]Ibrahim, I.B., and [1]Yakubu, C.M.

[1]Department of Food Science & Technology, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria
[2]Department of Hospitality and Tourism Management, Delta State Polytechnic, Ogwashi-Ukwu, Delta State, Nigeria
[3]Department of Applied Sciences, College of Science & Technology, Kaduna Polytechnic, Nigeria
[4]Federal University Kashere, Gombe State, Nigeria

***Corresponding author's email:** samaila.james@futminna.edu.ng

ABSTRACT

Pasta products were produced from partially gelatinized blends of wheat, cassava and bambaranut nut flours. The three flours from wheat, cassava and bambaranut nut were blended in the following ratios: 100% wheat flour, 64:10:26, 60:12:28, 56:14:30, 52:16:32 and 48:18:34 flour blends, representing samples A, B, C, D, E and F, respectively. 180 ml of water and 65 ml of vegetable oil were added to each blend and thoroughly mixed to form a dough. The dough from each blend was steamed for 20 min to partially gelatinize it and pressed manually through home pasta making machine. Pasta made from these blends were subjected to proximate analyses, sensory evaluation, mineral determination and physical properties evaluation. The result of the proximate composition showed significant ($p < 0.05$) variation in all the parameters measured. Also, various blends significantly influenced the mineral composition of the products. In physical properties, pasta products were significantly different in height, thickness and expansion ratio but, not significantly different ($p > 0.05$) in deformation strength. The sensory properties of the pasta products were significantly ($p < 0.05$) different from each other. However, pasta with high ratio of bambaranut flour received less sensory acceptability. Pasta with the least amount of bambaranut and cassava flour in this study compared favourably with the control.

Key words: pasta, wheat, bambaranut, cassava, functional

INTRODUCTION

Pasta is a type of food made from durum wheat flour and shaped into forms such as macaroni, noodles, ravioli and spaghetti (David and Bender, 2006). It is one of the most common sources of carbohydrate in a diet. Production and consumption of pasta products vary depending on the region of the world and culinary traditions within a society (Leszek, 2011).

Cold temperature extrusion involves extruding the flour blends without cooking or distortion of the food material into different pasta products (Fellows, 2000). Such pasta products have low functional properties and require considerable cooking time unlike the high temperature extruded food products. In conventional pasta extruded at low temperatures (below 50^{o}C), the degree of starch gelatinization after drying does not exceed 50%. Therefore, traditional pasta is cooked before serving.

Precooked pasta is usually made following a conventional technology, supplemented with a pasta cooking stage in water or steam or hot oil and followed by drying as in traditional pasta processing (Leszek, 2011). Pasta designed to have a short thermal treatment by steaming precooking, toasting or hydration displays a higher degree of gelatinized starch.

The machinery-set needed to produce pasta of good quality, proper rheological and sensory values consists of a mixer working at normal or low pressure, a press with a forming die, a drying unit set to a suitable drying cycle and a packaging device portioning the product into single packets (Mian, 2000). The extruder has a deep-flighted screw, which operates at a low speed in a smooth barrel, to knead and extrude the material with little friction.

Please cite as: James, S., Nwokocha, L., James, Y., Abdulsalam, R.A., Amuga, S.J., Ibrahim, I.B., and Yakubu, C.M. (2017). Chemical composition and sensory acceptability of partially gelatinised pasta produced from blends of wheat, bambara nut and cassava flours. *Agro-Science*, **16 (1),** 26-30. DOI: https://dx.doi.org/10.4314/as.v16i1.5

The most common raw material in pasta production is *Triticum durum* wheat semolina with granulation ranging from 200 to 300 mm and contains 0.8 to 0.9% ash in dry mass, 12 to 13% protein and no less than 30% of wet gluten (protein fraction determining the plasticity of dough) (Leszek, 2011). The production process may also involve the use of vegetable oil, additives, vegetables such as carrots, spinach and pumpkin, or legume seeds to improve the taste and nutritional value of the finished product.

In production of pasta, various types of additives may be used such as eggs (in processing of egg pasta), vegetables (influencing the colour and flavour of products) and substances affecting the rheological characteristics of the dough such as natural emulsifiers (soy or sunflower lecithin), or artificial chemical additives (mono- and diglyceride esters). Protein supplements are also added to improve the nutritional properties of the pasta or final product and enriching supplements, such as vitamins or minerals.

