



Quality and Sensory Characteristics of Cookies Fortified with Soybean and Rice Bran Blended Flour

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ABSTRACT

Background: The objective of this study was to determine the proximate compositions and sensory characteristics as well as functional properties of flour blends and cookies made from wheat, soybean and rice bran in the ratios of (M1) 100:0:0, (M2) 90:6:4, (M3) 80:12:8, (M4) 70:17:13 and (M5) 40:35:25%.

Methods: The cookies were prepared using the Okpala *et al.* (2013) method with slight changes. Moisture, protein, fat, fiber and carbohydrate contents were analysed using AOAC a standard analytical procedures. Fifty (50) semi-trained panelists evaluated the colour, taste, flavour, texture and overall acceptance of the cookie samples using a five point scale. Data were analysed using Analysis of Variance (ANOVA) and the significance level was chosen at $p < 0.05$.

Result: The proximate composition of the flours differed significantly ($p < 0.05$) from the control. Cookie sample (M5) had the highest moisture content of 12.20%. The crude protein level ranged from 10.22% to 18.70%. The maximum fat content was (M5) 13.88%. The greatest ash content was (M5) with 3.54%. The carbohydrate and fiber contents ranged from 51.20% to 75.22% and 0.30% to 4.8%. The highest average crude fiber level was found in (M5). Water absorption capacity, oil absorption capacity, bulk density, emulsion ability and foaming capacity were found to be in the ranges of 1.73-37.2%, 2.15-37.26%, 0.74-0.99%, 43.88-64.12% and 12.92 to 23.48%. The rice bran and soya bean flours substitution resulted in increased the functional characteristics and proximate composition. Sensory evaluation of the cookies differed significantly ($p < 0.05$) with panellists preferring formulations made from 80% wheat flour, 12% soybeans flour and 8% rice bran powder.

Key words: Blended flour, Cookies, Functional properties, Rice bran, Soybean flour, Wheat flour.

INTRODUCTION

Cookies are the most common bakery product and are generally accepted and consumed by people of all ages and socio-economic levels. They are a common baked food in the human diet that is typically taken with beverages (Ferial and Azza, 2011). They are ready-to-eat, convenient and low-cost food products that contain important digestive and dietary principles (Olaoye *et al.*, 2007). Cookies play an essential role in the baking business due to their diverse sensory and nutritional features (Chappalwar *et al.*, 2013). They provide significant amounts of iron, calcium, protein, calories, fiber and several B-vitamins to our diet and daily nutritional requirements. Cookies and other pastries have traditionally been made with soft wheat flour but they can also be made with non-wheat flour. To increase the nutritional value of cookies, partial replacement of refined wheat flour with soya bean and rice bran flour blends with superior nutritional attributes is required.

Soybean, according to Hegazy and Ibrahim (2009), is one of the world's most important oil and protein crops. Soybean protein is more nutritionally similar to animal protein than other vegetable proteins. Soybean protein accounts for roughly 40% of total solids and is used extensively in the enrichment of cereal-based baked foods (Fukushima, 1999). Soybean has long been utilized as a supplementary diet due to its properties. Soybean is one of these protein sources that, when used to partially replace or complement wheat flour in the production of baked products like biscuits, bread

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and other confectionery, can significantly improve the nutritional status of such products. As a result, soybean is considered to have the highest food value of any plant food consumed globally (Ndife *et al.*, 2011).

Rice bran is an underutilized by-product of rice as a source of value-added food. However, as food demand rises, new and unique ways to utilize the formerly inconspicuous waste item are required to be investigated. Rice bran has been found to have commercial benefits based on its

qualities (Nagendra Prasad *et al.*, 2011) and it has various unique traits that make it suitable for niche sectors like food, nutraceuticals and pharmaceuticals. Rice bran composition is mostly determined by the type of rice used and the effectiveness of the milling system (Sharif *et al.*, 2014). During processing, the external layer of the rice is eliminated to get the bran. Rice bran contains 15-22% lipids, 34-52% carbs, 7-11% fiber, 6-10% debris, 8-12% dampness and 10-16% protein, representing 5-8% of the absolute rice bit (Luh, 1991). Rice bran is a good source of E and B vitamins as well as the only natural source of oryzanol. The goal of this study was to produce and evaluate the nutritional qualities of wheat, soybean and rice bran flour blend cookies.

