Quality Evaluation of Cookies from Malted Sorghum (*Sorghum bicolor*), Sprouted Soybean (*Glycine max*) and Carrot (*Daucus carota*) Flour Blends

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ABSTRACT

Quality and acceptability of cookies produced from malted sorghum, wheat, and blends of malted sorghum, sprouted soybean and carrot flours were evaluated. Malted sorghum flour was enriched with sprouted soybean and carrot to produce cookies with varying amount of sproted sorghum and carrot (100:0:0, 80:10:10, 70:20:10, 60:30:10 and 50:40:10). The chemical, physical and sensory attributes of cookies were evaluated with results showing significant ($p<0.05$) differences. Results of chemical compositions of Composite flours and composite cookies showed similar trends. The ranges of cookies contents of moisture, crude protein, crude fat, crude fibre, ash, carbohydrate, energy spread ratio and general acceptability include 5.25–6.79%, 9.88–17.46%, 12.04–18.99%, 0.81–4.67%, 1.34–3.78%, 51.25–68.62%, 422.4–459.19Kcal, 6.53–7.79 and 7.11–7.98. Generally, all nutrients analysed increased with increased substitution of sprouted soybean and carrot flours into mated sorghum flour except moisture and carbohydrates. The results revealed that inclusion of 40% sprouted soybean and 10% carrot into malted sorghum served a complementary purpose in increasing cookies spread ratio and most of the nutrients analysed. Whereas, sensory scores of cookies with 10% sprouted soybean and 10% carrot inclusion compared favourably with the control.

1. INTRODUCTION

High rate of snack consumption in developing countries and the world at large is a major concern that draws attention to the nutritional quality of snacks, which may not meet the demand for nutrient balance [1-2]. Wheat presently the major ingredient in baking industries in Nigeria is deficient in vitamin A but is a good source of protein, fibre, carbohydrate and energy. However, these nutrients are concentrated in the wheat bran which is removed during milling and processing into flour [3]. Hence the resultant wheat flour and its products become deficient in these nutrients and consumers of such products are faced with the problems of protein–energy malnutrition. The use of composite flours based on wheat and other cereals with legumes in research and development has been given much attention to extensively over the years with resultant successes [4-8]. However, cost analyses conducted on these researches still necessitate attempts for a complete replacement of wheat flour with suitable underutilized crops such as cereals (e.g sorghum), legumes (e.g soybean) and carrots grown in the tropics.

Malting activities and sprouting processes have been reported to enhance the nutrients in these locally cultivated crops [9-12].

Cookies are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven. They are one of the popular cereal foods consumed in Nigeria and are ready to eat, convenient and inexpensive food products, containing digestive and dietary principles of vital importance [13]. When cookies are produced from composite locally available food substances it would serve as a vehicle for combating the prevailing protein-energy malnutrition among its consumers.

Sorghum (*Sorghum bicolor* (L.) Moench) plays a crucial role in food security in developing countries [11]. Data from the USDA office of Global Analysis showed that Nigeria is the second largest producer of sorghum (6.90 million metric tons) after the United States (9.85 million metric tons) [14]. In Nigeria, as in many semi-arid countries of Africa and Asia, it serves as source of nutrients including protein, fibre, carbohydrates and energy [15].

Soybean (*Glycine max*) is one of the most valuable crops in the world, providing a good source of protein (38%-55%) including adequate amount of lysine an essential amino acid for human diet but it is low in sulphur amino acids-methionine [16]. It contains 30% carbohydrates, and excellent amounts of dietary fiber, vitamins, and minerals. It also consists of 20% oil [17-18]. Nigeria produced 1.10 million metric tons of soybean behind South Africa as the Africa top producer of soybean producing 1.45 million metric tons and United States which produced 104.64 million metric tons as the world leading producer of soybean [14].

Carrot (*Daucus carota*) is one of the important root crops cultivated throughout the world for its fleshy edible roots and is used for human consumption [19]. Carrot is an excellent source of antioxidant compounds and the richest source of beta carotene, which is the most active form of carotenoids [20]. Consumption of carrot containing products would be very useful vehicle in alleviating vitamin A deficiency among children and adults in developing countries including Nigeria.