Pasta products are commercially produced from wheat flour, however, the flour contains inadequate amount of certain essential amino acids notably lysine and tryptophan. Hence, supplementing wheat flour with cheap and readily available legume flour such as bambara nut which is a good source of lysine and tryptophan, minerals, vitamins and phytochemicals would improve the nutrient content of the flour blend giving it a superior quality extrudates. Addition of cassava flour would improve the binding properties of the extrudates.

MATERIALS AND METHODS

Materials Used for the Study

Refined wheat flour, cassava flour, bambaranut flour and vegetable oil were purchased from Kure Ultra-modern Market Minna, Nigeria.

Preparation of Raw Materials

Bambaranut seeds were destoned and cleaned from contaminants manually. The seeds were soaked in three litre of clean water for 5 h. The soaked seeds were dehulled by working in a mortar and pestle and washed in a floating water to remove the seed coat. Dehulled seeds were drained and dried in an oven at 105^{o}C for 5 h to a moisture content of 6%. The dried bambaranut was milled in a disc attrition mill into fine flour, sieved through a 3-mm mesh and then packaged in an airtight plastic container and kept at room temperature.

Formulation of the Blends

Production of pasta

The flours were blended according to the ratios provided in the design block (Table 1). After blending and properly mixing the flour, 180 ml of water was added to the blended flour and mixed to form a dough. This was followed by addition of 65 ml of vegetable oil and properly kneaded. The dough was steamed for 20 min to partially gelatinize it and kneaded again to attain a homogenous mixture. The dough was manually extruded through a 0.25 mm die at room temperature (cold extrusion) and was dried in an oven at 65^{o}C for 5 h and packaged inside high density polyethylene bag.

Proximate analysis

The protein, fat, ash, crude fibre and moisture contents were determined as described by AOAC (2012). While carbohydrate was calculated using At-water-factor %carbohydrate = 100 – (%protein + %moisture + %fat + %ash).

Mineral composition

The mineral contents were determined by using atomic absorption spectrophotometer (Buck 210 VGP Germany). The sample was digested and filtered with Whatmann 1 quantitative circles 125 mm filter paper. The filtrate was placed in different corvettes and labeled accordingly. The concentration of the metal present was determined from the working corvettes after calibrating the instrument with standards of known concentrations.

Physical Properties

Expansion ratio

The expansion ratio of the pasta was determined by taking the diameter of 20 pasta at random using a laboratory micrometer screw gauge and the mean of the determinations taken. The expansion ratio (ER) was expressed as the mean diameter of the pasta to that of the die orifice (Art *et al*., 1990; James and Nwabueze, 2013).

Deformation strength

The deformation strength (DS) of the pasta was determined as reported by James and Nwabueze (2013). Ten cylindrical pastas of uniform thickness were placed between two smooth parallel iron bars (1 cm apart). Standard weights were added onto the pasta continuously until a visible deformation was noticed. The least weight that caused the deformation of the pasta was regarded as the deformation strength of the pasta. The pasta thickness (T) was determined using micrometre screw gauge while the height was determined using a graduated flexible tape.

Sensory evaluation

Sensory evaluation was carried out by a panel of 30 judges made up of staff and students of the Department of Food Science and Nutrition, Federal University of Technology, Minna, Nigeria using 9-point Hedonic scale. The characteristics evaluated included appearance, texture, taste, flavor and overall acceptability.

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) and separation of the mean values was carried out using Duncan multiple range test and significant difference between any two means was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Proximate Composition of Extruded Flour Blends

The proximate composition given in Table 2 shows that all the pasta samples were significantly ($p < 0.05$) different in the parameters measured. Fat of pasta made from 100% wheat (sample A) compared favourably with samples B, D and F. The blend ratios of cassava and bambaranut flour used in this study significantly ($p < 0.05$) influenced the fat content of the extrudates. The fat contents obtained in this study (2.21 to 2.75%) are lower as compared to 7.60% in the African breadfruit flour mix extrudates (James and Nwabueze, 2013). However, the value compares favourably with conventional pasta products which contain around 1% fat (Wanda, 2012). Low fat content implies that the extrudates would have less challenges of rancidity during storage. The extrudates made from 100% wheat flour had the lowest protein (16.20%) content. It could be deduced that the protein content of the extruded samples increased with increased concentration of bambaranut flour and decreased with the level of cassava flour addition in the blend. The protein obtained in this study (16.20 to 17.85%) is low compared with 24. 50% for extruded African breadfruit flour mix and high compared with 11, 12 and 5% for commercial whole wheat spaghetti, enriched macaroni and corn pasta respectively (Wanda, 2012; James and Nwabueze, 2013).

