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Nutrient assessment of processed rice (*Oryza sativa*), Soybean (*Glycine max* Merr) flours/ groundnut (*Arachis hypogea*) paste and sensory attributes of their composites)

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Abstract: This work was carried out to determine the nutrient composition of soaked/dehulled/fermented rice, soybean and groundnut, and the sensory attributes of their blends. Rice (*Oryza sativa*); soybean (*Glycine max*. Merr) and groundnut (*Arachis hypogea*) were purchased from Nsukka in Enugu State, Nigeria. Local rice was washed, soaked for 3h and sundried and toasted. Soybean was blanched, fermented for 24h and dehulled, sundried and toasted. These foods were separately milled into fine flour. Shelled raw groundnut was blanched, roasted, dehulled and milled to obtain its paste. The treated samples were separately analysed for proximate and mineral composition using standard assay techniques. Blends of these samples were produced to provide 16g Nitrogen (N)/ 1000g cookies. These composites were used to prepare cookies. Wheat flour based cookies served as the control. Data generated were statistically analysed with standard analytical methods to separate mean differences. The proximate values for soybeans and groundnut showed similarity in crude protein (22 vs 23%, respectively) and crude fibre (3.73 vs 3.22%, respectively). They differed widely in fat (19.3 vs 49.8% respectively) and carbohydrate (45.5 vs 19.3% respectively). The rice flour showed the least values in protein and fat but higher value (72.9%) in carbohydrate than soybean and groundnut. In mineral analysis, the values for phosphorus, zinc and copper were comparable in the samples. Soybean and groundnut showed superior values in calcium (65 and 56mg/100g, respectively) to rice (22.4mg/100g). However, rice contain appreciably more iron (7.23mg/100g) than both soybean and groundnut (1.25 and 0.16mg/100g). Sensory evaluation showed that control had better acceptability when compared with the other cookies. However, the test cookies had good acceptability (rice/groundnut – 7.18 and rice/soybean – 6.43). their differences were not significant ($P>0.05$).

Introduction

Snacks could be fun to eat but most of it are of low nutritive value. If they are taken in large quantities can suppress the appetite for the actual meal in the day. For this reason Somchai, Duangchan and Tavidsa (2000) stated that snack with high protein and high fiber should be developed as a supplementary diet. However, these snacks should be produced and sold at a reasonable price. Snack foods such as biscuits, cookies and crackers receive less attention than bread; however they offer several important advantages including: wide consumption, relatively long shelf life, good eating quality, highly palatable and acceptable in most countries and can be modified to suit specific nutritional needs of any target population (Elkhalifa & El-Tiny, 2002). These characteristics make protein rich biscuits attractive for target areas especially School Feeding Programmes (Ibrahim, 2009).

Cookies are snacks which are widely consumed all over the world especially by children. Okpala and Ekwe (2013) stated that wheat flour which is used to produce cookies is unavailable in many regions of the world resulting in importation of flour by regions with limited supplies. There is therefore a compelling need to develop an adequate substitute for wheat flour. Composite flour can be defined as a mixture of several flours obtained from roots and tubers, cereals, legumes etc. with or without the addition of wheat flour (Adeyemi & Ogazi, 1985). Composite flours have been used extensively in the production of baked goods. In fact, several attempts have been made to produce cookies from different types of composite flours (McWatters, Ouedraogo, Resurreccion, Hung, & Phillips, 2003; Nwabueze & Atuonwu, 2007; Okpala & Chinyelu, 2011). In countries, including Nigeria where malnutrition poses a serious problem especially among children, composite flours which have better nutritional quality would be highly desirable.

Proteins in human diets are gotten from several sources that include cereals, vegetables, root crops, legumes, meat, egg, milk and fish. Of all these, sources from animals are regarded as the best because of its amino acid content (Alabi & Anuonye, 2007). However, the cost of animal protein is increasing on daily basis, thus making it unavailable for most people in developing countries like Nigeria. This unavailability has given rise to other alternative protein sources.