2. MATERIALS AND METHOD

2.1 Materials

Sorghum (sorghum bicolor) grains, yellow type soybean (Glycine max) seeds and carrot (Daucus carota) were purchased at North bank market, Makurdi, Benue state, Nigeria. While wheat (Triticum aestivum) flour and other ingredients were purchased at Wurukum market Makurdi. The reagents used during the course of this study were of analytical grade.

2.2. Micro-Malting of Sorghum Grains and Processing into Flour

The malted sorghum flour was prepared using the modified method of [21]. Two kilograms (2kg) of sorghum grains were sorted to remove stones, dirt and other extraneous materials. The cleaned grains were thoroughly washed and steeped in portable water at room temperature (30±2^{0}C) in a ratio of 1:3 (w/v) grains to water in a plastic container for 12h so as to attain a 42-46% moisture level. The hydrated grains were spread on a moist jute bag which had been previously sterilized by boiling for 30 minutes and the grains were allowed to germinate for four days. Non-germinated grains were discarded and the germinated seeds were dried at 60^{0}C in a cabinet dryer to a moisture content of 10-12%. The withered rootless grains were gently brushed off, and the malted grains were dry milled into flour (270μ m) using Apex Hammer mill (Model No: 114S2/FLP), sieved (Endecotts Ltd, London, England) and packaged in an air tight container until ready for used.

2.3 Preparation of Sprouted Soybean Flour

Sprouted soybean flour was produced using the modified method of [22]. Soybean seeds (2kg) were sorted, cleaned, washed and soaked for 12 hours in a plastic bucket containing clean tap water. The soybeans were spread on a clean jute bag and covered to screen from direct sun light. The seeds were allowed to sprout for 48 hours at room temperature and cabinet dried at 60^{0}C for 8 hours, devegetated by hand rubbing, winnowed and milled into flour using hammer mill (Bremmer, Germany). The flour was sieved with the aid of a 425 μm sieve (Endecotts Ltd, London, England) to obtain a uniform particle size of flour which was packaged in polyethylene bag and stored at room temperature till needed.

2.4 Processing of Carrot Roots into Flour

Carrot flour was produced using the modified method of [23]. Fresh carrot roots were sorted washed with clean tap water to remove dirt, stones and other foreign materials. The washed carrot roots were scrapped and sliced to expose more surface area to heat treatments, blanched, cooled and oven-dried at 55^{0}C for 10 hours. The dried carrots were then milled into flour using hammer mill (Bremmer, Germany). The flour was sieved with the aid of a 425μm sieve (Endecotts Ltd, London, England) to obtain a uniform particle size of flour which was packaged in polyethylene bag and stored at room temperature till needed.

2.5 Formulation of Composite Flours from Malted Sorghum, Sprouted Soybean and Carrot Flours

Five blends of malted sorghum, sprouted soybean and carrots flours at ratios of 100:0:0, 80:10:10, 70:20:10, 60:30:10, 50:40:10 and 100% wheat flour were formulated. The 100% malted sorghum and 100% wheat flour were used as the controls.

2.4. Production of Cookies

Cookies were produced according to the method of [24] with slight modification. The composite flour with baking powder, sugar, salt, fat, milk, egg and vanilla flavour after scaling (weigh balance model: Sliding Harvard Trip balance, 2kg-51b capacity) were manually mixed in a bow. Egg is later added to the mixture and finally mixed together to form a batter. It was then rolled to a uniform diameter using a round cookies cutter and thus given it a round shape. The batter was then transferred after cutting into the oven (Model: IGNIS Brazil) and baked at 180^0C for 15 minutes. The Cookies were then removed and allowed to cool on a rack, after which they were packed in a low density polyethylene bags and kept for further analysis. The ingredients used are: flour (100g), butter (50g), sugar (35g), egg (30ml), powdered milk (10g), salt (0.5g) and baking powder (5g).

2.5 Determination of the Chemical Composition of Malted sorghum-Sprouted soybean-carrot Composite Flours, wheat flour and their Cookies

The proximate compositions of the flours and cookies from composite malted sorghum flour, wheat flour and composite flour of malted sorghum, sprouted soybeans and carrot flours were determined according to the methods of [25] and Carbohydrate content was determined by difference according to [26]. The caloric value (Kcal) was calculated by multiplying the mean of crude protein and total carbohydrate by Atwater factor of 4 each and that of crude fat multiplied by 9 and summing up the products as energy value.

