THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Nutritional and Functional Properties of a Developed Breakfast Meal from Maize, Soybean and Coconut

Adepeju A. B.
Lecturer, Department of Food Science and Technology,
Joseph Ayo Babalola University, Ikeji Arakeji, Osun State, Nigeria
Abiodun O. A.
Lecturer, Department of Food Science and Technology,
University of Ilorin, Kwara State, Nigeria
Otutu O. L.
Lecturer, Department of Food Science and Technology,
Joseph Ayo Babalola University, Ikeji Arakeji, Osun State, Nigeria
Pele I. G.
Lecturer, Department of Food Science and Technology,
Joseph Ayo Babalola University, Ikeji Arakeji, Osun State, Nigeria

Abstract:
Nutritional and functional properties of a developed breakfast meal was studied. A breakfast meal was developed from blends of Maize, Soybean and Coconut. The meal was developed in the ratio of maize: soybean: coconut (A- 60:30:10; B-60:20:20;C-60:10:30 and D-100:00:00).Sample D serves as the control. The protein, fat, ash and crude fibre in all the samples were higher than that of 100% maize but the carbohydrate content of the 100% maize was the highest. The moisture content were relatively the same. The swelling capacity, solubility and least gelation were higher in all the samples than that of control (100% maize). The bulk density is low in the control than the other samples. There was no difference in the water absorption capacity of the samples. There was no difference in colour, flavor, texture and overall acceptability of the blended samples. It is therefore concluded that consumption of the breakfast meal could be beneficial to individual requiring nutritious meal.

Keywords: *Nutritional, functional, swelling capacity, solubility, least gelation*

1. Introduction

Breakfast is the first meal taken after rising from a night sleep, most often eaten in the early morning before undertaking the day's work (Naivikul and D' Appolonia,1998). Breakfast foods vary from place to place, but often include carbohydrate such as tea, coffee, or fruit juice. Nutritional experts have referred to breakfast as the most important meal of the day; it has been discovered that people who skipped breakfast are disproportionately likely to have problems with concentration, metabolism and weight (Naivikul and D' Appolonia,1998). A complete breakfast meal contains some essential nutrients like proteins, vitamins, minerals, fats and carbohydrate (Ciacco and D' Appolonia,1998). A fibre is also one of the major constituents of a cereal grains. The purpose of mixing two or more cereal grains together is to make sure it contains all the essential nutrient. Perfect breakfast provides essential nutrient and fluid at a critical time of the day. Regular breakfast consumption may decrease the risk of heart disease (MacArthur and D Appolonia,1999; It aids in boosting energy level that kick start metabolism which helps to keep people active and fit as well as curbing hunger (Radley, 1996). This work is a development of breakfast foods from blends of maize, soybean and coconut. These blend is chosen in order to prepare a breakfast gruel of maximum nutrients that will meet the nutritional requirement of the consumer (FMOH, 2005). The maize, soybean and coconut contains high percentage of mono and polysaturated serum cholesterol levels (Anderson *et. al.*, 1995). Also, soybeans contains two essential fatty acid (linoleic and linolenic) that are not produced in the body. Linoleic and linolenic acids aids the body's absorption of vital nutrients and are require for human heart. They are precursor to hormones that regulate smooth muscle contraction, blood pressure and the growth of healthy cells.
Therefore, the objective of this study was to develop breakfast meal from blends of maize, soybeans and coconut and also to determine the nutritional and functional properties of the breakfast meal.

2. Materials and Methods

Yellow maize grains, soybean seeds and coconut were purchased from Iree central market, Iree, Osun state. Nigeria.

2.1. Methods

Maize grains were cleaned, steamed for 30mins and heat treated in the hot air oven at 70^0C for 2 hours. After, it was milled partly to remove the coat and later to fine powder and then sieved. This flour is packaged in a plastic container with lid at 4^0C in the refrigerator.

Soybean seeds were sorted, cleaned, soaked in warm water (containing 0.2% NAHCO3) for 3 hrs. It was then decorticated, washed and steamed for 1 hour. It was then dried, milled and sieved to fine powder using hammer mill. The flour is stored in plastic containers with lids at 4^0C in the refrigerator.

Coconut fruit was sorted and graded. The fruit was broken and shell removed. The brown skin cover was removed after which it was grated to increase the surface area. It was then dried and milled into fine powder using a blender (Philips, model HR,1702). It was packaged into plastic containers with lid at 4^0C in refrigeration.

3. Breakfast Meal Formulation

Each sample was mixed in the kenwood mixer, packaged and labeled.

