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Nutrient and Organoleptic Evaluation of Cereal and Legume Based Cookies

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Abstract: This study explored the nutrient and organoleptic potentials of wheat/ bambara groundnut based cookies. Bambara Groundnut (BG) (*Voandeia Subterranean Thouars*) and Wheat (W) (*Triticum* spp.) were purchased from Ogige market in Nsukka, Enugu state, Nigeria. Chemical composition, iron and zinc and phytochemical contents were analyzed using standard techniques. Wheat and bambara groundnut flours were blended in a ratio of 70:30 to provide 10% protein in cookies. The nutrient composition and sensory evaluation of the cookies were conducted. A panel of 38 judges and a 9-point hedonic scale were selected for use. Bambara groundnut complemented Wheat Cookies (BWC) contained 5.4% moisture, 9.85% protein, 19.7% fat and 10.32mg/100g iron which is much more than those of the 100% wheat based cookies. However, 100% wheat based cookies (WC) had six times ash and three times zinc content (1.2% and 23.28mg/100g) than those of the complemented (BWC) cookies. Nutrient composition of 100% wheat cookies (WC) could be improved when Bambara Groundnut (BG) blends it. The bambara groundnut-wheat cookies (BWC) were nutrient dense and culturally acceptable.

Key words: Cereal, legume, wheat, bambara groundnut, nutrient, organoleptic, cookies

INTRODUCTION

Undernutrition and malnutrition are major health problems, especially in developing countries (FAO, 2003). One of the underlying causes of undernutrition has been identified as inadequate food intake in terms of quality and quantity (Black *et al*., 2003; FAO, 2003; Shankar, 2000). The elimination of malnutrition, especially in infants and children as a public health problem was identified as a high priority in international nutrition. The modalities recommended as interventions include dietary modification, fortification and supplementation (ACC/SCN, 1993). One way of achieving this and ensuring the improvement of the micronutrient density of foods is by food to food fortification (Uvere *et al*., 2009).

Snacks are defined as light quick meals usually eaten between the main meals intended to assuage hunger or to satisfy the consumers craving for its taste (Nnam, 2003; Matz, 1993). Wholesome snacks boost energy, take the edge off appetite and most importantly provide useful nutrients needed for healthy growth, development and living (Karen, 2000). Lately, snacking is becoming prominent in the feeding of children, adolescents and working-class people.

Most of the snacks consumed in Nigeria are cereal-based. Snacks, especially those prepared commercially are wheat based. Wheat is a cereal, rich in carbohydrate, fat, minerals and vitamins. They supply about 75% calorie and 67% protein of people living in the tropics (Ihekoronye and Ngoddy, 1985). Wheat is a staple food used to make flour for leavened, flat and steamed bread, cookies, cakes, breakfast cereals, pasta and noodles (Cauvain *et al*., 2003). It is a grain, rich in nutrients like carbohydrates, fat, minerals and vitamins. Wheat is made up of 1.68% minerals, 61.7% carbohydrates, 12.2% moisture, 10.4% protein and 1.56% fat (Pamplona and George, 2004). However, wheat has poor essential amino acids (lysine and tryptophan) pattern (Okoh, 1998).

Legume seeds of plant origin have nutrients which can be used to supplement the nutrient content of cereals especially the protein quality (Ene-Obong, 2008). Legumes are high in protein especially in the essential amino acids, lysine and tryptophan (which are lacking in cereals), fats and oil, minerals, vitamins, phytochemicals and carbohydrates. Hence when combined with cereals, legumes facilitate the formation of a new pattern of amino acid which is adequate (Enwere, 1998). Legumes are locally available in Nigeria and affordable even to the low socioeconomic group.

Though legumes are deficient in the sulphur amino acids; cysteine and methionine, this deficiency is balanced when they are complemented with cereals (Obizoba, 1986). To ensure nutritional adequacy among the snack consuming population (children) who are the most vulnerable to nutritionally related diseases, consumption of blends of cereals and legumes have been recommended because of their low cost and nutritional quality (Ene-obong and Carnovale, 1992).This study explored the effects of blending wheat and bambara groundnut for production of cookies. Bambara groundnut is a legume and an inexpensive source of high quality protein (Obizoba, 1998).

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MATERIALS AND METHODS

Materials: Bambara groundnut (*Voandeia subterranee Thouars*) seeds as well as wheat flour (*Triticum* spp.) were purchased from Ogige main market in Nsukka, Enugu State, Nigeria.

Preparation of samples: One hundred grammes (100g) of the purchased bambara groundnut grains were destoned and cleaned of debris by handpicking. The cleaned grains were soaked in warm water in a ratio of 1.3 (w/v) for one hour, dehulled, washed, sun- dried, milled into fine flour, packaged and kept at room temperature for chemical analysis.