2.6 Determination of the Physical Properties of Cookies

The weight (g) of the Cookies was determined immediately after cooling according to the method of [27] using a digital weighing balance (Methler Toledo) and mean values of three individual cookies recorded. The diameter of the cookies was determined according to the method of [28]. Four Cookies were placed edge to edge and their total diameter was measured with the aid of a ruler. The Cookies were rotated at angles of 90^0 for triplicate readings. The experiment was repeated thrice and average diameter was recorded in centimeter. The thickness of the Cookie was determined according to the method of [29]. The Cookies thickness was measured with the aid of a digital vernier caliper with 0.01mm precision.

The spread ratio was determined according to method of [30]. Spread ratio was calculated using the formula:

$$Spread\ ratio = \frac{baked\ cookies\ diameter - unbaked\ cookies\ diametr}{baked\ cookies\ thickness - unbaked\ cookies\ thickness}$$

2.7 Sensory Evaluation

Sensory evaluation of the Cookies was carried out according to the method described by [31]. A panel of twenty members consisting of students and members of staff in Food Science and Technology Department, University of Agriculture Makurdi, Nigeria. Panelists were chosen based on their familiarity and experience with wheat-based Cookies for sensory evaluation. Cookies produced from control flours and their blends were represented in coded form and were randomly presented to the panelists. The panelists were provided with portable water to rinse their mouth between evaluations. However, a questionnaire describing the quality attributes (appearance, taste, texture, aroma and general acceptability) of the cookies was given to each panelist. Each sensory attribute was rated on a 9-point Hedonic scale (1 = dislike extremely and 9 = like extremely). Cookies produced from 100% malted sorghum and 100% wheat flours were used as controls.

2.8 Statistical Analysis

The GENSAT Statistical Program (Rothamsted Experiment Station, 2007) was used for data analyses. Data were subjected to analysis of variance (ANOVA) and difference of mean were separated by the Fisher's least significant difference (LSD) test at ($P<0.05$).

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Flours and Cookies from Wheat flour, Malted sorghum-Sprouted soybean-Carrot flour Blends

The observations of chemical compositions made on flours are recorded in table 1. This shows similar trends with the data in table 2 for cookies. The ranges of chemical composition of flours are moisture (8.56–10.93%), protein (9.37–16.55%), crude fat (0.28–5.89%), crude fibre (0.73–4.20%), ash (1.02–2.87%), carbohydrate (61.93–77.59%) and energy (350.36–366.58Kcal). There were general significant ($p<0.05$) differences in the results of the chemical parameters of all the flour and cookies samples. However, no significant ($p>0.05$) difference in ash and crude protein was observed amongst flour and cookies produced from 100% malted sorghum (sample A) and 100% wheat (sample F). Increased values of the proximate components were observed with increased level of soybean substitution into malted sorghum except in moisture and carbohydrates. The ranges of cookies proximate parameters include moisture (5.25-6.79g/100g), crude protein (9.88-17.46g/100g), crude fat (12.04-18.99g/100), crude fibre (0.81-4.67g/100g), ash (1.34-3.78g/100g), carbohydrate (51.25-68.62g/100g), and Energy (422.36-459.19Kcal). Sample F (100% wheat cookies) had the highest energy (459.19Kcal) and moisture (6.79Kcal) values while sample E (40% sprouted soybean incorporated cookies) had the highest values of crude protein (17.46g/100g), crude fat (17.59g/100g), crude fibre (4.67g/100g), and ash (3.78g/100g). Whereas, the highest carbohydrates content (68.62g/100g) was recorded from the 100% malted sorghum cookies.

