Effect of Roasted Soybean Flour Substitution on the Chemical and Sensory Properties of Maize Flour Snack (Aadun)

A. A. Amanyunose[1], O. O. Olosunde[1], T. O. Adedeji[1] and O. A. Abiodun[2*]

[1]*Department of Food Science and Technology, Osun State Polytechnic, Iree, Nigeria.*
[2]*Department of Home Economics and Food Science, University of Ilorin, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. Author AAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OOO and TOA managed the analyses of the study. Author OAA managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: To determine the effect of roasted soybean flour substitution on the chemical and sensory properties of maize flour snack (*Aadun*).
Study Design: Multiple comparison test was performed on the data obtained using Duncan test
Place and Duration of Study: Samples were prepared in Department of Food Science and Technology, Osun State Polytechnic, between August 2020 and November 2020.
Methodology: Composite flours were developed from roasted maize and soybean to produce snacks (*Aadun*). Proximate, mineral, amino acid profile and sensory properties of the samples were determined using standard procedure.
Results: The protein content of the sample ranged between 8.94–16.43% with sample with 40% soybeans having the highest value. The mineral content of the samples increased with increased addition of soybean. Total amino acid of the *Aadun* samples ranged between 64.81 and 83.42 g/100 g showing an increase as fortification with soybean flour increased. The sensory evaluation showed no significant differences (p>0.05) in the overall acceptability of all the snacks.
Conclusion: The chemical properties of *Aadun* increased with addition of soybean flour. Addition

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*Corresponding author: Email: Funmiabiodun2003@yahoo.com;

of 10 % soybeans to the maize snack did not have significant effect on the taste, texture and overall acceptability.

1. INTRODUCTION

Maize (*Zea mays*) has been ranked the fourth most important cereal food after millet, sorghum, and rice in Nigeria [1]. Its use includes but not limited to human consumption, feeds for livestock, bio-fuel production and as raw material for many industrial applications [2]. Maize have been processed and consumed in different ways which vary from region to region and from one ethnic group to another.

They can be used for production of different snack food which can be eaten [3]. Soybean is an excellent health food and it contains 40% good quality protein, 23% carbohydrates, 20% cholesterol free oil and sufficient amounts of minerals and vitamins. Amino acid profile of soy protein is excellent amongst plant proteins. Hence, it is superior to other plant proteins as it contains most of the essential amino acids except methionine, which is abundant in cereals, and it is most economical source of dietary protein [4]. There is increasing evidence that the consumption of soybean products reduces cancer, blood serum cholesterol, osteoporosis, chronic renal disease, heart disease, oxidative stress, and others [5]. Aadun is a traditional snack made from roasted maize and consumed by all ages in western part of Nigeria [6]. It is also used for prayers at social functions such as naming ceremonies and traditional marriages [7]. Aadun is a rich source of energy, phosphorus and magnesium but low in protein thus necessitating the substitution of whole maize flour with Soybean flour (rich in protein) for its production. Locally produced Aadun is high in carbohydrates but with low protein and mineral content [8]. Hence, there is need to improve the snack with readily available legume source.

Therefore, effect of roasted soybean flour substitution on the chemical and sensory properties of maize flour snack (*Aadun*) was determined in this study.

2. MATERIALS AND METHODS

2.1 Materials

Maize, soybean, palm oil and other materials used were purchased from a local market in Iree, Osun State, Nigeria.

2.2 Methods

2.2.1 Production of roasted maize flour

The maize grains were sorted, cleaned and winnowed to remove foreign materials. The grains were soaked, dehulled, dried and roasted at 170°C in oven (Model DHG-9063A) for 10 minutes, allowed to cool to room temperature (27±2°C) for 45 minutes and then milled into flour.

2.2.2 Production of roasted soybean flour

The soybean grains were sorted and cleaned to remove foreign materials. The grains were roasted at 170 °C for 10 minutes in oven (Model DHG-9063A). It was allowed to cool at room temperature (27±2 °C) for 45 minutes and milled into flour.

2.2.3 Production of fortified aadun

Laboratory "Aadun" samples were prepared by using the recipe and method of Adedokun [7]. The ingredient composition consist of roasted maize and soybean flour, palm oil, pepper and salt (Table 1). Aadun was produced by mixing resulting composite flours with palm oil, Pepper and salt. The mixture was packaged in polyethylene and stored at room temperature.

