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ASSESSMENT OF CHEMICAL AND ORGANOLEPTIC PROPERTIES OF FORTIFIED INDIGENOUS MAIZE-BASED SNACK

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ABSTRACT
Background: *Aadun* is an indigenous maize-based snack high in energy, phosphorus and magnesium but low in protein. It is often sold with minimal packaging under conditions which may lead to its rapid deterioration. Protein fortification and improved packaging could enhance its balance of nutrients and increase acceptability.
Objective: The study evaluated the chemical composition and organoleptic qualities of fortified *aadun*.
Methods: Four different samples of *aadun* were prepared. T_0 served as the control (unfortified *aadun*) while the three others (T_1, T_2 and T_3) were fortified with groundnut, crayfish and soybeans, respectively. The four samples were subjected to proximate and mineral analysis. Different packaging materials such as foil paper, polyethylene and plastic plate covered with kiln film were used to present the samples to 50 panellists for organoleptic assessment. Results were subjected to descriptive statistics and ANOVA using SPSS version 20.
Results: Fortified samples were found to be significantly different in their chemical composition and sensory attributes from the control sample. The fortified *aadun* samples had higher protein, crude fibre, ether extract, iron, magnesium, iodine, sodium, potassium and phosphorus than the control. The T_0 was rated highest for the colour and the T_1 for taste, texture, aroma and overall acceptability. The most preferred packaging material for the samples was plastic plate covered with kiln film while polyethylene was least preferred.
Conclusion: Fortifying *aadun* with different ingredients especially groundnut and improving the materials used in packaging will improve its consumer acceptability.
Keywords: Fortified *aadun*, organoleptic, chemical composition, packaging

Introduction

Food is any edible substance consumed by man or animal (1) to provide nutritional support for the body. These include fruits, snacks, drinks. In most parts of Nigeria, people depend on ready-made convenient foods for their nutritional requirements, such foods are biscuit, breads, cakes, roasted corn, roasted plantain (*Booli*), plantain chips (*Ipekere*), fried maize paste (*Kokoro*), corn cake (*aadun*) and others (2). These foods can serve as main meals or snacks for both children and adults (2). Having a snack can refer to either eating food between meals or eating a light meal. Snacks have been defined with respect to caloric consumption (3) or in relation to social interaction (4) or based on time of the day of consumption (5). Some authors defined snack as food or drink consumed other than during main mealtimes (1, 2). Staffer (6) referred to snack or snack food as an easy to handle, miniature-portioned, hot or cold products in solid or liquid form which need little or no preparation. The role of snacks is to offer a light, convenient and enjoyable food option when (for reasons of hunger or sociability) a food selection is required at a time between that allotted for the principal meal. Thus, snack foods are not designated to be alternatives for the main meals but are consumed to satisfy hunger at a time (7). Some snacks like potato chips and candy, not only have excess calories but also surplus fat and salt/sugar, hence can make a person to gain weight. When snacks do not provide the best balance of nutrients; they can be fortified with various nutrients (8).

Protein supplementation is of paramount interest, since most snacks are poor sources of protein and in most cases; the protein present is often of poor nutritional quality. Protein supplementation is possible either by increasing the protein efficiency ratio of the protein already present or increasing the total amount of protein present by adding some purified nitrogenous material such as casein, soy protein or egg white (9). *Aadun* is a savoury snack prepared with roasted whole maize flour, red pepper and salt thoroughly mixed with palm oil to obtain a uniform product (10, 11). It is known for its red colour, tenderness, fine texture and taste. It is popular among the Yoruba speaking people of Nigeria, where it is traditionally used during wedding, naming ceremony and twin's festival and eaten by people of all ages and classes (10, 11). During wedding and naming ceremonies, *aadun* is

used to signify sweetness, blessing and prosperous future for the couple or new-born.

Aadun is a good source of energy, phosphorus and magnesium but it is low in protein and it is often sold with minimal packaging under conditions which may lead to its rapid deterioration (10). Moreover, despite its nutritional benefits, consumption of *aadun* by people is at low ebb. This may be because it is considered an indigenous snack which is culturally affiliated to some people (10, 12); hence it is not widely accepted. Another problem may be the packaging materials used which include leaves, cellophane and paper. These do not make the snack appealing to consumers. More so, it is a street snack that is mostly sold at roadsides and car parks and not in eateries, supermarkets, and other outlets unlike other conventional snacks. Packaging is also another aspect of food attribute that enhances consumer's perception towards consumption. This helps to improve the quality and palatability of food. This study fortified *aadun* with groundnut, crayfish and soybeans and evaluated its chemical and organoleptic properties, with a view to improving and enhancing its nutrients content, taste and packaging to meet a wide acceptable standard.