The result of moisture indicates that sprouted soybean flour confer hydrophobic ability to malted sorghum. [32] reported higher moisture content of 11.0g/100g for sorghum flour than 7g/100g for soybean flour. The relatively high moisture content of the control sample, A, compared to that of composite cookies could be attributed to the high carbohydrates value (68.62%) of the 100% malted sorghum cookies which decreased with increase in substitution of sprouted soybean into the malted sorghum. This deduction is explained by [33] who stated that increase in moisture content is a function of the high sugar content present in the sample. Moisture contents obtained from this study is higher than range of moisture (3.34-4.06%) reported by [24] but lower than those obtained by [22] which ranged from 7.24 – 9.80% for wheat and full fat soybeans cookies. All moisture contents recorded from this study were below 10% moisture content recommended by [34]. Since low moisture contents predict shelf longevity of foods, it could be inferred that all cookies samples analysed would keep longer without easily getting spoilt. [35] reported that moisture content is an indicator of shelf stability, thus increase in moisture content can enhance microbial growth which leads to deterioration of food products. High moisture content is not desirable in a product such as cookies, because it has an inverse relationship with the texture of the product, which is an important attribute that consumers desire in cookies [9]. According to [5], baked foods such as cake, cookies and bread with high moisture content encourages bacterial, yeast and mould growth that could lead to spoilage. However, cookies in the present study having low moisture is safe for long term storage as the moisture contents levels recorded are reasonably low to inhibit of microbial growth.

The gradual increase in protein contents of samples with substitution of malted sorghum with sprouted soybean and carrot flours showed that sprouted soy bean is a rich source of protein as explained by the report of [36] who reported protein content of 11.78 % for malted sorghum flour; [37] who reported 9.38% protein in carrots flour and [38] who analysed soybean flour and recorded 34.99% protein content. The generally higher protein contents in 100% malted and the composite cookies may probably be attributed to biochemical changes that occur as a result of activation of enzymes during germination, which led to the change in chemical compositions of the malted and sprouted products [39]. [40] related increase in crude protein content to protease enzymatic activity during germination. They stated that during proteolysis, protein is degraded and hydrolysed into free amino acids which can be rapidly transformed into new protein compounds. With the protein contents of cookies conformed to the FAO/WHO minimum recommended protein of 10% [41]. [42] also stated RDA range of 10-35% for food product to be considered adequate for consumption by human in term of protein content. Protein value recorded here is similar to that reported by [43] who evaluated the nutritional composition of cookies produced from pigeon pea, cocoyam and sorghum flour blends. The increasing trend of protein content of composite cookies are within the range of the findings of [24] and [27]. It is worthy of note to state that sorghum protein is superior to wheat protein in biological value, digestibility and is totally gluten free [44]. Thus cookies sample A would be the right choice for the consumers who are allergic to gluten intake to avoid coronary disease conditions such as celiac disease. The increase in protein content would be useful in eliminating the challenges of protein deficiencies notably among children of the low income group [45-46].

The progressive increase in crude fat contents recorded for cookies samples with inclusion of sprouted soybean and carrot flours in the blends suggests that sprouted soybean flour is a rich source of crude fat. This point is buttressed by [38] who recorded 24.6% crude fat for soybean flour and [32] who stated that sorghum is a poor source of lipid from his recorded data of 4.0% sorghum flour crude fat. This suggests that composite cookies with higher sprouted soybean inclusion could be more palatable. [38] stated that higher fat contents of raw materials could be useful in improving palatability of foods in which it is incorporated. The range of 12.04–18.99% crude fat contents for cookies recorded in this study were slightly lower than the fat content of cookies produced from soybean and maize flour blends by [45]. In their study, they recorded a range of crude fat of 16.10 – 18.13%. This is contrary to expectation since soybean is richer in fat content than maize but the rationale behind this anomaly may be the fat reducing effect of sprouting processes applied to the soybean seed. Several studies have been reported that germination reduces fat content [12, 47] due to hydrolysis and utilization of fats as an energy source for biochemical reactions during germination [48, 39, 12]. [9] reported a decreased soybean fat content from 15% to 10% during sprouting. This investigation also agrees with [49] and [50]. [26] stated that levels of fat in food products should be ≤25% as levels above this specification could lead to rancidity in foods and development of unpleasant and odorous compounds. Lower crude fat values were recorded for wheat flour substituted with potato in the study conducted by [51]. Fat content plays a role in the shelf life stability of flour samples and relatively low fat content of cookies makes them suitable food products for the elderly [52]. The study conducted by [51] showed the concentration of fat in cookies ranging between 10.90g/100g and 18.93g/100g for the substitution of wheat with potato flour which is in a close agreement with the fat recorded from the present study. The present result is also in agreement with the value of crude fat reported by [5, 2]. Proteins are necessary for growth and development of the body; for body maintenance and the repair and replacement of worn out or damaged tissues; to produce metabolic and digestive enzymes; and they are an essential constituent of certain hormone [5].

