PROXIMATE COMPOSITION AND SENSORY PROPERTIES OF COOKIES PREPARED FROM WHEAT AND SPROUTED SORGHUM FLOUR BLENDS

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ABSTRACT
The study was conducted to determine the proximate composition of raw and sprouted sorghum flour as well as the proximate and sensory properties of cookies prepared from wheat and sprouted sorghum flour blends. Sorghum flour was sprouted for 72 h and its proximate composition was evaluated while non-sprouted sorghum flour served as control. Wheat flour was substituted with different proportions of sprouted sorghum flour for the preparation of cookies where 100 % wheat cookie served as control. The proximate and sensory properties of cookie samples were evaluated using standard methods. Results obtained showed that sprouting increased the protein, fat and crude fiber content of sorghum flour while ash and carbohydrate content decreased. Substitution of wheat flour with increasing level of sprouted sorghum flour increased the protein, ash, crude fiber and fat contents of the prepared cookies while carbohydrate and energy values decreased compared to control. Acceptable cookie was prepared by substituting wheat flour with 20 % sprouted sorghum flour.

Key words: Sorghum, Sprouted, Wheat, Substitution.

INTRODUCTION

Cereals supply the bulk of the food eaten by the human race. They are the cheapest source of food energy and protein intake of man particularly in developing countries. Commonly cultivated cereals are wheat, rice, rye, oats, corn and sorghum. Sorghum is a cereal crop that is grown in semi-arid zones of Africa, Asia and South America because of its drought tolerance. It is the fifth most important world cereal, followed by wheat, maize, rice and barley (Zohary, 2000, Aremu et al., 2007). Sorghum contains some nutrients such as carbohydrate, protein, lipids, minerals and vitamins. However, they are made unavailable for use by the body because of the presence of some anti-nutritional factors such as phytic acid and polyphenols (Chavan & Kadan, 1993).

Germination processes have been developed to overcome these disadvantages of sorghum in food products (Zohary, 2000). Germination which also means sprouting is a complex metabolic process during which lipids, carbohydrate and storage proteins

Within the seeds are broken down to obtain the energy and amino acid necessary for the plant's development (Malomo *et al.*, 2013). Germination or sprouting is a common problem for grain during harvest when the weather is moist or when the environment is humid during storage. Germination promotes the development of cytolytic, proteolytic and amylolytic enzymes that are not active in dry kennels (Akpapannan and Derbe, 1994, Ashcroft, 1973, FAO, 1996) and could cause significant changes in kernel composition and physical properties (Zohary, 2000).

Cookies are snacks that are widely recognized and eaten globally by people of all ages (Giwa and Ikujenlola (2010). In Nigeria cookies are one of the most consumed snacks apart from bread, because they are energy giving foods made traditionally and readily available in shops as ready to eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance (Kulkarni, 1997). Cookies are produced as nutritive snacks from unpalatable dough that is transformed into appetizing products through the application of heat in the oven (Olaoye *et al.*, 2007). They are made from soft wheat flour but can also be produced with substitute grain flour with better nutritional quality which may be desirable particularly in the developing world where household malnutrition is common. Such grains may be processed using methods like sprouting / fermentations which have been reported to increase nutritional quality (Hallen et al ,2004). It is therefore expected that processing of sprouted sorghum flour in cookies production may greatly improve its nutritive value. Therefore, the objectives of the study were to determine the proximate composition of raw and sprouted sorghum flour. In addition, the proximate and sensory properties of cookies prepared from sprouted sorghum were analyzed.

METHODOLOGY

Materials: Sorghum grains, wheat flour, baking materials such as sugar, fat, egg, common salt and sodium bicarbonate or baking powder used in this study were purchased from Samaru Market, Zaria Kaduna State, Nigeria.

Preparation of raw and sprouted sorghum flour: The method of Houssou and Ayemor (2002) was used in the preparation of sprouted and non-sprouted sorghum flour. Sorghum grains were sorted to remove stones and unwanted materials. The cleaned sorghum grains were soaked in water for 24 hours; the sprouting grains were changed with clean water every 12 hours to prevent fermentation. The sprouted and non-sprouted sorghum grains were separately dried under room temperature for about 72 hours, milled into flour and sieved through 100 µm sieve size. The flour samples were packaged in plastic bag until used.