The meals were blended as shown in Table 1.

Sample	Maize Flour	Soybeans Flour	Coconut Flour
A	60%	30%	10%
B	60%	20%	20%
C	60%	10%	30%
D	100%	0	0

Table 1: Percentage ratios of the blends

4. Methods of Analysis

Moisture content, protein, fat, crude fibre and ash content were carried out on the breakfast meals using the methods of the Association of official Analytical chemists (AOAC, 2000).

4.1. Functional Analysis

The water absorption capacity (WAC) was determined by a method of AACC (1995). A 2g sample was dispersed in 20ml of distilled water. The contents were mixed for 30 seconds every 10 minutes using a glass rod and after mixing five times, it was centrifuged at 4000 g for 20 minutes. The supernatant was carefully decanted, and then the content of the tube was allowed to drain at a 45^0 angle for 10 minutes and then it was weighed. The water absorption capacity was expressed as percentage increase of the sample weight.

4.2. Solubility Determination

The method modified by Okoli (1998) was used. One gram sample was suspended in 50ml distilled water in a clean dry beaker. The suspension was mechanically stirred at a rate sufficient to keep the sample completely suspended. The beaker was placed in a thermo stated water bath with the temperature set at 60^0C for 30 minutes with gentle stirring. The stirrer was subsequently removed and rinsed with distilled water to bring the total water content to 60 ml. The mixture was then centrifuged at 4000 g. The supernatant was decanted into tared evaporating dish. It was thereafter evaporated to dryness at 120 ^{0}C. The percentage of soluble extract from the sample was calculated on dry weight basis.

4.3. Swelling Capacity

3-5gm samples weighed into a tarred 50 ml centrifuge tube. About 30 ml distilled water was added and mixed gently. The slurry was heated in a water bath at 95 ^{0}C for 15 mins. During heating, the slurry was stirred gently to prevent clumping of the sample. On completion of the 15 min, the tube containing the paste was centrifuged at 3000 g for 10 minutes. The supernatant was decanted immediately after centrifugation. The tubes were dried at 50 ^{0}C for 30 minutes, cooled and the weighed (W_2). Centrifuge tubes containing sample alone were weighed prior to adding distilled water (W_1). Swelling capacity was calculated as follows:

$$\text{Swelling capacity} = \frac{W_{2(g)} - W_{1(g)}}{\text{Weight of sample (g)}}$$

4.4. Gelation Capacity

2-20%(w/v) sample suspension was prepared in 5 ml distilled water. The sample in the tests tube was heated for 1hr followed by rapid cooling under running cold water. The test tubes were further cooled for 2 hrs at 4 ^{0}C. Least gelling concentration was determined as that concentration when the sample from the inverted test tube did not fall down or slip.

4.5. Bulk Density

A 10ml graduated cylinder, previously tared, was gently filled with the sample. The bottom of the cylinder was gently tapped on a laboratory bench several times until there was no further diminution of the 10ml mark. Bulk density was calculated as weight of sample per unit volume of sample (g/ml).

4.6. pH

A portion of the sample was taken into a 50 ml capacity beaker and the pH glass electode (probe) inserted into the beaker and the reading taken at a steady display and recorded accordingly. The glass electrode of the pH meter was then removed and rinsed thoroughly with distilled water after each determined so as avoid cross contamination of other sample.

4.7. Determination of Titratable Acidity

It was determined by titrating a 10 g sample mixed with 90 ml of diluted water against 0.1N NaoH using phenolphthalein as indicator (AOAC, 1998). The acidity was then calculated as stated below:

$$\% \text{ lactic acid} = \frac{0.1\text{N NaoH} \times 0.009 \times \text{Titre value} \times 100}{\text{Weight of sample.}}$$

5. Statistical Analysis

Data were analyzed by analysis of variance (ANOVA). The difference between mean values were determined by the least significant difference (LSD) test. Significance was accepted at 5% probability level (Ihekoronye and Ngoddy, 1985).