2.2.4 Analyses

2.2.4.1 Proximate and mineral composition

The moisture, protein, fat, ash and crude fibre of the samples were determined in triplicate by method of AOAC [9] while carbohydrate was determined by difference. Mineral content (sodium, potassium, sodium, potassium, phosphorus, calcium and magnesium) of the Aadun samples was determined using an AOAC [9] method.

2.2.4.2 Amino acid analysis

This was determined using the method described by Benitez [10]. About 500mg of sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer (Model 120A, USA). 50 µL of the

hydrolysates was directly injected into the analyser. About 7 ml of 6N HCl was added and oxygen was expelled by passing nitrogen into the ampoule to avoid possible oxidation of methionine and cysteine during hydrolysis. The glass ampoule was then sealed with Bunsen burner flame and put in an oven pre-set at 105 ºC± 5 ºC for 22 h. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humins. Tryptophan was destroyed by 6N HCl during hydrolysis.

The filtrate was then evaporated to dryness using rotary evaporator. The residue was dissolved with 5 ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer. The amount loaded was 60 microliters. This was dispensed into the cartridge of the analyser. The analyser is designed to separate and analyse free acidic, neutral and basic amino acids of the hydrolysate. An integrator attached to the Analyser calculates the peak area proportional to the concentration of each of the amino acids.

2.2.4.3 Sensory evaluation

A 9-point Hedonic scale assessment as described by Iwe [11] was used. Twenty panellists from the Department of Food Science and Technology were selected based on their familiarity with Aadun.

The panellists scored the five coded samples in terms of degree of likeness for colour, taste, texture and overall acceptability. The 9-point Hedonic scale used by the panellists for the evaluation ranged from 1 to 9 representing "extremely dislike" to "extremely like".

2.3 Statistical analysis

Data were subjected to Analysis of Variance (ANOVA) and differences between means were evaluated by Duncan's multiple range tests using SPSS (version 17.0). Significant differences were expressed at $P<0.05$.

3. RESULTS AND DISCUSSION

The result of proximate composition of fortified Aadun samples are shown in Table 2. The moisture content ranged between 2.50–3.28% with sample A having the lowest value while Sample B had the highest value. The values

obtained for the moisture content was lower than 6.97% to 8.93% reported by Adeyanju et al. [6] for maize/kidney bean blends. The low moisture content obtained implies that the keeping quality of Aadun would be improved thus has good storage potential. Moisture content and water activity of a product determine greatly the keeping quality of the food [12]. The protein content of *Aadun* ranged between 8.94–16.43%. Sample A had the lowest protein value while Sample E had the highest value. The protein content of the samples increased with increased addition of soybean flour. Akinola and Enujiugha [13] reported a similar trend for Aadun fortified with African oil bean seed flour with values ranging between 7.26–14.55%. The ash content of Aadun samples ranged between 1.65–2.58% where Sample A had the lowest value while sample E had the highest ash content. The increased ash content follows a similar trend for Aadun fortified with groundnut and crayfish by Apata et al [14] with values ranging from 1.74–2.77%. The fat content of Aadun samples ranged between 31.40–34.09%. The high percentage of fat (palm oil) suggest a predisposition of "Aadun" to oxidation and rancidity during storage [15]. Fat contents observed in this study were higher than the values reported by Badejo et al. [16]. This could be due to the amount of palm oil added to the snack. The carbohydrate content varied between 40.01–50.61% with sample A having the highest value. The carbohydrate content of the samples decreased with increased substitution with soybean flour.

3.1 Mineral Composition of Aadun Fortified with Soybean

The result of the mineral composition of fortified *Aadun* samples are presented in Table 3. The minerals analysed in the samples include Calcium, Potassium, Magnesium, Iron and Sodium. The Calcium content ranged from 20.35–32.21 (mg/100g). It was observed that the Calcium content of Aadun samples significantly ($p<0.05$) increased with increased addition of soybean flour. The result obtained was similar to that presented by Adeyanju et al. [6] with values ranging from 19.03–28.05 mg/100g. The values ranging from 35.78-43.07 mg/100g for sodium, 58.13-98.82 mg/100g for potassium and 25.01-37.89 mg/100g for magnesium. These mineral values presented in this study were lower than that reported by Agunbiade et al. [17] for *Aadun* 279.92 mg/100g sodium, 264.09 mg/100g potassium, 175.07 mg/100g calcium,

