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Quality Assessment of Energy Bars from Acha (*Digitaria Exillis*) and Breadnut (*Artocarpus Camansi*) Flours

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ABSTRACT

Four samples of energy bars were produced using acha and breadnut seed flours in the ratio 80:20, 70:30, 60:40 respectively while 100% acha flour served as the control. The samples were subjected to analysis to ascertain their chemical and sensory qualities. Moisture, protein, fat, ash, fiber and carbohydrate contents ranged from 5.11-6.82%, 8.61-18.66%, 7.15-19.46%, 2.14-2.91%, 2.33-4.48% and 51.53 – 70.80% respectively. Energy values varied significantly ($p< 0.05$) and ranged from 381.99 - 455.90Kcal, increasing as the level of inclusion of breadnut flour increased. There was a significant difference ($p<0.05$) in phytate, oxalate tannins and saponin with the concentration ranging from 1.35-2.93, 0.75-2.88, 0.37-1.50 and 0.14-0.87mg/100g respectively. The results obtained for sensory evaluation showed that the samples were generally acceptable and that the products could serve as energy dense bars or snacks for human consumption.

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Introduction

Energy bars are supplemental bars mostly made from cereals and other energy dense foods designed for people who need quick energy but do not have time for meal. The bars need no preparation and refrigeration and have a long shelf life. Fat, protein and carbohydrate present in the food are the main sources of energy. They are snacks with high nutritional and sensory properties as they contain large amounts of carbohydrates, protein, lipids and minerals. The demand by consumers for ready to eat healthy foods is on the rise, and energy bars, a food product that fits these criteria, continue to increase in sales. Acha (Digitaria exillis), also known as folio or hungry rice belongs to the family of Gramineae and is a locally available cereal that is underutilized. It is nutrient rich grain with about 7% protein and with an abundance of the amino acids methionine, cystine, valine and leucine which are not present in cereals such as maize, wheat, sorghum, rice, rye and barley. Breadnut (Artocarpus camansi) belongs to the family Moraceae of flowering plants. It has a high protein, carbohydrate, vitamin and mineral content but low in fat. It is reported to have antioxidant, anti-caarcinogenic and anti-inflammatory properties. The present study was aimed at developing energy dense bars from acha and breadnut composite flours and to examine their proximate, anti-nutrient and sensory properties [1-4].

Materials and Methods

Material Procurement

The acha (Digitaria exillis) grain was purchased from kaduna, Nigeria, while Breadnut seed (Brosimum alicastrum) was gotten from Itam Market, Itu, Akwa Ibom State, Nigeria. Chemicals and other reagents were of analytical grade.

Preparation of Raw materials

Preparation of Acha Flour

This was done according to the method of. Acha grains were washed, de-stoned manually (Using sedimentation Method), dried (Cabinet -APV-drier at 50°C for 3 h), milled (wet milling) and sieved (0.4 mm sieve aperture) to obtain acha flour. The flour was packed heamatically in polythene bags till usage [3].

Preparation of Breadnut Flour

This was prepared according to the method described by with slight modifications. Mature breadnut seeds were harvested and opened using a sharp knife. The seeds were removed manually, washed with water, allowed to drain and oven dried at 50°C for 12 h using hot air rapid drying oven (Soyokaze type ASF-1135). This was followed by milling and defatting with N-hexane for 2 days to obtain a flour without oil. The flour was packed heamatically in polythene bags till usage [5].

Formulation of Composite Flour

Four blends were prepared by mixing acha and breadnut flours using an electric blender in the percentage ratio of 80:20, 70:30, 60:40 respectively while 100% acha flour served as the control.

Preparation of Energy Snack Bar

Composite flour (200g), glucose syrup (160ml), hydrogenated fat (80g), baking powder (1.6g), cellulose (1.6g), salt (1.6g) and cocoa powder (3.2g) were properly mixed together in a bowl. This was followed by a thorough kneading of the mixture. The homogenous mixture was then cut and compressed into bar shaped pans and baked at 110°C for 30 minutes. The baked bars were then cooled and packaged in air tight containers.

Methods of Analysis

Proximate Analysis

Moisture, crude protein, crude fat, total ash, crude fiber and carbohydrate contents were determined using the method of. The Atwater factor formula was used to calculate energy value [6].

Anti-nutrient Analysis

Phytate, oxalate, saponin and tannin were determined according to the method of [7].

Sensory Evaluation

Sensory evaluation of the coded energy bars was carried out by twenty (20) semi-trained panelists on a nine-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely). The sensory attributes evaluated were: taste, mouthfeel, aftertaste, appearance, aroma and overall acceptability [8].

Statistical Analysis

All results were analyzed statistically at 5% significance level. Data generated were subjected to statistical analysis (ANOVA) using Statistical Package for the Social Sciences (SPSS) version 20.0 software. Mean separation was done using Duncan multiple range test.