The results of crude fibre shows that the composite blends are good sources of fibre and can be used in the preparation of functional food products. Consumption of high fibre food products has been linked to reduction in hermorrhoids, diabetes, high blood pressure, and obesity [53, 54]. [55] and [56] stated that the presence of high fibre in food products is essential owing to its ability to facilitate bowel movement (peristalsis), bulk addition to food and prevention of many gastrointestinal diseases in man. The fibre contents conforms to the observation of [50] but higher than the crude fibre (1.05–1.65%) of cookies produced from wheat-defatted cashew nut flour blends as reported by [49]. In addition, the fibre contents of composite cookies ranging from 3.00 to 4.67g/100g is relatively higher than the range of 0.24 to 0.94% reported by [45] who analysed cookies from soybean and maize composite flours. The recommended dietary allowance (RDA) for crude fibre in foods for children according to [57] is 4.0 mg/100g, implying that all cookies crude fibre contents met this specification.

The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent [58-59]. The increasing ash contents of cookies observed with increased inclusion of sprouted soybean in the blends implies that the substituted sprouted soybean flour contained higher mineral elements than the malted sorghum. [60] attributed high ash content in cookies to the formation of mineral content from enzymatic activities as observed from the present study. Minerals such as magnesium, potassium and zinc are formed during germination process. The higher the ash content, the higher the mineral content of the food [61]. Result obtained for ash contents of cookies in this study having the ash values ranging between 1.34–3.78% is higher than the result of ash content (1.00-1.82%) of cookies baked from blends of soybean and maize flour by [45]. The observed increase in the ash values is in contrast to the report of [62]. [63] and [64] reported increases in ash content in their fortified products. All cookie samples met the recommended dietary allowance (RDA) for ash in foods for the ≤5.0 mg/100g specified by [57].

The decrease in carbohydrate contents as the percentage inclusion of sprouted soybean increased in the blends, may be because of low amount of starch and sugar content in sprouted soybean than malted sorghum [11, 65-66]. [32] reported 15g/100g and 81g/100 of carbohydrates in soybean and sorghum respectively. The higher carbohydrate content observed in 100% malted sorghum cookies than 100% wheat cookies could be attributed to the malting activity which may have mobilized endogenous enzymes which facilitated breakdown of more starch in the sorghum grains [11]. [8] reported that the higher the protein, fat, and ash content the less the carbohydrate content. Carbohydrate values are in agreement with the finding of [67, 33]. Values of carbohydrates of cookies met the recommended dietary allowance (RDA) for carbohydrate of 45-65% in foods [42]. Carbohydrates have a wide range of physiological effects which are important for health. They are the main source of energy in most populations [66].

The increase in energy values is in line with the statement of [8] who stated that energy value increases with increase in fibre. Other reason for the increasing energy values of composite cookies is the higher crude fat, protein and carbohydrates contents of composite cookies as buttressed by [68] who stated that the greatest amount of food energy 9kcal/g while proteins and most carbohydrates have about 4kcal/g. The lower energy values recorded from the 100% sorghum cookies is advantageous as regular intakes could facilitate better weight reduction in overweight/obese individuals or in managing diabetes mellitus. Higher energy value of composite cookies sample E could find application in infant formula. [69, 52] pointed out that high-energy content may be advantageous for formulation of breakfast cereal and complementary foods. The caloric values of cookies are higher than that reported by [33]. The human body requires energy for all bodily functions, including work and other activities, the maintenance of body temperature and the continuous action of the heart and lungs. Energy is needed for the breakdown, repair and building of tissues as well as essential for growth of children [70].

3.2 Physical Properties of Cookies from Wheat Flour, Malted Sorghum-Sprouted Soybean-Carrot Flour Blends

The physical properties of cookies are presented in Table 3. There was significant ($p<0.05$) difference in cookies weights, diameters, thicknesses and spread ratios. Decreasing trends were observed in values of cookies weights, diameters and thickness while an increasing trend was observed in cookies spread ratios when the addition of sprouted soybean increased in the blends. The ranges of cookies weights, diameter, thicknesses and spread ratios are 13.10-16.04g, 4.17-5.09cm, 0.53-.078cm and 6.76-7.79cm respectively.