Table 1. Composition (%) of *Aadun* blend

Sample	Roasted maize flour	Roasted soybean flour	Palm oil	Salt	Pepper
A	70	-	27	0.5	1.5
B	60	10	27	0.5	1.5
C	50	20	27	0.5	1,5
D	40	30	27	0.5	1.5
E	30	40	27	0.5	1.5

Table 2. Proximate composition (%) of *Aadun* fortified with soybean

Sample	Moisture	Ash	Protein	Fat	Fibre	Carbohydrate
A	2.50 ± 0.03^c	1.65 ± 0.02^e	8.94 ± 0.04^e	31.40 ± 0.05^c	4.55 ± 0.06^b	50.96 ± 0.07^a
B	3.28 ± 0.02^a	1.94 ± 0.02^d	12.92 ± 0.03^d	34.34 ± 0.02^a	4.80 ± 0.02^a	42.72 ± 0.13^c
C	3.07 ± 0.05^b	2.31 ± 0.04^{bc}	13.89 ± 0.02^c	34.09 ± 0.03^a	4.13 ± 0.02^c	47.13 ± 0.07^b
D	2.91 ± 0.03^b	2.44 ± 0.01^{ab}	14.92 ± 0.04^b	32.53 ± 0.01^b	4.84 ± 0.01^a	42.36 ± 0.07^c
E	2.83 ± 0.01^b	2.58 ± 0.02^a	16.43 ± 0.03^a	31.52 ± 0.04^c	4.65 ± 0.03^b	42.02 ± 0.04^d

Values are means of duplicate determinations ± standard deviation
Mean values along the same column with different superscripts are significantly different ($p<0.05$)

452.79 mg/100 g magnesium. The iron content ranged between 1.69–2.48 mg/100 g. Variation in mineral
values may be due to the types and species of maize and soybean used for the study. The mineral composition increased with increased fortification with soybean flour.

3.2 Amino Acid Composition of Aadun Fortified with Soybean

The amino acid composition in g/100 g protein of Aadun fortified with soybean is shown in Table 4. Generally, the total amino acid of the Aadun samples ranged between 64.81 and 83.42 g/100 g protein of the Aadun samples. The total amino acid content of all the fortified Aadun samples were higher than that of the 100% maize samples. The increase in the amino acid composition of fortified Aadun showed the higher protein content and quality of the Aadun produced from the blend. It was observed that the values of the total non-essential amino acids were higher than that of the total essential amino acids of all Aadun samples. The values of the total non-essential amino acids for the Aadun samples ranged between 40.06 and 48.52 g/100 g protein. The non-essential amino acids are those the body can synthesize and therefore non-essential in the diet. The values of isoleucine, leucine, lysine, methionine, phenylalanine, valine, threonine and tryptophan of the Aadun samples were higher than that produced from 100% maize. The results also showed that lysine and the sulphur containing

amino acids (methionine, cysteine) and trytophan, which are known to be limiting in cereals and legumes, respectively are significantly improved in the blends. This shows that the complementary effect of cereal/legume mixture improves both the protein quality and the levels of the limiting amino acids. The essential amino acids are important from nutritional point of view since the body cannot synthesize them and should therefore be supplemented in the diet. The values of glycine, alanine, serine, proline, aspartate, glutamate, histidine, arginine, tyrosine and cysteine of the biscuit samples increased with addition of soybean. The results showed that the amino acid composition increased with increased incorporation of soybean. This showed a direct relation with the crude protein content of Aadun samples since amino acids are building blocks of protein.

3.3 Sensory Properties of Aadun Fortified with Soybean

The mean score for all the parameters analyzed for Aadun fortified with soybean is presented in Table 5. Mean score for appearance ranged between 4.50 and 8.58, mean score for texture ranged between 4.13 and 7.99, taste ranged between 4.20 and 8.42 while overall acceptability ranged between 6.35-8.27. Aadun sample produced from maize had the highest mean score in terms of taste, texture, appearance and overall acceptability. There were no significant differences (p>0.05) in sample A snack and sample B in texture, taste and in the overall acceptability of the snack.