MATERIALS AND METHODS

Ingredients

The experiment was conducted in May 2019 at the Mycotoxin and Food Analysis Laboratories, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Soybeans and rice bran were purchased from the merchant store at the Kumasi Central Market. Other ingredients were collected from the Tafo local market in Greater Kumasi, Ghana.

Preparation of full-fat soybean flour

Full-fat soybean flour was made using the method outlined by Ihekoronye and Ngoddy (1985). Two kilograms of soybean seeds free of dirt and other foreign particles such as stones and leaves, were weighed, cleaned and steeped in tap water for eight (8) hours during preparation. The seeds were then drained, dehulled by hand, boiled for 30 minutes at 100°C and dried in a cabinet dryer (650°C for 12 hrs). To maintain constant drying, the dehulled seeds were mixed every 30 minutes during the drying process. To make cooked full-fat soybean flour, the dry seeds were ground, sieved and the flour obtained was finally packaged in an airtight container until needed.

Defatted rice bran preparation

Rice bran was defatted twice using a 1:2 (w=v) ratio of rice bran to n-hexane and a stirring speed of 1,500 rpm at 250°C for 1 hour. The mixture was then centrifuged at 5,000 × g and the residue was defatted again using rice bran and n-hexane in a 1:1 (w=v) ratio at 250°C for 30 minutes while stirring at 1,500 rpm. Under a hood, the mixture was centrifuged at 5,000 × g and air-dried overnight. Before use,

defatted rice bran was milled and sieved through a 50-mesh screen, then packed in polyethylene bags and kept at 50°C.

Sample formulation

The five different flour tests were created from a mix of wheat, soya bean and rice grain (Table 1). The five flour test definitions were coded as M1, M2, M3, M4 and M5. Every one of the measured flours was consistently mixed by using a blender. The composite flour tests were put away in water/airproof compartments until required. Wheat flour (WF) was utilized as a control flour.

Method of cookies preparation

The cookies were made using a mixture of 90%, 80%, 70% and 40% wheat flour; 6%, 12%, 17%, 35% soya bean flour and 4%, 8%, 13% and 25% rice bran powder were used respectively to produce the cookies. Cookies were made according to the Okpala *et al.* (2013) method with slight modifications. For every 100 g of flour, 40 g of baking fat, 31 g of fresh eggs, 7.8 g of powdered milk, 5 ml of vanilla essence, 25 g of white granulated sugar, 0.3 g of nutmeg, 1 g of baking powder and 1 g of salt were used. With the help of a mixing bowl and a wooden ladle, the sugar and fat were creamed for 45 minutes, until the mixture became light and fluffy. Following that, the beaten eggs were added and creamed for another 15 minutes. The other ingredients were mixed in well to produce soft dough. The dough was lightly kneaded and cut into circular shapes. The cookies were baked for 15 to 25 minutes at a temperature of 185°C. The cookies were preserved in plastic airtight containers after cooling and maintained at room temperature until further analysis was required. A cookie made entirely of wheat flour was used as a control.

Proximate composition

Standard analytical procedures (AOAC 2000) were used to analyze the proximate composition (moisture, protein, fat, fiber and carbohydrate) of the wheat-soya-rice bran cookies. The functional properties of wheat-soybean-rice bran blended flour were carried out using Narayana and Narsinga Rao (1982) method with slight modifications.

Sensory analysis

The five cookie samples were evaluated using Larmond's (1977) approach. The evaluation included a total of 50 semi-trained panelists. The cookies were assessed using the

Table 1: Formulation of ingredients for cookies preparation.