Higher weight recorded for the 100% malted sorghum cookies could be due to the presence of fibre containing bran in the flour. Cookies weights observed in this study were higher than the observation of [2] who recorded lower weights from their study of biscuits from composite flour of wheat, carrot and cowpea but lower than the report of [24]. The higher weight of cookies in this study could be attributed to the higher moisture contents of cookies and the malting and sprouting activities that the sorghum and soybean were subjected to respectively. [72] related higher biscuit weights to processing techniques. Similar decrease in weight of cookies was recorded by [73-75].

The decreasing trends in diameter and thickness of cookies could be attributed to high protein contents of cookies. [76] and [77] reported similar trends and attributed significant reduction in thickness of biscuits and cookies respectively to increasing protein contents. [33] reported increase in cookies diameters from 3.08 to 3.45cm and decrease in thickness from 4.00- to 3.61cm. Similar decreasing trend for the diameter was reported earlier by [78], who reported a decrease in diameter for cookies with increasing substitution level of oat bran for high fibre biscuits.

Cookies spread ratio is an important parameter for evaluating the rising ability of cookies [77]. Cookies with low spread ratio will have better-rising ability than those with high spread ratio [79]. The addition of sprouted soybean and carrot flour to the malted sorghum increases the spread ratio of the cookies. This indicates that malted sorghum exhibited higher rising ability than sprouted soybean and carrot used in the cookies formulation. Previous studies showed similar trend and attributed high-fat contents to high spread ratio [80]. Cookies with larger spread ratio are more desirable [75, 81]. Thus composite cookies with high spread ratio will be more acceptable to consumers than 100% malted sorghum flour cookies with low spread ratio.

3.3 Sensory Attributes of Cookies from Wheat Flour, Malted Sorghum-Sprouted Soybean-Carrot Flour Blends

The sensory scores of cookies showed that cookies prepared from 100% malted sorghum flour were rated similar to cookies from and 100% wheat flour in all sensory characteristics evaluated, except for aroma.

These characteristics could be responsible for lower rating of the composite cookies than the two control samples A (100% malted sorghum cookies) and B (100% wheat cookies). An increase in the substitution level of malted sorghum with sprouted soyabean and carrot flour resulted in a decrease in colour scores. With sample A (100% malted sorghum cookies) scoring higher (7.88) than composite sample E (50:40:10), it is possible to hypothesize that the effect of Maillard reaction in the malt flour was more effective than in the sprout which resulted in reduced mean scores for cookies colours with increased incorporation of sprouted soybean into malted sorghum. The gradual decrease in the taste scores of cookies with increase in substitution of malted sorghum with sprouted soybean and carrot flours may be attributed to lesser sugar contents of the substituted flours. In addition, [24] stated that astringent taste among cookie samples could be attributed to the development of bitter substances, owing to the presence of tannin. Sorghum malt is highly rich in simple sugar [82].

The decrease in texture scores could be attributed to addition of less appreciable textured sprouted soybean into the mix. The insignificant difference ($p>0.05$) in the texture scores of cookies for samples A, B and C may be related to the inability of the panelists to distinguish between cookies textures. The texture of the crust was related to the external appearance of the cookies top which implies smoothness or roughness of the crust [83]. This cookies textural claim suggests better smoothness of the crust of the 100% malted sorghum cookies than any other composite cookies.

The gradual decrease in aroma scores with substitution of malted sorghum flour with sprouted soybean and carrot flours at different levels could be due to the beany flavour of soybean flour [84]. However, aroma scores for cookie samples were considerably high which indicate lesser deleterious effect of beany flavour as a result of sprouting of raw soy bean.

The general acceptability of the cookies was significantly ($p<0.05$) influenced by the other sensory qualities. The mean sensory scores for different levels of sprouted flour and carrot flour incorporated into malted sorghum cookies, for all the sensory attributes evaluated were more than the minimum acceptable score of 6 [2]. The result revealed high mean scores in all the sensory attributes evaluated as all the samples maintained a high level of acceptability by the panelists which reflected positively on the overall acceptability of the cookies. The high general acceptability score for the 100% malted sorghum cookie could apparently be a reflection of excellent taste and aroma resulting from the fine malty flavour.

Colour, taste, aroma and texture are important attributes considered by consumers in determining cookies acceptability [85]. Cookies colour is generally due to Maillard reaction, which occurred during baking. Starch dextrinization and caramelization, which are induced by heating can also affect cookies colour [86]. Similar sensory trends were observed by [87-91].