Blending wheat flour with bambaranut flour has significantly improved the protein content of local pasta and this would help in alleviating protein related nutritional problems. The low moisture content (0.57 to 2.80%) would enhance the keeping quality of the pasta. Different flour blends significantly ($p < 0.05$) influenced the fibre contents of the extrudates. However, samples A and C showed no significant ($p > 0.05$) difference. The low fibre content in this study (2.21 to 2.75%) could be attributed to the use of refined flour. The value is low compared with 19% in whole wheat spaghetti (Wanda, 2012). For increased physiological contribution of local pasta, there is a need for a way of increasing its dietary fibre content. The carbohydrate content of the flour extrudates ranged from 75.10 to 77.32% with the control having the highest value while, sample F had the least value. High carbohydrate implies that, pasta from blends of wheat, cassava and bambaranut flour would be a good source of energy.

Mineral composition of the extrudates

Table 3 shows the mineral composition of the extruded blends of wheat, cassava and bambaranut flour. The samples were significantly ($p < 0.05$) different in all the minerals measured. The control (sample A) was significantly high in sodium and calcium contents compared to pastas made from different flour blends. Reducing wheat flour and increasing cassava and bambaranut flours in the blends significantly increased the phosphorus content. While highest levels of cassava and bambaranut flour inclusion significantly reduced potassium content. The range in this study (38.28 to 51.82 mg/100g) is significantly lower as compared to 225.20 mg/100g for extruded African breadfruit flour mix (James and Nwabueze, 2013) but, favourably compared with 58.00 mg/100g for commercial corn pasta (Wanda, 2012). Moderate replacement of wheat flour significantly ($p < 0.05$) increased the manganese and magnesium contents of the extrudates. The result for manganese obtained in this study (1.10 to 1.70 mg/100g) compares favourably with commercial whole wheat spaghetti (1.38 mg/100g) and higher than corn pasta and enriched macaroni (Wanda, 2012). Extrudate made from 100% wheat four was significantly ($p < 0.05$) lower in iron (1.30%) content than the other samples.

Table 1: Sample formulation

Sample	Ingredients in %		
	Wheat flour	Cassava flour	Bambara nut flour
A (control)	100	-	-
B	64	10	26
C	60	12	28
D	56	14	30
E	52	16	32
F	48	18	34

Table 2: Proximate composition of the extrudates.

Proximate (%)	A	B	C	D	E	F
Fat	$2.40^{a}\pm0.01$	$2.41^{a}\pm0.03$	$2.24^{b}\pm0.06$	$2.35^{ab}\pm0.23$	$2.21^{b}\pm0.29$	$2.75^{a}\pm0.12$
Crude protein	$16.20^{e}\pm0.11$	$18.95^{a}\pm0.03$	$16.30^{e}\pm0.17$	$17.25^{c}\pm0.04$	$16.60^{d}\pm0.06$	$17.85^{b}\pm0.29$
Moisture content	$1.20^{d}\pm0.03$	$1.40^{c}\pm0.03$	$2.20^{b}\pm0.02$	$0.57^{f}\pm0.01$	$0.80^{e}\pm0.00$	$2.80^{a}\pm0.20$
Crude fiber	$1.33^{d}\pm0.01$	$1.00^{e}\pm0.09$	$1.28^{d}\pm0.03$	$2.02^{b}\pm0.01$	$2.67^{a}\pm0.02$	$1.75^{c}\pm0.14$
Ash	$1.08^{b}\pm0.22$	$1.50^{a}\pm0.01$	$1.50^{a}\pm0.03$	$1.50^{a}\pm0.02$	$1.50^{a}\pm0.01$	$0.50^{c}\pm0.17$
Carbohydrate	$77.32^{a}\pm0.11$	$75.12^{c}\pm0.11$	$77.28^{a}\pm0.03$	$76.05^{b}\pm0.03$	$77.07^{a}\pm0.29$	$75.10^{c}\pm0.03$