Ingredients	M ₁	M ₂	M ₃	M ₄	M ₅
Soft wheat flour (g)	100	90	80	70	40
Soya bean flour (g)Rice bran powder (g)	00	64	128	1713	3525
sugar (g)	25	25	25	25	25
Margarine (g)	40	40	40	40	40
Eggs (large size) (g)	31	31	31	31	31
Baking powder (g)Milk powder (g)	17.8	17.8	17.8	17.8	17.8
Salt (g)	1	1	1	1	1
Nut meg	0.3	0.3	0.3	0.3	0.3
Vanilla essence (ml)	5	5	5	5	5

following parameters; color, taste, flavour, texture and overall acceptance. The coded cookie samples were served in clean plastic plates at room temperature in segregated cubicles with adequate lighting. A random sample presentation was delivered to the panelists. Panelists were told to try out the items and rate them on a five-point scale.

Statistical analysis

A one-way analysis of variance was performed on the data (ANOVA). Duncan's multiple range test was used to separate the means using the Statistical Package for the Social Sciences (SPSS) version 20. The significance level was chosen at $p < 0.05$.

RESULTS AND DISCUSSION

Proximate composition of wheat, soybean and rice bran cookies

Table 2 shows the proximate composition of the various cookie samples produced. The moisture level varied between 9.6 and 12.20%. The composite samples M2, M3, M4 and M5 had higher moisture contents of 9.94, 9.99, 10.93 and 12.20% than the control M1 (9.6%). The moisture content increased from 9.6 to 12.20% with the addition of soy flour and rice bran. However, these findings are in contrast to those of Sutharshan *et al.* (2001), who found that increasing the quantity of soy flour in the biscuits reduced the moisture content. High moisture content has been linked with a short shelf life of baked products because they inspire microbial growth that leads to spoilage (Elleuch *et al.*, 2011). Cookies fortified with soya bean flour and rice bran had high moisture values that were significantly different ($p < 0.05$).

Cookie Sample M5 had the greatest ash level (3.54%), while control M1 recorded the lowest (1.42%). The ash content was found to be 9.94%, 9.99% and 10.93% in cookie samples M2, M3 and M4. As it can be seen in Table 2, the ash content gradually increased from 1.42% to 12.20% as the percentage of soy flour and rice bran increased. The results agree with those of Ayo *et al.* (2014) on the use of soy flour in biscuits. With the addition of soy flour and rice bran, the fat content of the cookies increased from 2.28 to 13.88%. Sample M5 had the highest fat content (13.88%), while the control (M1), which consisted of 100 % wheat flour cookies, had the lowest (2.28%). The fat content of samples M2, M3 and M4 were found to be 4.50%, 7.03% and 8.74%, respectively (Table 2). This upward trend is consistent with previous studies (Ayo *et al.* 2014).

According to Reddy (2004), soy flour has 20-24% fat, whereas wheat flour comprises 0.9-1.1% fat, the majority of which is unsaturated. The study's higher fat content could be attributed to a higher amount of soy flour and rice bran in the cookies. With the addition of soy flour and rice bran, the fiber level of the cookies increased from 0.30 to 4.80%. Cookie sample M5 had the highest fiber content (4.80%), while the control (M1) had the lowest (0.30%). The fiber

content in samples M2, M3 and M4 were found to be 0.92%, 1.63% and 2.50%, respectively (Table 2). Ayo *et al.* (2014) showed similar increases in fiber content when malted soy flour was added to prepare biscuits. The protein content was observed to have increased from 10.22% to 18.70% in the current study. Cookie sample M5 had the highest protein level (18.70%), while M1 had the lowest (10.22%).

Fiber content was found to be 11.57%, 13.54% and 14.71% in samples M2, M3 and M4 (Table 2). Several investigations backed up this tendency of higher protein content in the treatments as compared to the control (Ayo *et al.* 2014). This increase could be due to an increase in the proportion of soy flour and rice bran in the flour blend, as soybean and rice bran are high-protein legumes and cereals that are an excellent complement to lysine-limited cereal protein.

Functional properties of wheat-soybean-rice bran blended flour

The ability of food products to link with water when water is scarce, such as in dough and pastries is referred to as their "water absorption capacity" (WAC) (Oppong *et al.*, 2015). The highest WAC (37.23 mL/g) was found in the flour composite sample M₅ while the lowest (1.73 mL/g) was found in the control flour sample M₁. The WAC of the flours differed significantly ($p < 0.05$) from one another. The samples' high WAC could be attributable to their high fibre content since water holding and retention abilities have been found to be improved by fibre.