CHEMICAL ANALYSIS

Proximate analysis: Moisture determination: The moisture content of the samples was determined by the hot oven method described by Pearson (1976).

Ash determination: The ash content of the samples was determined using the method of Association of Official Analytical Chemists (1995).

Fat determination: This was done using the soxhlet extraction method described by AOAC (1995).

Crude fibre determination: The Weende method described by Pearson (1976) was used.

Crude protein determination: This was done using the microkjeldahl method described by Pearson (1976).

Carbohydrate determination: This was done by the difference method described by Pearson (1976).

Mineral determination: The iron and zinc content of the samples were determined using atomic absorption spectrophotometry described by AOAC (1995).

Antinutrient determination: Determination of the phytate and tannins contents of the samples was done using Latta and Eskin (1980) method.

Formulation of composite: The wheat and bambara groundnut flours were blended to contain 10% protein in a ratio of 70:30 (cereal: legume) for production of cookies. Cookies based on 100% wheat flour served as the control. The recipes for the cookies were as follows:

Recipe for the 100% wheat cookies (control)	
Wheat flour	-500g
Sugar	-330g
Margarine	-280g
Vanilla essence	-4 drops
Egg yolk	-20g
Recipe for the wheat-bambara groundnut cookies	
Wheat flour	-350g
Bambara groundnut	-60g
Sugar	-330g
Margarine	-280g
Vanilla essence	-4 drops
Egg yolk	-20g

Preparation of the cookies: The baking sheets were greased, margarine and sugar were creamed until they were pale and fluffy. Vanilla was added and beaten in the egg yolk. The flour was stirred in and mixed to a firm dough. The dough was kneaded lightly and rolled to about 0.5cm thickness on a lightly floured surface. The rolls were cut into rounds with a 6.5cm cutter and put on the baking sheets. They were baked at mark 4 for 15 minutes and brought out to cool. The cookies were stored in air tight containers for analysis.

Organoleptic evaluation: The organoleptic evaluation of the cookies was carried out by a panel of 38 judges using a 9-point hedonic scale where 9 represented ‘liked extremely’ and 1 represented ‘disliked extremely’. Texture, flavour, colour, taste and general acceptability of the cookies were evaluated. The 100% wheat cookies were used as control.

Statistical analysis: Data generated from the study were statistically analyzed using percentages, means and standard error of the means. One way analysis of variance and Duncan’s studentised new multiple range test were used to separate and compare means ($p<0.05$).

RESULTS

The proximate composition of both wheat and bambara groundnut flours is shown in Table 1. Bambara groundnut flour had higher levels of moisture, protein, ash, fat and energy than wheat flour. However, wheat flour had more carbohydrate than bambara groundnut flour. Bambara groundnut flour had more than double values for the protein, ash and fat than those of wheat flour. Surprisingly, fat value for bambara groundnut flour was more than 7 times that of wheat flour. On the other hand, energy value for bambara groundnut was about one and a half times that of wheat flour (381.10 vs 277.00 kcal).

The mineral (iron and zinc) composition of the samples is shown in Table 2. Bambara groundnut flour had almost three times iron of the 100% wheat flour. It also had more than one and a half times zinc content of the 100% wheat flour.

The antinutrient (phytate and tannins) content of the samples is shown in Table 3. Bambara groundnut flour had more than 10 times the phytate content of wheat flour. It also had 300 times the tannins content of 100% wheat flour.

Table 1: Percentage proximate composition of processed wheat and bambara groundnut flours (dry weight)

Samples	Moisture	Protein	Ash	Fibre	Fat	CHO	Energy (kcal)
W	11.80	10.00	1.50	Trace	1.00	72.00	277.00
BG	12.25	25.28	3.35	Trace	7.90	50.70	381.10

Key: W : Wheat flour BG : Bambara groundnut flour

Table 2: Minerals (iron and zinc) content of the flours (per 100g dry weight)

Samples	Iron (mg)	zinc (mg)
W	2.00±0.01	8.00±0.01
BG	5.51±0.03	12.82±0.02

Key W : Wheat flour BG :Bambara groundnut flour

Table 3: Phytate and tannins content of flour samples (mg/100g dry weight basis)

Samples	Phytate	Tannins
W	0.0001±0.0000	0.0001±0.0000
BG	0.001±0.0001	0.03±0.0010

Key W : Wheat flour BG :Bambara groundnut flour

Table 4 shows the nutrient composition of the baked cookies. Bambara groundnut and wheat blend cookies contained higher levels of moisture, protein, fat and iron than the 100% wheat cookies. On the other hand, wheat cookies had more carbohydrate, about 6 times the ash content and about 3 times the zinc content of the bambara groundnut and wheat blend cookies.