Table 1: Proximate Composition (g/100g) of Flour from Wheat Flour, Malted Sorghum Flour, and Malted Sorghum-Sprouted Soybean-Carrot Flour Composite

Sample	Moisture content	Crude Protein	Crude Fat	Crude Fibre	Ash	Carbohydrates	Energy (KCal)
A	10.06^{b}±0.02	9.37^{e}±0.00	0.28^{e}±0.00	1.64^{e}±0.01	1.06^{d}±0.01	77.57^{a}±0.10	350.36^{c}±0.42
B	9.79^{bc}±0.00	12.65^{d}±0.03	3.94^{d}±0.01	2.78^{d}±0.01	2.20^{c}±0.00	68.64^{b}±0.02	360.62^{b}±0.02
C	9.40^{c}±0.01	14.31^{c}±0.01	4.30^{c}±0.00	3.02^{c}±0.02	2.38^{c}±0.00	66.59^{c}±0.02	362.30^{b}±0.12
D	8.72^{d}±0.00	15.95^{b}±0.00	5.10^{b}±0.00	3.65^{b}±0.04	2.61^{b}±0.02	63.97^{d}±0.04	365.58^{a}±0.21
E	8.56^{d}±0.00	16.55^{a}±0.02	5.89^{a}±0.00	4.20^{a}±0.00	2.87^{a}±0.02	61.93^{e}±0.03	366.93^{a}±0.07
F	10.93^{a}±0.01	9.57^{e}±0.10	0.31^{e}±0.00	0.73^{f}±0.00	1.02^{d}±0.00	77.44^{a}±0.06	350.83^{c}±0.50
LSD	0.67	0.22	0.15	0.15	0.20	1.50	1.71

Values are Mean±Standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each column are not significantly ($p>0.05$) different.

A = 100% malted sorghum flour

B = 80% malted sorghum flour + 10% sprouted soyabean flour + 10% carrot flour

C = 70% malted sorghum flour + 20% sprouted soyabean flour + 10% carrot flour

D = 60% malted sorghum flour + 30% sprouted soyabean flour + 10% carrot flour

E = 50% malted sorghum flour + 40% sprouted soyabean flour + 10% carrot flour

F = 100% wheat flour

Table 2: Proximate Composition (g/100g) of the cookies from wheat Flour, Malted Sorghum Flour, and Malted Sorghum-Sprouted Soybean-Carrot Flour Composite

Sample	Moisture content	Crude Protein	Crude Fat	Crude Fibre	Ash	Carbohydrates	Energy (KCal)
A	$6.25^{b}\pm0.00$	$9.88^{e}\pm0.00$	$12.04^{e}\pm0.08$	$1.81^{e}\pm0.00$	$1.40^{d}\pm0.00$	$68.62^{a}\pm0.08$	$422.4^{d}\pm0.42$
B	$6.12^{b}\pm0.00$	$13.40^{d}\pm0.00$	$15.70^{d}\pm0.00$	$3.00^{d}\pm0.00$	$2.90^{c}\pm0.00$	$58.88^{c}\pm0.00$	$430.42^{c}\pm0.00$
C	$5.80^{bc}\pm0.00$	$15.09^{c}\pm0.01$	$16.11^{d}\pm0.00$	$3.36^{c}\pm0.04$	$3.13^{bc}\pm0.01$	$56.51^{d}\pm0.06$	$431.39^{bc}\pm0.20$
D	$5.45^{cd}\pm0.01$	$16.81^{b}\pm0.01$	$16.81^{c}\pm0.06$	$4.05^{b}\pm0.10$	$3.44^{ab}\pm0.00$	$53.44^{e}\pm0.04$	$432.29^{bc}\pm0.71$
E	$5.25^{d}\pm0.00$	$17.46^{a}\pm0.00$	$17.59^{b}\pm0.00$	$4.67^{a}\pm0.00$	$3.78^{a}\pm0.00$	$51.25^{f}\pm0.00$	$433.15^{b}\pm0.00$
F	$6.79^{a}\pm0.01$	$10.10^{e}\pm0.18$	$18.99^{a}\pm0.16$	$0.81^{f}\pm0.01$	$1.34^{d}\pm0.01$	$61.97^{b}\pm0.06$	$459.19^{a}\pm0.92$
LSD	0.48	0.23	0.61	0.17	0.53	1.11	2.01

Values are Mean±Standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each column are not significantly ($p>0.05$) different.