The physical trapping of oils is primarily responsible for oil absorption capacity (OAC) (Singh *et al.*, 2005). The rate at which protein binds to fat in food compositions is measured by OAC (Singh *et al.*, 2005). Low hydrophobic proteins, which show superior lipid binding, could explain flour's decreased oil absorption capacity (Adeleke and Odedeji, 2010). The flour's OAC levels ranged from 2.15 to 35.26 ml/g. The OAC content of the flours differed

Table 2: Proximate composition of wheat, soybean and rice bran cookies.

Samples	Moisture (%)	Ash (%)	Fat (%)	Fibre (%)	Protein (%)	CHO (%)
M ₁	9.86 ^e	1.42 ^e	2.28 ^e	0.30 ^e	10.22 ^e	75.22 ^a
M ₂	9.46 ^d	2.03 ^d	4.50 ^d	0.92 ^d	11.57 ^d	51.20 ^e
M ₃	9.99 ^c	2.46 ^c	7.03 ^c	1.63 ^c	13.54 ^c	51.30 ^d
M ₄	10.93 ^b	2.97 ^b	8.74 ^b	2.50 ^b	14.71 ^b	57.71 ^c
M ₅	12.20 ^a	3.54 ^a	13.88 ^a	4.80 ^a	18.70 ^a	64.89 ^b

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p > 0.05$). Keys: M₁ (100% wheat flour), M₂ (90% wheat flour, 6% soybeans flour and 4% rice bran powder), M₃ (80% wheat flour, 12% soybeans flour and 8% rice bran powder), M₄ (70% wheat flour, 17% soybeans flour and 13% rice bran powder) and M₅ (40% wheat flour, 35% soybeans flour and 25% rice bran powder).

significantly ($p < 0.05$). Table 3 shows that M_5 has a higher oil absorption capacity of 35.26 ml/g. The lowest concentration was 2.15 ml/g for M_1 . The OAC in the flour also aids in the enhancement of flavour and mouth feel when it is used in food preparation.

The bulk density (g/cm^3) of flour refers to the density measured without any compression. Flours bulk densities ranged from 0.74 g/cc to 0.99 g/cc. The M_5 had the highest bulk density (0.99 g/cc), followed by M_4 (0.92 g/cc) and M_1 (0.74 g/cc). According to the current study, the bulk density of flour is determined by particle size and initial moisture content. The bulk density of composite flour increased as the percentage of other flours added to wheat flour increased. Flour's high bulk density signifies that it is suitable for use in food preparations.

The ability of a protein solution or suspension to emulsify oil is known as "emulsifying ability." The emulsion ability (EA) of all the flour blends ranged from 43.88% to 64.12%, with the M_5 having the highest EA of 64.12%, followed by M_4 and the control sample M_1 having the lowest EA of 43.88%. The EA of the flours was significantly different ($p < 0.05$). The results of this study are similar to and connected to Iwe *et al.* (2016) findings of 42.50, 56.78 and 56.67% for rice, cowpea and AYB flours, respectively.

The flour's foaming capacity (FC) ranged from 12.92 to 23.48 per cent. These findings are similar to those reported by Iwe *et al.* (2016), who found foaming abilities of 10.41% to 18.17% in soy-wheat and rice bran flour. The ability of a chemical in a solution to produce foam after vigorous shaking is known as foaming capacity (FC). The FC of the flours

was significantly different ($p < 0.05$) and the higher the flour's protein concentration, the better the foaming capacity.