Soybean is considered as a cheap source of protein. The protein quality of soybean is deficient in some essential amino acids (methionine + cystine) but is rich in essential amino acids (lysine) (Dhingra & Jood, 2000). Its protein quality can be improved by fortification with the protein source from cereals such as rice which are rich in methionine and cystine but deficient in lysine (Keregero & Mtebe, 1994).

Materials and Methods

Materials and sources

Rice, groundnut, soybean, wheat flour, eggs, and flavourings used for this study were purchased from local retailers in Nsukka main market in Enugu State, Nigeria.

The thrust of this work was therefore to produce cookies with adequate protein value from locally cultivates and therefore, cheap crops. This is proposed to be part of nutrition intervention for snack-consuming population especially children.

Methods

Sample preparation

(These samples were processed during dry season)

Processing of rice – Ten kilogram of local rice grains (*Oryza sativa*) were sorted to remove debris and coloured grains, and washed repeatedly to remove dust. The grains were soaked in cold clean tap water in the ratio of 1:3 (grain to water) for 3 hours. Thereafter, the soaking water was drained out and the grains were spread out thinly for a 24h-sundrying at a temperature of about 30^oC. The grains were milled into flour, sieved (70 mesh screen) and packaged in labeled air-tight polythene bag for use.

Processing of groundnut – Five kilogram of raw groundnut (*Arachis hypogea*) was sorted to remove spoilt groundnut and other unwanted materials. The nuts were blanched for 3 minutes with boiling clean tap water and drained completely. Thereafter, they were toasted (clean white sand was the medium) under moderate temperature (to avoid charring) until they were light brown. They are cooled, dehulled manually by rubbing them between palms, winnowed and ground to obtain a straw-coloured paste-like food product "peanut butter". The product was packaged in coloured glass container with tight lid.

Processing of soybean – Five kilograms of soybean (*Glycine max*. Merr) was sorted to remove spoilt grains, stones and other debris. The grains were parboiled for 30 minutes. The boiling water was drained out, and the grains steeped in clean tap water in a ratio 1:3 (grain-to-water) for a 24h fermentation. Thereafter, the grains were washed, dehulled, thinly spread out and sun-dried for 24h at a temperature of about 30^oC. After sun-drying, they were roasted under moderate heat to obtain light brown coloured grains. The brown grains were milled, sieved (76 mesh screen), and packaged for use.

Product development: The flours were blended (at 10% protein level) in the ratio of 60:40 (cereal to legume) to obtain two blends, namely, rice/ groundnut and rice/soybean. The composite flour was used to prepare cookies. The following ingredients were used together with 400g of the respective composite flour to prepare the cookies. Margarine (250g); sugar (160g); liquid vanilla flavor (5ml); baking powder (2.5g); salt (2.5g); and eggs (2 medium). Cookies prepared with 100% wheat flour instead of the composite flour served as the control.

Chemical analysis

The moisture, ash, fat, protein and crude fibre content of the flours/ paste were determined using AOAC (2005) methods. Carbohydrate content was obtained by difference. AOAC (2005) was also used to determine mineral values.

Sensory evaluation: Fifty-two judges made up of final year and post-graduate students of the Department of Home Science, Nutrition and Dietetics of the University of Nigeria, Nsukka, Nigeria were selected. The selection was based on their previous experience, knowledge and exposure to sensory evaluation of foods.

A 9-point hedonic scoring instrument was developed for this study. It included test for appearance (colour), texture, flavor, taste and general acceptability. For colour, texture, flavor and taste, nine degrees of likeness were recorded under the following options: (a) Like extremely (b) Like very much (c) Like moderately (d) Like slightly (e) Neither like nor dislike (f) Dislike slightly (g) Dislike moderately (h) Dislike very much (i) Dislike extremely. In the case of general acceptability, the options were (a) I will eat this at every opportunity (b) I will eat this often (c) I will eat this occasionally (d) I will eat this sparingly (e) I will eat this when available (f) I don't this but would manage it (g) I would hardly ever eat this (h) I would only eat this if I were forced (i) On no account would I eat this.

For analysis, the score of nine (9) was assigned to the highest degree of likeness and one (1) to the least acceptable on the hedonic instrument.