6. Results and Discussion

The nutritional analysis of the breadfruit meals is given in Table 2. The crude protein content of the meals increased with increase in soybean substitution and ranged from 4.32% in the control sample (100% maize flour) to 19.65% in the meal that contained 30% soybeans. This increase was due to higher content of crude protein in soybean relative to coconut (Elegbede, 1998). Several workers have also reported increases in protein contents of foods supplemented with soybean (Ayo *et. al.*, 2007, Edema *et. al.*, 2005, Babajide *et. al.*, 2003).. Similarly, same thing was observed when the percentage ash content was viewed. It also increased with increase in soybean substitution. This result was higher than that of control sample. The ash content of the blended samples fell within the recommended value (1.40 to 2.41%) which must not exceed 5%. Conversely, the fat and crude fibre decreased with increase in soybean substitution i.e the values increased with increase in coconut substitution. The high level of fat and crude fibre in the coconut substituted samples could be attributed to the higher content of fat and crude fibre in coconut relative to soybeans. These results were higher than the values of the control meal. Fiber in human diets lower serum cholesterol which tends to reduce the risk of heart attack, colon cancer, obesity, blood pressure, appendices and many other diseases (Rehinan *et. al.*, 2004).

The carbohydrate content in the breakfast meals was lower than that of the control sample.

The low carbohydrate content observed in the sample when compared with the control is as expected since the control is 100% maize. The result further showed that the carbohydrate content of the meals served as a source of energy to man. The result compared well with range (65.12 to 73.16%) that was reported by Adegunwa et. al., (2010) in his work on enrichment of noodles with soybean and carrot flour. The moisture content of the breakfast meals increased significantly ($P<0.005$) with increase in soybean substitution and ranged from 4.63% in the control sample to 5.40% in the meal that contained 30% soybean. This could be due to the water retention property of soybean constituents. Iwe, (2003) had earlier reported that soy flours in bakery products facilitate greater water incorporation, improve dough handling and improve moisture retention. The moisture contents of the meal samples and control were below the 10% moisture level recommended for safe keeping of flour samples (SON, 2007).

Sample	%Protein	% Fat	% Moisture	% Fibre	%Ash	% Carbohydrate
A	19.67	15.67	5.40	2.94	2.41	53.93
B	15.66	17.38	4.28	3,04	2.34	57.30
C	13.88	20.23	4.11	3.16	2.22	56.40
D	4.32	1.80	4.63	2.21	1.14	85.90

Table 2: Result of Nutritional Analysis of the Breakfast meal

A : 60%M, 30%S, 10%C,, B: 60%M, 20%S, 20%C, C: 60%M, 10 %S, 30%C, D: 100%M, 0%S, 0%c

Sample	WAC (%)	BD (g/ml)	LGC (%)	pH (%)	Titrable Acidity
A	210.00	0.55	16.0	6.70	0.40
B	200.00	0.53	16.0	6.60	0.27
C	200.00	0.57	14.0	6.60	0.26
D	200.00	0.70	08.0	6.40	0.32

Table 3: Physicochemical and functional properties of breakfast meal

A : 60%M, 30%S, 10%C,, B: 60%M, 20%S, 20%C, C: 60%M, 10 %S, 30%C, D: 100%M, 0%S, 0%c

Sample	60 ^{0}C	70 ^{0}C	80 ^{0}C	90 ^{0}C
A	3.36	4.55	4.92	6.40
B	3.20	5.44	5.51	7.44
C	3.12	5.71	5.80	6.21
D	0.24	0.68	1.02	1.37

Table 4: Percentage (%) Swelling capacity in Relationship to Temperature
A : 60%M, 30%S, 10%C,, B: 60%M, 20%S, 20%C, C: 60%M, 10 %S, 30%C, D: 100%M, 0%S, 0%c

Sample	60 ^{0}C	70 ^{0}C	80 ^{0}C	90 ^{0}C
A	180.51	182.86	184.23	186.68
B	184.59	201.43	206.49	208.98
C	185.64	196.37	211.13	213.44
D	191.23	208.34	210.82	213.89

Table 5: Percentage (%) Solubility in Relationship to Temperature
A : 60%M, 30%S, 10%C,, B: 60%M, 20%S, 20%C, C: 60%M, 10 %S, 30%C, D: 100%M, 0%S, 0%c