Results and Discussion

Table 1: Proximate Composition of Energy Bars Produced from Acha and Breadnut Seed Flours

Sample Code	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrate (%)	Energy (Kcal)
A	5.11±0.01^{d}	18.66±0.01^{a}	19.46±0.02^{d}	2.91±0.00^{d}	4.43±0.01^{d}	51.53±0.03^{a}	455.90±0.01^{d}
B	5.78±0.00^{c}	18.17±0.00^{a}	18.87±0.01^{c}	2.40±0.00^{d}	51.91±0.01^{a}	51.91±0.01^{a}	450.15±0.00^{c}
C	6.23±0.01^{b}	17.42±0.01^{b}	18.23±0.01^{d}	2.25±0.00^{c}	2.87±0.01^{c}	52.19±0.01^{b}	442.51±0.01^{b}
D	6.82±0.00^{a}	8.61±0.01^{a}	7.15±0.00^{c}	2.14±0.01^{c}	2.33±0.01^{b}	70.80±0.02^{c}	381.99±0.00^{a}

Values were means ± SD of triplicate determinations. Means differently superscripted along the columns are significantly different ($p<0.05$)
Key:
Sample A: (60% Acha and 40% breadnut flour).
Sample B: (70% Acha and 30% breadnut flour).
Sample C: (80% Acha and 20% breadnut flour).
Sample D: (100% Acha flour).

Table 2: Anti-Nutrient Composition of Energy Bars produced from Acha and Breadnut Seed Flours

Sample Code	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (mg/100g)	Saponin (mg/100g)
A	2.93±0.01^{d}	2.88±0.01^{d}	1.50±0.00^{a}	0.87±0.00^{d}
B	2.21±0.00^{c}	2.41±0.00^{c}	0.80±0.01^{b}	0.60±0.01^{c}
C	1.76±0.01^{b}	1.46±0.01^{b}	0.63±0.00^{c}	0.33±0.00^{b}
D	1.35±0.00^{a}	0.75±0.01^{a}	0.37±0.00^{d}	0.14±0.01^{a}

Values were means ± SD of triplicate determinations. Means differently superscripted along the columns are significantly different ($p<0.05$)
Key:
Sample A: (60% Acha and 40% breadnut flour).
Sample B: (70% Acha and 30% breadnut flour).
Sample C: (80% Acha and 20% breadnut flour).
Sample D (: 100% Acha flour).

Table 3: Sensory Properties of Energy Bars Produce from Acha and Breadnut Seed Flour

Sample Code	Taste	Mouth feel	After taste	Appearance	Aroma	Overall acceptability
A	5.25±0.04^{d}	5.55±0.03^{d}	4.45±0.02^{d}	4.45±0.00^{c}	4.80±0.00^{d}	5.25±0.00^{d}
B	6.35±0.00^{c}	5.80±0.01^{c}	5.70±0.00^{c}	6.05±0.00^{c}	7.00±0.01^{c}	6.45±0.01^{c}
C	6.60±0.00^{c}	6.07±0.01^{b}	6.30±0,00^{b}	5.95±0.01^{d}	6.68±0.00^{b}	6.66±0.00^{b}
D	6.65±0.00^{c}	6.00±0.01^{a}	6.35±0.01^{a}	5.90±0.01^{d}	6.75±0.02^{a}	6.60±0.02^{a}

Values were means ± SD of triplicate determinations. Means differently superscripted along the columns are significantly different ($p<0.05$)
Sample A: (60% Acha and 40% breadnut flour).
Sample B: (70% Acha and 30% breadnut flour).

Sample C: (80% Acha and 20% breadnut flour).
Sample D: (100% Acha flour).

Proximate composition

The proximate composition of the various energy bars samples as shown in Table 1 revealed that the moisture content was within the range of 5.11-6.82 %. This was lower than the range (9.74-9.80%) reported by for protein rich sorghum based cereal bars. The low moisture content showed that the energy bars will have a long shelf life. The moisture content was significantly ($p< 0.05$) different among the different samples. Sample D (100% acha flour) exhibited higher moisture content of 6.82%. The protein content of sample D (100% acha flour) was 8.61% while the other different formulations ranged from 17.42-18.17%. There was noticeable increase in protein content as the amount of breadnut seed flour used in the formulations increased. Sample A (60% acha and 40% breadnut seed flour) had a significantly higher protein content than the other samples. The addition of breadnut seed flour into the formula boosted the protein quality of the energy bar. The results for protein content were lower than the values (24.69-25.97%) reported by for protein rich sorghum based cereal bars [9-11].

The fat content of the energy bars ranged between 7.15-19.46%. The fat content of the energy bars increased ($p< 0.05$) significantly with the addition of breadnut seed flour as breadnut is high in fat. The fat content of the energy bars in this study was slightly lower than the range of values (20.01-23.00%) reported by for nutritional bars with different proportions of oat flour and brown rice flour. High fat content in baked products enhances mouth-feel and also retains flavor [1,4,12].

The ash content indicates the amount of mineral present in a food sample. The result showed significant increase in the ash content of the energy bar samples with addition of breadnut seed flour. This means that breadnut seed flour had significant effect on the ash content of the bars. The ash content of the energy bars ranged from 2.14% in sample D to 2.91% in sample A. It was within the range of values (2.43-2.80%) reported by for protein rich sorghum based cereal bars but higher than the range of values (1.44-2.16%) reported by for nutritional bars with different proportions of oat flour and brown rice flour. These high values for ash content signified that the energy bars would be rich in minerals [1,9].