Sensory attributes of the wheat, soybean and rice bran flour cookies

Sensory evaluation of wheat, soybean and rice bran flour cookies in Table 4 revealed that the sensory qualities of M_3 was deemed to be the best in terms of flavour, taste, texture, colour, crispiness and overall acceptability, while M_1 and M_2 were closest to cookie sample M_3 . The flavour of the cookies was reduced from 2.15 to 4.26 as a result of the increased in substitution of soybean flour and rice bran. The flavour scores decreased rapidly as the percentage of flours containing wheat and rice bran increased from 25 and 35%. This has a lot of consequences and it is a crucial criterion in organoleptic evaluation. Taste is the most important component in determining whether or not a product is acceptable and it has the greatest impact on the product's commercial success. With the increase in the level of soy flour and rice bran substitution, the taste score increased from 2.41 to 4.41. The cookie with M_5 was rated the worst in terms of taste (2.81) while biscuit sample M_3 recorded the highest mean score for taste (4.41).

The texture of the cookies was increased from 2.95 to 4.46 by increasing the substitution of soy flour and rice bran. The composite biscuit sample M_3 had a high mean score for texture (4.46) followed by sample M_2 with a mean score of (3.50). The control sample M_1 had the third mean value (3.40) and this brought a significant difference ($p < 0.05$) between the texture of the control and composite cookies. The average colour score of the cookies rose from 2.53 to 4.37. Cookie sample M_3 had the highest score (4.37) and the lowest colour score (2.53) was for sample M_5 . As the amount of soy flour and rice bran in the cookies increased, the average colour score decreased.

With regard to the crispiness, cookie samples made with 12% soybean flour and 8% brown rice bran powder achieved the highest mean score (4.39) and was significantly different ($p < 0.05$) from the control sample (3.30) and all other composite cookie samples. For overall acceptance, cookie sample M_3 had the greatest mean value (4.56), followed by the control sample M_1 with a 4.51 mean score. The cookie sample M_3 , made up of 80% wheat flour, 12% soybean flour and 8% brown rice bran was most accepted by the panelists.

Table 3: Functional Properties of wheat-soybean-rice bran blended flour.

Samples	WAC	OAC	BD	EA	FC
M_1	1.73 ^e	2.15 ^e	0.74 ^e	43.88 ^e	12.92 ^e
M_2	7.06 ^d	4.45 ^d	0.79 ^d	23.75 ^d	16.27 ^d
M_3	12.77 ^c	8.23 ^c	0.87 ^c	25.55 ^c	17.96 ^c
M_4	19.79 ^b	12.03 ^b	0.92 ^b	32.35 ^b	19.58 ^b
M_5	37.23 ^a	35.26 ^a	0.99 ^a	64.12 ^a	23.48 ^a

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p > 0.05$). WAC = Water absorption capacity, OAC = Oil absorption capacity, BD = Bulk density, EA = Emulsion ability, FC = Foaming capacity.

Table 4: Sensory attributes of the wheat, soybean and rice bran flour cookies.

Samples	Flavour	Taste	Texture	Colour	Crispiness	Overall Acceptability
M_1	4.26 ^a	3.20 ^d	3.40 ^c	3.30 ^c	3.30 ^c	4.51 ^b
M_2	3.15 ^b	3.38 ^b	3.50 ^b	3.28 ^b	3.32 ^c	4.50 ^b
M_3	3.10 ^c	4.41 ^a	4.46 ^a	4.27 ^a	4.39 ^a	4.56 ^a
M_4	3.00 ^d	3.30 ^c	3.30 ^d	3.23 ^d	3.45 ^b	3.39 ^d
M_5	2.15 ^e	2.81 ^e	2.95 ^e	2.50 ^e	2.66 ^e	2.70 ^e

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p > 0.05$).

CONCLUSION

The functional qualities (water absorption capacity, oil absorption capacity, bulk density, emulsion ability and foaming capacity) of the formulation with the maximum replacement of 40%, 35% and 25% of wheat, soybeans and rice bran blended flour achieved relatively the highest values in this study. The dispersibility of the flour blends was reduced as the amount of soybean and rice bran flour substituted increased. Sensory evaluation revealed significant differences ($p < 0.05$) in the flavour, taste, texture, colour and overall acceptability of the cookies produced. The cookie sample made with 80% wheat flour, 12% soybean flour and 8% brown rice bran was the most preferred with an overall mean value of 10.56 and was significantly different ($p < 0.05$) from the control.

Conflict of interest: None.

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