Materials and methods

Chemical analysis and sensory evaluation were the data collection methods used in this study.

Sourcing of ingredients and recipe

Maize grains (yellow variety), soybean, crayfish, roasted groundnut, dry pepper and table salt were purchased from Bodija Market, Ibadan, Oyo State, Nigeria. Palm oil was purchased from Moniya, Ibadan. Four *aadun* samples with codes T_0, T_1, T_2 and T_3 were prepared in the Department of Wildlife and Ecotourism Management Food Laboratory. The ingredients for making the samples are shown in Table 1.

Table 1: Ingredients for the *aadun* samples

Ingredient	T_0	T_1	T_2	T_3
Corn flour (g)	500	250	250	250
Groundnut paste (g)	-	250	-	-
Crayfish (g)	-	-	250	-
Soybean (g)	-	-	-	250
Red oil (ml)	125	125	125	125
Dry pepper (g)	5	5	5	5
Salt (g)	0.2	0.2	0.2	0.2
Onion (g)	0.2	0.2	0.2	0.2

T_0 (control) = Unfortified *aadun*; T_1 = Control sample + groundnut paste; T_2 = Control sample + crayfish; T_3 = Control sample + soybean

Method of sample preparation

Maize grains, soybeans, crayfish and groundnut were roasted separately in a frying pan using gas cooker as a source of heat at a temperature of 250^{0}C, till they were golden brown in colour. Maize grains, soybeans, crayfish and dry pepper were milled separately into powder and groundnut into paste. The powdered ingredients were sieved manually to a particle size of <0.4mm to obtain a uniform texture, which is necessary for the characteristic fine texture of *aadun*. The ingredients were properly mixed (for the final quality and stability of the *aadun*) manually with the hand. At this stage, palm oil percolated all the fine particles of the corn flour, while spices are evenly distributed to achieve a fine texture and uniform product. Each mixture was moulded manually into different shapes of cake pans (heart, rectangle and triangle shapes).

Packaging of the samples

Traditional method in which *aadun* has direct contact with the packaging materials was adopted. The T_0 was packaged in plastic plate covered with kiln film, the T_1 and the T_2 in polyethylene bag, and T_3 in aluminium foil paper.

Proximate analysis

The chemical composition of the samples determined were proximate and minerals (iron, magnesium, calcium, iodine, sodium, potassium and phosphorus). Energy was calculated. Moisture, protein, fat, crude fibre, ether extract, ash and carbohydrate were determined using the AOAC (13) methods, while energy values were calculated using the Atwater factor (14). Calcium, magnesium, iron, were determined after wet ashing using a PYE UNICAM (model 969) Atomic Absorption Spectrophotometer. Vanado-molybdate colorimetric method was employed for determination of phosphorus using a PYE UNICAM (model SP 6450) UV-visible colorimeter (15).

Sensory evaluation

Sensory evaluation test was used to determine how well the samples were liked or which of the sample was the most preferred. This was done with the use of a 5-point Hedonic scale where judges were asked to rank samples according to their preference thus: 5 = Like Extremely, 4 = Like Slightly, 3 = Neutral (Neither Like nor Dislike), 2 = Dislike Slightly and 1 = Dislike Extremely. Fifty judges made up of staff and students of the University of Ibadan, whose selection was as a result of the location of the study area evaluated the samples for colour, aroma, taste, texture and overall acceptability. Their perception of the packaging materials used was also assessed. The left-over of the samples were disposed.

Data analysis

Using Statistical Package for Social Sciences version 21, data were subjected to descriptive statistics and Analysis of Variance (ANOVA). Pearson's square range test was used to establish if there were significant differences between the samples.