The crude fiber of the energy bars increased significantly ($p< 0.05$) with the addition of breadnut seed flour. The crude fiber content of the energy bars ranged from 2.33-4.48%. reported lower values (0.56-1.15%) for crude fiber of nutritional bars with different proportions of oat flour and brown rice flour. Consumption of significant amounts of fiber helps in regulation and control of blood pressure as well as blood glucose [1,13].

Carbohydrate content of the samples showed significant ($p< 0.05$) difference with decrease in breadnut seed flour. The carbohydrate content ranged between 51.53-70.80%. The control sample (100% acha flour) exhibited higher carbohydrate content of 70.80%, which showed that acha is a rich source of carbohydrate. This result supports the claims of. The high carbohydrate content recorded in the study makes them ideal for children and sportsmen since they require energy for rapid growth [10,11].

Energy Value

The energy values of the energy bars varied significantly ($p< 0.05$) and ranged from 381.99Kcal in the control sample to 455.90Kcal in sample A (60% acha and 40% breadnut seed flour). This is within the range of values (416.67 – 424.85 Kcal) reported by for nutritional bars with different proportions of oat flour and brown rice flour. reported energy values ranging from 4742.50 – 5267.80 call for Canavalia ensiformis tempeh energy bar. The energy value of the samples was seen to increase as the level of inclusion of breadnut flour increased. This may be due to the fact that breadnut flour has high fat and protein contents [1,4,14].

Anti-Nutrient Composition

The results of the anti-nutrient composition of the energy bars produced from the composite flour blend of acha and breadnut is shown in Table 2. The antinutrients (phytate, oxalate, tannin and saponin) content increased with increased inclusion of breadnut flour.

High phytate content in food can lead to mineral deficiency by binding some essential minerals in the digestive tract. Phytate content of the energy bars ranged from 1.35-- 2.93mg/100g. Phytate content increased with increased inclusion of breadnut flour. reported a phytate content ranging from 1.17-2.50% for Canavalia ensiformis tempeh energy bar [4,14].

The oxalate content ranged from 0.75-2.88 mg/100g. According to, Canavalia ensiformis tempeh energy bar had an oxalate content ranging from 45.10-59.41 mg. Consumption of large amounts of oxalate can lead to renal calcium absorption and is also said to be responsible for the formation of kidney stones [14].

Tannins are plant polyphenols that have the ability to form complexes with metal ions and with macro-molecules such as protein and polysaccharides. The tannin contents ranged from 0.37-- 1.50 mg/100g and were lower than the permissible level. reported a tannin content ranging from 0.01-0.03% for Canavalia ensiformis tempeh energy bar. Similar observations as seen in phytate, oxalate and tannin contents were noticed for saponin contents. There was a sharp decrease in saponin content of samples that had higher percentage of acha seed flour when compared with sample A which had (60% acha and 40% breadnut seed flour). Anti-nutrients are naturally occurring proteinous substances and breadnut is rich in protein, hence, the reason for the sharp increase being directly proportional to the increase in the addition of breadnut flour [14].

Sensory Properties

The results of the sensory properties of the energy bars produced from the composite flour blend of acha and breadnut is shown in Table 3. Sensory properties are important in food acceptance as consumers want food with specific sensory properties. Foods are accepted based on their ability to satisfy consumer needs and also based on the level of satisfaction they give Sample C (80% acha and 20% breadnut seed flour) had the highest score for appearance while the least liked sample in terms of appearance was sample A. Appearance is an important attribute in food choice and sensory evaluation [15].

The taste sensory score indicated that Sample D (100% acha flour) was rated highest with a score of 6.65 while sample A (60% acha and 40% breadnut seed flour) scored the lowest with 5.25. There was no significant ($P< 0.05$) difference among samples B, C and D in terms of taste. The lower scores noticed in the other samples could be attributed to the inclusion of breadnut seed flour. This may be due to the higher tannin content in those samples. According to tannin decreases palatability of food. There were significant ($P< 0.05$) differences between the bars with regards to mouth-feel, after taste, aroma, and general acceptability. In terms of aroma, sample B (70% acha and 30% breadnut seed flour) was rated the

highest with a mean value of 7.00 while sample C was rated the highest as regards mouth-feel with a value of 6.07. Sample D (100% acha flour) was rated highest in terms of after taste while Sample B (70% acha and 30% breadnut seed flour) was rated the highest (6.66) in terms of the overall acceptability [16].

Conclusion

This study showed that nutrient dense and healthy energy bars could be produced from a composite blend of acha and breadnut seed flours. The result showed that as the ratios of the composite flours changed, slight changes in the nutritional, anti-nutrient and sensory properties of the different samples were also observed. The combination of acha and breadnut seed flour presents cost effective, locally available raw materials for the production of energy bars for human consumption.

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