Table 3. Mineral Composition (mg/100 g) of roasted maize-soybean flour

Sample	Calcium	Magnesium	Potassium	Sodium	Iron
A	20.35±0.01[e]	25.01±0.01[e]	58.13±0.01[e]	35.78±0.02[d]	1.84±0.01[c]
B	25.80±0.02[d]	27.13±0.01[d]	73.12±0.01[d]	37.07±0.05[c]	2.48±0.02[a]
C	26.10±0.01[c]	32.21± 0.02[c]	80.10±0.01[c]	38.62±0.01[c]	1.56±0.01[c]
D	28.04±0.02[b]	35.21±0.01[b]	95.04±0.01[b]	41.13±0.01[b]	2.01±0.01[b]
E	32.21±0.01[a]	37.89±0.01[a]	98.82±0.01[a]	43.07±0.01[a]	1.69±0.02[c]

Values are means of duplicate determinations ± standard deviation
Mean values along the same column with different superscripts are significantly different (p<0.05)

Table 4. Amino Acid Composition (g/100 g protein) of Aadun Fortified with roasted soybean

Amino Acid	A	B	C	D	E
Isoleucine	4.36±0.09	3.56±0.08	3.60±0.05	3.83±0.06	4.06±0.07
Leucine	6.12±0.04	8.21±0.04	8.58±0.04	8.97±0.08	9.75±0.11
Lysine	1.91±0.02	2.78±0.05	3.13±0.02	4.21±0.03	4.94±0.06
Methionine	1.75±0.05	1.76±0.03	1.75±0.02	2.56±0.02	1.99±0.02
Phenylalanine	3.60±0.03	5.01±0.06	4.29±0.05	4.63±0.04	4.83±0.05
Valine	3.19±0.06	4.10±0.04	3.92±0.05	3.96±0.04	4.67±0.07
Threonine	1.91±0.04	2.98±0.03	3.16±0.04	2.59±0.03	3.61±0.02
Tryptophan	1.92±0.03	2.01±0.03	0.87±0.01	0.89±0.01	1.05±0.02
Total Essential	24.75	30.41	29.3	31.64	34.90
Non-Essential					
Glycine	2.81±0.02	2.98±0.03	3.56±0.04	3.83±0.05	3.74±0.04
Alanine	4.61±0.03	4.72±0.04	3.87±0.05	3.91±0.04	4.48±0.04
Serine	3.02±0.02	2.91±0.03	3.30±0.03	3.41±0.04	3.84±0.03
Proline	3.52±0.03	3.76±0.04	4.06±0.02	4.32±0.05	4.87±0.04
Aspartic acid	5.10±0.04	5.56±0.06	5.89±0.04	6.21±0.05	6.26±0.05
Glutamic acid	12.41±0.08	12.97±0.07	13.55±0.06	13.7±0.09	14.61±0.06
Histidine	1.61±0.02	1.81±0.02	1.69±0.02	1.71±0.02	1.92±0.02
Arginine	2.82±0.02	3.20±0.02	3.18±0.02	3.47±0.03	3.44±0.03
Tyrosine	2.95±0.03	3.10±0.03	3.19±0.03	3.84±0.03	3.79±0.04
Cysteine	1.21±0.01	1.37±0.02	1.33±0.01	1.25±0.02	1.57±0.02
Total Non-Essential	40.06	42.38	43.62	45.65	48.52
Total Aminoacid	64.81	72.79	72.92	77.29	83.42

Values are means of duplicate determinations ± standard deviation

Table 5. Sensory Properties of Aadun Fortified with Soybean

Sample	Appearance	Texture	Taste	Acceptability
A	8.58 ± 0.05[a]	7.99 ± 1.23[a]	8.42 ± 0.95[a]	8.27 ± 1.72[a]
B	8.02 ± 0.13[b]	7.95 ± 1.02[a]	8.22 ± 0.87[a]	8.26 ± 0.80[a]
C	5.05 ± 0.12[b]	4.77 ± 2.01[cd]	6.06 ± 1.85[a]	6.55 ± 1.25[b]
D	4.93 ± 0.34[b]	4.41 ± 1.13[b]	5.83 ± 1.26[b]	6.46 ± 0.91[b]
E	4.50 ± 0.07[c]	4.13 ± 1.52[c]	4.20 ± 1.05[b]	6.36 ± 1.31[b]

Values are means of duplicate determinations ± standard deviation
Mean values along the same column with different superscripts are significantly different (p<0.05)

4. CONCLUSION

This study determined the effect of roasted soybean flour substitution on the chemical and sensory properties of maize flour snack (*Aadun*). The chemical compositions of the snacks were improved with addition of roasted soybean flour. However, the sensory properties of snacks with 70% maize and 60% maize with 10% soybeans flours were more acceptable. This showed that soybean could be added to *Aadun* up to 10% without significant differences in their sensory qualities attributes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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