The results of the sensory evaluation of the cookies is shown in Table 6. Bambara groundnut and wheat blend cookies were much more preferred to the 100% wheat cookies in terms of flavour, colour, texture and general acceptability. However, the preferences were not significantly different ($p>0.05$).

DISCUSSION

Proximate composition: The traces of fibre observed for both samples were not a surprise. During dehulling, hulls that contain fibre were removed and as such the flours had low values for fibre. The slightly lower moisture (11.80%) for wheat flour has some nutritional implications. It is known that the lower the moisture content of a given food, the higher are the shelf-life and nutrient density.

The higher protein for bambara groundnut (25.28%) than that of wheat (10.00%) was not also unusual. Bambara groundnut as a legume would have more protein than wheat (a cereal). The lower ash for the 100% wheat flour (1.50%) than bambara groundnut flour (3.35%) could be attributed to vegetative loss during processing; a commonly observed phenomenon. Cereals in general are not good sources of fat, except corn. Based on this, one would not be surprised that bambara groundnut had more fat than wheat (7.90 vs 1.00%). The higher carbohydrate for wheat (72.00%) relative to 50.70% for bambara groundnut is expected. This is because legumes store less carbohydrate than cereals as source of energy. The higher energy (381.10kcal) for bambara groundnut than for wheat (277.00kcals) was because legumes store more energy in form of fat than cereals.

The high protein content of the bambara groundnut flour presents legumes as better sources of protein than cereals. This agrees with the reports of Obizoba (1998). The high fat content of the bambara groundnut flour presents it a better baking aid and source of polyunsaturated fatty acids than the 100% wheat flour (Matz, 1993). The ash content of the samples agrees with the ranges reported by Enwere (1998) while the proximate and mineral values observed in this study falls within the range reported by UNICEF (1990).

Mineral (Zn and Fe) composition of the flours: The higher zinc and iron for bambara groundnut (5.51 and 12.82mg/100g)(Table 2) might be attributed to two factors. Cereals of which wheat is one contain high levels of phytate and tannins which chelate these minerals and make them unavailable irrespective of processing. The lower zinc for wheat might be due to lower extraction rate of cereals (WHO/FAO, 2004).

Antinutrient composition: The phytate and tannins values observed in this study were lower than those reported by Osagie (1998). The reduced phytate and tannins in the present study could be as a result of the leaching effect of the soaking and dehulling employed on the samples before milling since most of the antinutrient factors are contained in the seed coat of seeds especially that of legumes. The reduced phytate and tannins in the foods (Table 3) have some nutrition implications. Recently, low levels of phytate and tannins were reported to lower serum cholesterol in both rat and man. The levels of these antinutrients qualify them as phytochemicals that have the efficacy to lower serum cholesterol and might fight some forms of cancer. The lower phytate content of the wheat flour is attributed to the lower extraction rate of cereal grains.

Nutrient composition of the baked cookies: The higher protein, fat and iron composition of wheat-bambara groundnut blend cookies (Table 4) agree with those of Kazimi and Kazimi (1979). They observed that nutrient levels in cereals are better utilised when they are complemented with legumes. The increases in protein and iron further confirmed those of Ene-Obong (2008) and Enwere (1998). These increases in nutrients for the cookies confirms that bambara groundnut and wheat blend cookies are better source of protein, fat and iron than 100% wheat based cookies.

Organoleptic evaluation of the cookies: Bambara groundnut-wheat cookies appeared to have an edge over 100% wheat cookies in all the organoleptic attributes. This might be associated with better mutual supplementary effects between cereals and legumes. For example, the better texture for the bambara groundnut-wheat cookies was solely attributable to higher fat for the bambara groundnut flour that improved the texture much more than 100% wheat flour (Matz, 1993).

Table 4: Nutrient composition of the baked cookies

Samples	Moisture	Protein (%)	Ash (%)	Fibre (%)	Fat (%)	CHO (mg/100g)	Iron	Zinc (mg/100g)
WC	3.6	8.98	1.2	Trace	17.8	68.42	7.23	23.28
BWC	5.4	9.85	0.2	Trace	19.7	64.85	10.32	8.59

Key: WC :100% wheat based cookies, BWC : Bambara groundnut + wheat cookies, CHO :Carbohydrate

Table 5: Sensory evaluation of cookies (as consumed)

Samples	Flavour	Colour	Texture	General acceptability
WC	7.47±0.22[a]	7.66±0.21[a]	7.03±0.25[b]	7.53±0.22[b]
BWC	7.79±0.22[a]	7.87±0.291[a]	7.74±0.22[b]	7.84±0.19[b]

Means±SEM of 38 replications.
Values in a column with different superscript letters were significantly different ($p<0.05$)

The improved texture of the cookies consequently precipitated their higher acceptance relative to the control cookies. Nutrition education is imperative to diversify processing, preparation and utilization of many known and lesser-known cereals and legumes to improve general public health.

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