Values are means of triplicate determinations. Values with the same superscript along the row are not significantly ($p > 0.05$) different.
Key: A - (wheat flour 100%); B - (wheat 64%, cassava 10% and bambaranut 26% flours); C - (wheat 60%, cassava 12% and bambaranut 28% flours); D - (wheat 56%, cassava 14% and bambaranut 30% flours); E - (wheat 52%, cassava 16% and bambaranut 32% flours); F - (wheat 48%, cassava 18% and bambaranut 34% flours)

Table 3: Mineral composition of the extrudates

Minerals (mg/100g)	A	B	C	D	E	F
Sodium	274^{a}±0.29	6.45^{f}±0.14	25.7^{b}±0.12	17.3^{c}±0.03	26.08^{e}±0.36	37.97^{d}±0.07
Calcium	112.8^{a}±0.12	5.87^{c}±0.01	14.80^{b}±0.12	7.75^{d}±0.14	4.50^{e}±0.02	7.90^{d}±0.29
Potassium	102.55^{d}±0.26	101.0^{e}±0.29	318.01^{a}±0.01	308^{b}±0.01	304.75^{c}±0.14	205^{f}±0.14
Manganese	1.30^{bc}±0.03	1.70^{a}±0.12	1.60^{ab}±0.17	1.60^{ab}±0.03	1.40^{abc}±0.12	1.10^{c}±0.06
Magnesium	11.00^{c}±0.29	14.27^{a}±0.37	12.01^{b}±0.02	14.0^{a}±0.01	12.00^{b}±0.12	10.00^{d}±0.23
Iron	1.30^{d}±0.06	9.70^{c}±0.17	13.10^{a}±0.29	9.20^{c}±0.12	11.60^{b}±0.23	13.10^{a}±0.23
Phosphorus	42.11^{c}±0.29	38.28^{d}±0.12	38.94^{d}±0.12	41.94^{c}±0.12	47.88^{b}±0.23	51.82^{a}±0.29

Values are means of triplicate determinations. Values with the same superscript along the row are not significantly (p>0.05) different.
Key: A- (Wheat flour 100%); B- (Wheat 64%, cassava 10% and bambara nut 26% flours); C- (Wheat 60%, cassava 12% and bambara nut 28% flours); D- (Wheat 56%, cassava 14% and bambara nut 30% flours); E- (Wheat 52%, cassava 16% and bambara nut 32% flours);
F-(Wheat 48%, cassava 18% and bambara nut 34% flours)

At higher replacement of wheat flour with bambaranut flour, the extrudates showed a significant increase in iron content. Extrudates from different flour blends had significantly ($p < 0.05$) high iron compared with commercial pastas such as corn pasta, whole wheat spaghetti and enriched macaroni containing 0.20, 1.06 and 1.28 mg/100g iron content, respectively (James and Nwabueze, 2013). This implies that bambaranut flour would significantly address iron deficiency problems if bioavailable.

Physical properties of extrudates

Table 4 shows the physical properties of pastas prepared from the different flour blends. The results show that all the samples were not significantly ($p > 0.05$) different in deformation strength and expansion ratio. However, the samples were significantly ($p < 0.05$) different in height and thickness. In height, sample A (100% wheat flour) was found to be significantly ($p < 0.05$) higher than the other samples prepared from different flour blends. The thickness of extrudates from different blends was significantly ($p < 0.05$) higher than the control. Significantly high height of the extrudate from 100 % wheat flour could be attributed to the gluten content which made it form a firm bond with other macromolecules and upon drying the bond firmed giving the extrudates that characteristics continuous shape. The expansion ratio of the test samples and that of the control was not significantly ($p > 0.05$) different. Hence, blending the flours at different ratios did not influence the expansion ratio.

Sensory evaluation of the extruded flour blends

The result of the sensory attributes (Table 5 of the pastas shows that, samples B, C, D and E compared favourably with the control in appearance, texture, flavour and overall acceptability. This implies that acceptable pasta can be produced by replacing wheat flour with bambara nut and cassava flour up to 32% and 16%, respectively. However, for taste, pasta from 100% wheat received higher acceptability. Sample F had the least acceptability in all the sensory attributes determined. This could be attributed to the fact that, higher incorporation of bambara nut flour in the blend resulted into decreased carbohydrate content of the blend which made the pasta come out as pellets and easily breakable. Also high bambara nut groundnut contributed to the beany flavour in the pasta and that affected the acceptability.