Statistical analysis

All chemical analysis on the sample were done in triplicates. Means, standard deviation, standard error of the mean, percentages, analysis of variance (ANOVA) of one way classification to compare means, and Duncan's new multiple range test (Steal and Torrie, 1960) were statistical tools used to analyse will data generated from chemical analysis and sensory evaluation.

Table 1: Proximate and energy composition of processed rice, soybeans flours and groundnut paste (%)

Food	Moisture%	Protein %	Fat %	Ash %	Crude Fibre %	CHO %	Energy (Kj)
Rice (*Oryza sativa*)	9.33±0.3	8.92±0.01	0.99±0.00	3.28±0.00	72.91±0.02	72.91±0.02	1405.44
Soybean (*Glycine max* Merr.)	5.33±0.04	22.44±0.04	19.30±0.05	3.65±0.05	3.73±0.02	45.55±0.06	1904.66
Groundnut (*Arachis hypogea*)	2.06±0.02	23.20±0.05	49.85±0.08	2.35±0.08	3.22±0.02	19.32±0.07	2586.29

Mean±SD of three determination
*CHO = carbohydrate
Kj = kilojoule

Table 1 shows the proximate and energy content of the processed rice, soybean and groundnut. The moisture content of the samples differed. It ranged from 2.06 to 9.33%. Rice flour had the highest moisture (19.33%) and groundnut the least (2.06%). Groundnut and soybean flour had comparable protein (23.22 and 22.44%, respectively). The fat values differed widely with groundnut having the highest value (49.85%) followed by soybean (19.30%) and the leaf being rice flour (0.99%). There was slight variation in ash values and it ranged from 19.32 to 72.91%. Rice flour had the highest carbohydrate value of 72.91% followed by soybean 45.55%. Nevertheless, groundnut had the highest energy value (2,586.29Kj).

Table2: Mineral content of rice, soybean flour and groundnut paste (mg/100g).

Food	Ca	Fe	P	Zn	Cu
Rice (*Oryza sativa*)	22.40±0.02	7.23±0.04	317.40±0.47	2.44±0.02	0.003±0.00
Soybean (*Glycine max* Merr.)	65.00±0.02	1.25±0.01	388.40±1.47	2.55±0.02	0.003±0.00
Groundnut (*Arachis hypogea*)	56.08±	0.16±0.00	354.60±3.29	2.38±0.02	0.003±0.00

Mean±SD of three determination

There was variation in the calcium values. The range was 22.40 to 65.00mg/100g. Soybean had the highest value (65.00mg/100g) followed by groundnut (56.08mg/100g). The iron level in the rice flour was the highest (7.23mg/100g) while soybean and groundnut had 1.25 and 0.16mg/100g, respectively. The samples recorded slight variations in phosphorus values (354.60 to 371.40mg/100g) and in zinc (2.38 to 2.55mg/100g) and the copper values were similar (0.003mg/100g)

Table 3: Sensory evaluation of cookies produced from blends of rice (*Oryza sativa*), groundnut (*Arachis hypogea*), and soybean (*Glycine max*. Merr) flours.

Cookies	Colour/appearance	Flavor	Taste	Texture	GA
RC:GR	$7.18{\pm}0.24^{b}$	$6.59{\pm}0.29^{c}$	$6.67{\pm}0.26^{b}$	$6.92{\pm}0.23^{b}$	$7.18{\pm}0.23^{b}$
RC:SY	$6.43{\pm}0.23^{c}$	$7.05{\pm}0.24^{b}$	$6.57{\pm}0.24^{b}$	$6.54{\pm}0.26^{b}$	$6.43{\pm}0.23^{c}$
WHEAT	$8.00{\pm}0.15^{a}$	$7.93{\pm}0.14^{a}$	$7.74{\pm}0.22^{a}$	$8.00{\pm}0.14^{a}$	$8.00{\pm}0.15^{a}$

Mean±SD of three determination
GA* - General Acceptabililty
RC:GR – Rice: Groundnut cookie (60:40 – protein basis)
RC:SY – Rice: Soybean cookie (60:40 – protein basis)
WHEAT – Wheat flour cookie (control)