A = 100% malted sorghum flour

B = 80% malted sorghum flour + 10% sprouted soyabean flour + 10% carrot flour

C = 70% malted sorghum flour + 20% sprouted soyabean flour + 10% carrot flour

D = 60% malted sorghum flour + 30% sprouted soyabean flour + 10% carrot flour

E = 50% malted sorghum flour + 40% sprouted soyabean flour + 10% carrot flour

F = 100% wheat flour

Table 3: Physical Properties of the Cookies from wheat Flour, Malted Sorghum Flour, and Malted Sorghum-Sprouted Soybean-Carrot Flour Composite

Sample	Weight (g)	Diameter (cm)	Thickness (cm)	Spread ratio
A	15.16^{b}±0.00	4.80^{b}±0.06	0.71^{b}±0.03	6.76^{e}±0.18
B	14.51^{c}±0.00	4.71^{bc}±0.00	0.67^{bc}±0.00	7.03^{d}±0.00
C	13.61^{d}±0.01	4.55^{c}±0.03	0.63^{c}±0.00	7.22^{c}±0.04
D	13.33^{e}±0.00	4.30^{d}±0.00	0.57^{d}±0.00	7.40^{b}±0.00
E	13.10^{f}±0.00	4.17^{d}±0.02	0.53^{d}±0.00	7.79^{a}±0.27
F	16.04^{a}±0.00	5.09^{a}±0.02	0.78^{a}±0.00	6.53^{f}±0.13
LSD	0.17	0.19	0.05	0.10

Values are Mean±Standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each column are not significantly ($p>0.05$) different.
A = 100% malted sorghum flour
B = 80% malted sorghum flour + 10% sprouted soyabean flour + 10% carrot flour
C = 70% malted sorghum flour + 20% sprouted soyabean flour + 10% carrot flour
D = 60% malted sorghum flour + 30% sprouted soyabean flour + 10% carrot flour
E = 50% malted sorghum flour + 40% sprouted soyabean flour + 10% carrot flour
F = 100% wheat flour

Table 4: Sensory Properties of Cookies from Wheat Flour, Malted Sorghum Flour, Malted Sorghum-Sprouted Soybean-Carrot Flour Composite

Sample	Taste	Texture	Colour	Aroma	General acceptability
A	7.92^{ab}	7.71^{ab}	7.75^{ab}	8.22^{a}	7.80^{a}
B	7.77^{ab}	7.02^{bc}	7.69^{ab}	7.82^{ab}	7.66^{a}
C	7.62^{ab}	6.70^{c}	7.60^{bc}	7.70^{ab}	7.49^{a}
D	7.57^{b}	6.32^{cd}	7.44^{cd}	7.32^{b}	7.11^{b}
E	7.56^{b}	5.52^{d}	7.30^{d}	6.52^{c}	7.13^{b}
F	8.15^{a}	8.22^{a}	7.88^{a}	7.20^{bc}	7.98^{a}
LSD	0.42	1.00	0.19	0.57	0.48

Values are Mean±Standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each column are not significantly ($p>0.05$) different.
A = 100% malted sorghum flour
B = 80% malted sorghum flour + 10% sprouted soyabean flour + 10% carrot flour
C = 70% malted sorghum flour + 20% sprouted soyabean flour + 10% carrot flour
D = 60% malted sorghum flour + 30% sprouted soyabean flour + 10% carrot flour
E = 50% malted sorghum flour + 40% sprouted soyabean flour + 10% carrot flour
F = 100% wheat flour

4. CONCLUSION AND RECOMMENDATIONS

The combination of malted sorghum flour, sprouted soybean flour and carrot flour at levels up to 50%, 40% and 10% respectively in the present study served a complementary purpose in increasing the protein, fat, fibre, ash, energy contents and spread ratio of the cookies whereas sensory scores were highest at 80%, 10% and 10%. However, further studies would be required to investigate the *In-vitro* Protein Digestibility (IVPD) of cookies from blends of malted sorghum, sprouted soybean, and carrot flours.

COMPETING INTERESTS

Authors have declared that there are no competing interests.

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