Results

The proximate composition of *aadun* samples is presented in Table 2. The samples were significantly different ($p < 0.05$) in their protein, carbohydrate and ash contents while there was no significant difference ($P > 0.05$) in the moisture, ether extract and crude fibre contents of the samples. However, the fortified samples (T_1, T_2 and T_3) were found to be generally higher in protein, crude fibre and ether extract when compared with the control sample. Moisture content of the T_2 (9.80%) and T_3 (9.9%) were lower than that of the control sample (10.27%). However, the ash content of T_2 (4.33%) and T_3 (4.13%) were higher than that of T_0 (3.97%). The T_0 was high in caloric value containing 42.32% carbohydrate and 3158KJ energy.

Table 2: Proximate composition of the *aadun* samples

Variable	T_0	T_1	T_2	T_3
Moisture (%)	10.27	10.33	9.80	9.90
Protein (%)	9.03^d	14.33^b	16.67^a	11.67^c
Ether extract (%)	31.63	32.17	31.73	32.23
Ash (%)	3.97	3.63	4.33	4.13
Crude Fibre (%)	2.86	2.93	3.10	3.33
Carbohydrate (%)	42.32^a	36.60^b	34.37^d	38.73^c
Energy (kj)	3158^a	3129^c	2908^d	3151^b

T_0 (control) = Unfortified *aadun*; T_1 = Control sample + groundnut paste; T_2 = Control sample + crayfish; T_3 = Control sample + soybean. Means ± SD of 2 determinations. Means on the same row with different superscripts are statistically significant ($p < 0.05$)

The mineral composition of *aadun* samples is presented on Table 3. The samples were significantly different ($p < 0.05$) in all the tested minerals (magnesium, calcium, iodine, sodium, potassium, and phosphorous) except for iron. T_1, T_2 and T_3 were found to be generally higher in Fe, Mg, I_2, Na, K and P when compared with the control sample.

Table 3: Mineral composition of the *aadun* samples

Variable(mg)	T_0	T_1	T_2	T_3
Iron (Fe)	10.17^d	10.63^a	10.43^b	10.30^c
Magnesium (Mg)	36.67^c	38.33^b	41.67^a	38.33^b
Calcium (Ca)	170.00^c	175.00^b	176.67^a	168.33^d
Iodine (I_2)	0.04^c	0.05^b	0.06^a	0.05^b
Sodium (Na)	1241.67^d	1321.67^b	1333.33^a	1281.67^c
Potassium (K)	12.00^d	30.00^b	35.00^a	26.67^c
Phosphorus (P)	128.33^d	138.33^b	140.00^a	136.67^c

T_0 (control) = Unfortified *aadun*; T_1 = Control sample + groundnut paste; T_2 = Control sample + crayfish; T_3 = Control sample + soy bean Means ± SD of 2 determinations. Means on the same row with different superscripts are statistically significant ($p < 0.05$)

Organoleptic attributes of the *aadun* samples

Table 4 shows the organoleptic characteristics of all the *aadun* samples. The T_0 was rated highest in terms of colour with a mean value of 4.62±0.25. This was followed by the T_1 (4.42±0.53), the T_2 (3.92±0.85) and the T_3 (3.85±1.04). The colour rating of the T_0 was significantly ($P > 0.05$) the same as T_1 but significantly different $p < 0.05$ from the T_2 and T_3. The T_1 had the highest taste (4.71±0.32) and aroma (4.61±0.08) rating, while the T_0 had the lowest (2.34± 1.04 and (3.07±1.11), respectively). Aroma differed significantly ($p < 0.05$) among the samples. The T_0 had the highest texture rating (4.25± 0.72) followed by T_3 (4.12±0.08), T_2 (4.05±1.11) while T_1 was rated lowest (3.82±1.01). On overall acceptability, T_1 was ranked highest (4.52±0.12) while T_0 had the lowest (3.58±0.39). Most of the respondents preferred the packaging of T_0 (plastic plate covered with kiln film) followed by T_3 (aluminium foil paper) while the least preferred were that T_1 and T_2 which were wrapped in polyethylene.