Table 3 shows the sensory attributes of cookies produced from blends of rice, groundnut and soybean. In all the attributes, the control showed superior values that the test samples. In colour attributes, they differed significantly ($P<0.05$). The control had the highest score (8.00) followed by RC:GR blend (7.18) and the least RC:SY (6.43). There were also differences in flavor. RC:SY had better flavor than RC:GR ($P<0.05$). However, there were no significant difference between RC:GR and RC:SY in terms of taste and texture ($P>0.05$). Differences existed significantly ($P<0.05$) in their general acceptability. The control was the most preferred (8.00) compared with RC:GR (7.18) and RC:SY (6.43). Nevertheless, the scores for the test samples in terms of acceptability were more than 5, indicating acceptability.

Discussion

The low moisture content for processed rice, soybeans flours and groundnut paste has nutritional implications. This could be so due to processing methods the samples were exposed to. It is known that the lower the moisture content of a given food the higher would be the keeping quality and shelf life (Bothast, Anderson, Warner & Kwolek, 1991). Groundnut and Soybean had more protein than rice. This is expected because legumes are generally richer in protein than cereals. The high values for protein, fat and ash (22.44%, 19.4% and 3.65%) in soybean supports the findings of Ugwuona *et al.* (2012) who reported that fermentation increased protein, fat, ash and calcium and phosphorus content but decreased crude fibre and total carbohydrate. This could also be attributed to increased phytase activities which resulted in the release of soluble protein and minerals. Groundnut paste had a high fat content (49.85%). This is beneficial as it improves the satiety quality of the cookies. The high total carbohydrate of rice flour is expected. Cereals store starch as source of energy and are low in protein, fat and ash. Ugwuona, Ogara and Awogbena (2012) reported similar observation.

There was a higher observed value for minerals in soybean flour and groundnut paste than in processed rice flour. The high calcium, iron and zinc content of the flours have nutrition implications. Minerals are essential in human diets. Calcium is needed for bone and teeth formation; it is also required for clotting of blood and control of fluid movement through the cell membrane. Iron is a component of haemoglobin which carries oxygen and is related to the rate of growth and to blood loss or gain. The high values for iron and zinc in the food samples might be due to their release from organic complex during fermentation. According to Reddy and Love (1991) fermentation increases the bioavailability of minerals such as iron, zinc, calcium and other minerals that would have been chelated and made unavailable. Adul and Yu (2000) reported that fermentation and roasting reduced dietary bulk and increased nutrient availability, shelf life and safety of local staples.

The texture, colour and appearance, taste and general acceptability were much more acceptable compared to the control. However the control had a superior acceptability than the text samples. RY:SY had better flavor than RC:GR ($P<0.05$), this could be due to the effect of fermentation on soybean. The decrease in overall acceptability was due to decrease in color, flavor, taste, texture and crispness scores. These results were in close agreement with those of observed in earlier studies (Pasha, Butt, Anjum & Shahzadi, 2002; Butt, Sharif, Nasir, Iftikhar &Rehman, 2004; Sharif, Butt, & Huma, 2005). Cookies are considered better for supplemented flours due to their wide consumption, relatively long shelf-life, ready-to-eat form and excellent eating quality (Tsen, Peters, Schaffer & Hoover 1973). Cookies with high sensoric attributes have been produced from blends of millet/pigeon pea flour (Eneche, 1999), raw rice and wheat (Singh *et al*., 1989), blackgram and wheat (Singh, Bajaj, Kaur, Sharma & Sidhu, 1993), chickpea and wheat (Singh, Harinder, Sekhon, Kaur, 1991), wheat, fonio and cowpea (McWatters, *et al.*, 2003) and soybean, chickpea or lupine with wheat (Hegazy and Faheid, 1990).

Conclusion

From this work it was concluded that replacement of wheat flour with rice flour is possible without adversely affecting the sensory properties of cookies. Rice flour supplementation significantly improved the mineral, protein content and dietary fibre of the cookies.

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