The results of bulk density, water absorption capacity, least gelatin capacity, pH and titratable acidity were presented in Table 3. The bulk density ranged from 0.53 to 0.70 g/ml for sample B and control meal. The bulk density of all the meal samples were lower than that of the control meal. The high volume per gram of flour material is important in relation to its packaging. Increase in bulk density in desirable in that it offers greater packaging advantage, as a greater quantity may be packed within a constant volume (Fagbemi, 1999). The aqueous solutions of all the meal samples were slightly acidic, The values were relatively the same. The pH of flour suspension is important since, some functional properties are affected by pH. The water absorption capacity of the samples ranged between 20%-21%. WAC is the ability of flour to absorb water and smell for improved consistency in food. It is desirable in food systems to improve yield and consistency and give body to the food (Osundahunsi *et. al.*, 2003). There was no significant difference in the water absorption capacity of the meal samples. The water absorption capacity of the meal samples was almost the same as those reported for native red (24%) and white (26%) sweet potato flour (Osundahunsi *et. al.*, 2003); but lower than that reported for yam flour (88.48%) by Jimoh and Olatidoye (2009), fermented maize flour (271.7%) and bambara groundnut flour (227%) by Fasasi *et. al.*, 2007, and Siri Vong paisal (2008) respectively. The control breakfast meal exhibited superior gelling power by forming a stable gel at 8.0% flour concentration. The least gelling concentrations obtained for all the meals compared well with the value reported for fermented maize (10%W/V) by Fasasi *et. al.*, 2007, and Lipin seed (14% W/V) (Sathe *et. al.*, 1982). The difference in gelling concentration of the control and other meals may be attributed to the relative ratios of different constituents such as proteins, carbohydrates and lipids that make up the flours and the interactions between such components (Sathe *et. al.*, 1982).

The ability of the breakfast to swell in excess water was significantly affected by temperature. The swelling pattern of the meals and control showed that the granules of the meals swelled rapidly between 60-90 ^{0}C. Sample B exhibited the highest SP (3.20 to 7.44) at all the temperatures of investigation. This was closely followed by sample A (3.36-6.40) and sample C (3.12-6.21) while sample D (control) showed the lowest SP (0.24-1.37). The SP of all the samples was lower than the values (58.8g water/g starch) reported by Betancur- Ancona et. al., 2001) for cassava starch. The SP has been related to the associative binding within the starch Sgranules and apparently the strength and character of the micellar network is related to the amylose content of the starch in the meal, low amylose content produces high swelling power (Wootton and Tumaalii, 1998). The solubility of all the meal samples increased with increasing temperature reaching the maximum 186.68%, 208.98%, 213.44%, and 213.89% at 90 ^{0}C for sample A,B,C and D (control) respectively. Gujska et al., 1994 reported a notable increase in solubility for pinto, navy bean and field pea starches beginning at 70 ^{0}C because the swollen starch granules allow amylose exudation. This is similar to the behavior of the breakfast meals whose solubility began to rise at 60 ^{0}C. Solubility increased as the temperature increased because of increase in mobility of the starch granules of the meals, which facilitated and enhanced the dispersion of starch molecules in water (Adebowale *et al.*, 2005).

From the results of the nutritional analysis, it can be observed that the formulated breakfast meals from the blends of maize, soybean and coconut is highly nutritious even superior to the control meal-100% maize, which is deficient in quality proteins and can accentuate protein deficiency diseases (Adepeju and Abiodun, 2011). From the functional parameters investigated, the formulated breakfast meals showed higher values than the contol. This means that more of the meals were soluble, without increasing viscosity, thus providing more calories and nutrients than the control meal at spoonable viscosity.

7. Conclusion

It can thus be concluded that formulating breakfast meals from maize, soybean and coconut is viable. The implications of these findings are far reaching since all the components used in the formulation are obtained from local resources. This would indicate that the products would be cheap and easily accessible. The improvement of the nutritional status by the inclusion of soybean and coconut was a welcome development.