Table 4: Physical properties of the extrudates

Physical Properties	A	B	C	D	E	F
Height (cm)	6.60^{a}±0.58	1.70^{c}±0.06	3.16^{b}±0.58	2.20^{b}±0.58	1.56^{c}±0.06	1.70^{c}±0.06
Thickness (mm)	0.24^{b}±0.01	0.27^{a}±0.01	0.25^{b}±0.01	0.27^{a}±0.01	0.27^{a}±0.01	0.28^{a}±0.01
Deformation strength (kg)	4.80±0.58	4.20±0.58	4.20±0.58	4.80±0.58	4.80±0.58	4.80±0.58
Expansion ratio	1.14±0.01	1.28±0.06	1.19±0.06	1.28±0.06	1.28±0.06	1.33±0.06

Values are means of triplicate determinations. Values with the same superscript along the row are not significantly (p > 0.05) different.
Key: A - (wheat flour 100%); B - (wheat 64%, cassava 10% and bambaranut 26% flours); C - (wheat 60%, cassava 12% and bambaranut 28% flours); D - (wheat 56%, cassava 14% and bambaranut 30% flours); E - (wheat 52%, cassava 16% and bambaranut 32% flours);
F - (wheat 48%, cassava 18% and bambaranut 34% flours)

Table 5: Sensory evaluation of the extrudates

Sensory properties	A	B	C	D	E	F
Appearance	7.15^{a}±0.34	6.65^{a}±0.26	6.70^{a}±0.19	6.75^{a}±0.27	6.85^{a}±0.30	5.05^{b}±0.44
Taste	7.20^{a}±0.26	6.35^{b}±0.29	6.40^{b}±0.20	6.15^{b}±0.20	6.10^{b}±0.24	5.15^{c}±0.40
Texture	6.90^{a}±0.37	6.55^{a}±0.35	6.45^{a}±0.21	6.45^{a}±0.25	6.40^{a}±0.28	5.05^{b}±0.36
Flavour	7.15^{a}±0.26	6.40^{ab}±0.33	6.50^{ab}±0.27	6.50^{ab}±0.25	6.00^{bc}±0.18	5.45^{c}±0.41
Overall acceptability	7.35^{a}±0.26	6.70^{a}±0.25	6.85^{a}±0.21	6.60^{a}±0.22	6.60^{a}±0.27	5.15^{b}±0.39

Values are means of triplicate determinations. Values with the same superscript along the row are not significantly (p > 0.05) different.
Key: A - (wheat flour 100%); B - (wheat 64%, cassava 10% and bambaranut 26% flours); C - (wheat 60%, cassava 12% and bambaranut 28% flours); D - (wheat 56%, cassava 14% and bambaranut 30% flours); E - (wheat 52%, cassava 16% and bambaranut 32% flours);
F - (wheat 48%, cassava 18% and bambaranut 34% flours)

CONCLUSION

This study has shown the possibility of using bambara groundnut and cassava flour for the production of pasta with desirable sensory properties and appreciable nutrient density. The replacement of wheat with a combination of 32% of bambara groundnut flour and 16% cassava flour gave pasta with superior proximate, mineral and sensory attributes. However, addition beyond a combination of 32% bambara groundnut flour 16% cassava flour negatively affected the sensory acceptability of the pasta.

REFERENCES

A.O.A.C. (2012). Association of Official Analytical Chemist(16th ed.),Washington DC, USA

Art, W.E., Warren, C. and Villota, R. (1990). Twin screw extrusion modification of corn fibre and corn starch extruded blend. *J. Food Sci*., **55** (3): 746-754

David, A. and Bender, H. (2006). Bender' Dictionary of Nutrition and Food Technology (8 th ed.), Woodhead Publishing Ltd., Cambridge, England

Fellows, P. (2000). Food Processing Technology: Principles and Practice (2nd ed.), Woodhead Publishing Ltd., Cambridge, England

James, S. and Nwabueze, T.U. (2013). Quality evaluation of extruded full fat blend of African breadfruit-soybean-corn snack. *International Journal of Scientific and Technology Research*, **2** (9): 212-216

Leszek, M. (2011). Extrusion-Cooking Techniques Applications, Theory and Sustainability. WILEY-VCH Verlag & Co. KGaA, Weinheim, Germany

Mian, N.R. (2000). Extruders in Food Applications, (1st ed.), CRC press USA

Wanda, E. (2012). Nutrient information in pasta and other products. Retrieved 8 August, 2012 at: https://bostonpizza.com/en/nutrition.html