Table 3: Organoleptic attributes of the *aadun* samples

Parameter	T_0	T_1	T_2	T_3
Colour	4.62±0.25[a]	4.42±0.53[a]	3.92±0.85[b]	3.85±1.04[c]
Taste	2.34± 1.04[a]	4.71±0.32[b]	3.54±1.33[c]	3.51±0.18[d]
Aroma	3.07±1.11[a]	4.61±0.08[b]	3.45±1.28[c]	3.63±0.82[d]
Texture	4.25± 0.72[a]	3.82±1.01[b]	4.05±1.11[a]	4.12±0.08[a]
Overall acceptability	3.58±0.39	4.52±0.12	4.02±1.42	3.95±0.10
Packaging material	4.53±0.12	3.45±0.81	3.85±1.02	4.10±0.88

T_0 (control) = Unfortified *aadun*; T_1 = Control sample + groundnut paste; T_2 = Control sample + crayfish; T_3 = Control sample + soy bean
Means ± SD of 2 determinations. Means on the same row with different superscripts are statistically significant ($p < 0.05$)

Discussion

The fortified samples (T_1, T_2 and T_3) were found to be generally high in protein, crude fibre, ether extract and some minerals (iron, magnesium, iodine, sodium, potassium and phosphorus) compared to the control sample. The result is in line with the findings of Allen et al. (16), which showed that fortification improved the nutritional quality of the fortified food. However, two of the fortified samples (T_2 and T_3) were found to be low in moisture but higher in ash content than the control sample (T_0). Low moisture content in food is used as a quality parameter of food products as it influences the shelf stability of foods, hence the lower the moisture, the better the storage ability of the food product (17). The *aadun* samples with low moisture content might have longer shelf life than samples with high moisture content. The high ash content indicated higher mineral content in the fortified samples. Minerals are essential requirements by man. For instance, calcium and phosphorous form the base, hard material of the teeth and bones (18); iodine is required by the thyroid gland to synthesize thyroxin while sodium is essential for the regulation of acid base equilibrium in the body (1). High ash content reported in this study is consistent with the report of Idowu and Adedokun (19) that *aadun* is high in mineral content especially magnesium and phosphorus.

The control sample (T_0) was high in caloric value but lower protein content than the fortified samples. This asserted the work of Idowu and Adedokun (19) that *aadun* is high in calorie but low in protein content. Atolagbe (20) reported high protein content in some of the *aadun* samples collected in south western part of Nigeria due to the inclusion of cooked cowpea. The high protein content in the fortified samples was as a result of the crayfish, soybean and groundnut used in the fortification. This could be a way to diversify the ingredients of the product especially in areas where the it is a staple food.

The organoleptic attributes of the *aadun* samples were significantly different. This was due to the different ingredients used. The T_0 was rated highest for the colour. Colour is one of the essential parameters of snacks which are strictly related to consumer's perception (22). It is considered as an attribute critically assessed by consumers and often forms the basis for their selection or rejection of products. The T_0 had a normal yellowish colour characteristic of the everyday *aadun*. T_1 had a glossy yellow colour, T_2 was brownish while T_3 was brownish gold. The T_1 (control + groundnut) however had the highest ratings for aroma, taste, texture and overall acceptability. This aligned with the findings of Arisa *et al.* (23) who worked on chemical and sensory attributes of *garri* fortified with groundnut and observed that the fortified sample was more acceptable in all sensory attributes than the control.

Generally, the aroma of a food forms a crucial sensory signal and a fundamental component of flavour perception and shape the way people experience taste and texture. Cho *et al.* (24) opined that attracting consumers with very pleasant food aromas can easily stimulate salivation, promotes prospects of consumption and increase appetite. The feel of a food in the mouth and the accompanying taste are also very important aspects of food acceptance and consumption. They constitute the overall determining factors that enhance the primary attributes of colour and aroma, which brings about the overall acceptability. For instance, a food may have a very attractive colour, a scintillating aroma but has a nasty feel in the mouth and an unpleasant taste. The judges preferred sample $T_1$and the reasons given was of the taste. According to Meludu (1) and Cho *et al.* (24) taste forms a significant reason in the preference of any food or snack.

Furthermore, the effect of different packaging materials on *aadun* could influence the consumers' decision on consumption. *Aadun* is traditionally packaged with leaves which is one of the reasons why purchasing and consuming the food item does not appeal to them. This validated the findings of Adefalu et al. (12) that poor packaging of local snacks is one of the factors militating against

consumption and could lead to its rapid deterioration (10).

Conclusion

Fortifying *aadun* with groundnut, crayfish and soybean increased its nutrient contents especially protein. Sample T_1 (*aadun* fortified with groundnut) was the most acceptable in terms of taste, texture and aroma. The most preferred packaging material was plastic plate covered with kiln film. The *aadun* could be fortified with protein rich foods and the packaging materials improved to enhance consumer acceptability and consumption.

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