8. References

i. AACC(1995).Approved Methods of American Association of cereal chemists. The Association, St. Paul, M. N.
ii. Adebowale, K.O., Olu-Owolabi, B.I., Olawumi E.K and Lawal, O.S. (2005).Functional properties of native, physically and chemically modified breadfruit (Artocarpus altilis) starch. Industial Crops and products, 21:343-351.
iii. Adegunwa, M.O., Bakare, H.A. and Akinola, O.(2012). Enrichment of Noodles with soy flour and carrot powder. Journal of Nigera Institute of Food Science and Technology, NIFOJ 30(1): 74-81
iv. Adepeju A.B. and Abiodun A.O.(2011).Effect of protein rich foods mixtures on the quality of formulated weaning food diet. International Research of Biochemistry and Bioinformatics, 1(5): 114-118.
v. Anderson, J.W, Johnstone, B.M and Cook- Lewell, M.E (1995) Meta-analysis of effects of soy-protein intake on serum lipids in humans. Journal of medicine, 333:276-282.
vi. AOAC (1995). Official Methods of Analysis 17th Edn. Association of Official Analytical chemists, Gaithersburg, Maryland, pp 1-64.
vii. AOAC(2000) Analysis of the Association of Official Analytical Chemists (AOAC) International. William, H. (ed.) 17th Ed.,Gaithsburg, M.D. USA: Official Method 923.03,923.05, 962.09, 979.09.
viii. Ayo, J.A, Ayo. V.A., Nkama, I and Adewori,R. (2007). Physiochemical, in-vitro digestibility and organoleptic evaluation of acha- wheat biscuit supplemented with soybean flour, Nig. Food J. 25:77-85.
ix. Babajide, J.M., Idowu,M.A. and Lasebikan, O.O.(2003). Effect of soy and wheat variation on the functional and sensory properties of cassava-soy-wheat noodles. Nig. Food J. 21:23-28.
x. Betancur- Ancona, D.A., Chei-Guerrero,L.A., Camelo-Matos, R.I and Davila-Ortiz, G.(2001). Physicochemical and functional characteristization of baby line bean (Phaseolus lunatus starch/starke, 53:248-254).
xi. Ciacco, C.F. and D'Appolonia B.L.(1998). Baking studies with cassava and yam flour. Biochemical composition of cassava and yam flours. Cereal chem.. 55,402-411.
xii. Ciacco,C.F. and D'Appolonia B.L. (1997). Characterization of starches from various tubers and their use in bread- baking. Cereal Chem. 54, 1096-1108.
xiii. Edema,M.O., Sanni, I.O. and Sanni, A.I (2005) Evaluation of maize bread production in Nigeria. Afri. J. of Biotech. 4(9):911-918.
xiv. Elegbede, J.A(1998). Legumes In:Osagie, A.U and Eka, O.U (eds), Nutritional Quality of Plant Foods. Post Harvest Research.
xv. Fagbemi, T.M,(1999) Effect of blanching and ripening on functional properties of plantain (Musa aab) flour. Plants Food for Human Nutr., 54:261-269
xvi. Fasasi, O. S. Adeyemi, I.A. and Fagbenro, O.A.(2007). Functional and Pasting characteristic of fermented maize and Nile Tilapia (Oreochromis niloticus) flour diet. Pakistan Journal of Nutrition 6(4):304-309.
xvii. FMOH (2005) Infant and Young child Feeding in Nigeria-Guidelines Federal Ministry of Health, Abuja.
xviii. Gujska, E., Reinhard, W.D. and Khan, K.(1994). Physicochemical properties of field pea, pinto and navy bean starches. Journal of Food Sci. 59(3):634-636.
xix. Ihekoronye a.i and Ngoddy, P.O.(1985).Integrated Food Science and Technology for the Tropics. Macmillan Publ., London, pp. 189-193.
xx. Iwe, M. O.(2003) The Science and Technology of soybean. Rojoint Communication services Ltd., Enugu, pp. 115-262.
xxi. Jimoh,K.O. and Olatidoye, O.P.(2009) Evaluation of physicochemical and rheological characteristics of soybean fortified yam flour. Journal of Applied Biosciences 13:703-706.
xxii. MacArthur, L.A. and D'Appolonia B.L (1997). Comparison of oat and wheat carbohydrates (11):Starch. Cereal Chem. 56, 458-461.
xxiii. Okoli, E.C.(1998) Effect of Gamma Irradiation on Biochemical malting and keeping quality of sorghum grains. Ph.D Thesis. Obafemi Awolowo University, Ile-Ife.
xxiv. Osundahunsi, O.F., Fagbemi, T.N., Kesselman, E. and Shimoni, E. (2003) Comparism of the physicochemical properties and pasting characteristics of flour and starch from red and white white sweet potato cultivars. Journal of Agriculture and Food Chemistry 51:2232-2236.
xxv. Radley, J.A.(1996).Industrial uses of starch and derivatives. Applied Sciences Publishers, London.
xxvi. Rehinnam,N.M. Rashid, o. and Shah, W.H. (2004). Insoluble dietary fiber components of food legumes as affected by soaking and cooking process. Food Chemistry, pp. 245-249.
xxvii. Sathe s.k.,Salunkhe, D.K. and Desphande, S.S.(1982) Functional Properties of Lupin seed Protein concentrates. Journal of Food science, 47:491-492.
xxviii. Sirivong paisal, P.(2003) Structure and functional properties of starch and flour from Bambara groundnut. Song klanakerin. Journal of science and Technology. 30(suppl. 1):51-56.
xxix. Son (2007). Nigerian Industrial standard for Biscuits ICS.664,68 Standard organization of Nigeria, pp.1-8.
xxx. Wootton, M. and Tumaali, F.(1998). Composition of flours from samoan Breadfruit. J. Food Sci. 49:1396-1397.