Formulation of blends: The composite flour was prepared by replacing sprouted sorghum flour (SSF) with wheat flour (WF) at 20%, 40%, 60%, 80% and 100%, and were labelled as T1, T2, T3, T4 and T5 respectively. Sample T0 with 100% SSF served as a reference sample.

Preparation of Cookies: Cookies were prepared using the method reported by Abayomi *et al.* (2013) and Olapade and Ogunade (2014), with little modification. Cookies dough prepared from wheat flour and composite flours combinations using flour (250g), margarine 100g, sugar100g, salt a pinch, sodium bicarbonate 10g, egg 150g. Sugar was creamed with margarine until a light and fluffy constituency was obtained; beaten egg was added, followed by flour, baking powder, and salt were added and mixed until a stiff paste (batter) was obtained. The batter was rolled on a food board using rolling pin to a thickness of 0.1–0.2 cm. The rolled batter was cut into desired shapes with a cutter and arranged on a greased tray and baked at 150°C for 30 min to golden brown. The cookies were brought out, cooled, and packaged in plastic bag until used for analysis.

Determination of proximate compositions of flour and cookies: Moisture, protein, fat, crude fiber and ash contents of samples were determined according to the method described in Association of Official Analytical Chemists (AOAC, 2005, AOAC,2000). The total carbohydrate (CHO) was calculated by difference as: CHO = 100-% moisture + % protein + % fat + %ash). Energy value (kcal/100 g) was determined according to the method of Marero *et al.* (1998) using Atwater factor method: 4 × % protein + 4 × % carbohydrate) + 9 × % fat.

Sensory evaluation of cookies: Sensory evaluation was carried out according to the method described by Retapol and Hooker (2006). A twenty- member panelists were selected based on their familiarity and experience with wheat-based cookies for sensory evaluation. Cookies produced from each flour blend, along with the reference sample were presented in coded form on white plastic plates and were randomly presented to each member. The panelists were provided with portable water to rinse their mouth between evaluations. Sensory attributes (colour, taste, flavour, crispiness and overall acceptability) of the cookies were evaluated on a 7-point Hedonic scale (1 = dislike extremely and 7 = like extremely).

Data Analysis: Data (triplicate values) obtained were analyzed using the Statistical Package for Social Sciences (SPSS version 20).

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of raw and sprouted sorghum flour. Proximate composition of a grain gives a profile of nutrient constituents. Moisture, ash, protein, fat, crude fiber, carbohydrate and total energy of raw sorghum flours were 7.46%, 1.55%, 9.28%, 2.27%, 2.34%, 85.20%, 376.9%, respectively, while sprouted sorghum flour contained 7.54 % moisture, 1.33 % ash, 11.63 % protein, ,2.33 % fat, 4.84 % crude fiber, 81.91 % carbohydrate and 372.4 Kcal/100g energy value. The moisture content of sprouted sorghum was higher compare to raw sorghum flour. These results agree with the report of Mir *et al.* (2015) for sprouted wheat /wheat flour biscuit. The values of moisture (7.6–10.7%) and protein (9.6–13.5%) contents agreed with those reported by Onabanjo and Ighere (2014). The fibre content of sprouted sorghum flour sample (4.84) had the highest value while raw sorghum had the lowest value (2.34). The values of fibre contents of raw and sprouted sorghum agreed with the finding of Onabanjo and Ighere (2014). Sprouted sorghum flour has relatively higher crude fibre content than wheat flour. Higher crude fiber content of sprouted sorghum than raw flour could be attributed the formation of sprouts. 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 (Satinder *et al.*, 2011; Omeire and Ohambele, 2010). The fat content of sprouted sorghum flour was lower compared to that of raw sorghum probably because the sprouted grains utilized lipid as source of energy during sprouting. Carbohydrate content of the sprouted sorghum (81.91 %) was lower compared to raw sorghum flour (85.20%). This may be attributed to starch hydrolysis during sprouting process. Sprouted sorghum flour had the lowest energy value (372. 4%) while the raw sorghum sample had the highest value (376.9%). Similar trend in the carbohydrate and energy contents of sprouted sorghum flour made from wheat-brewers spent grain flour blends and whole wheat- full fat soya flour blends were previously reported by Nagaraj *et al.* (2013).

The results of proximate composition of cookies from sorghum flour and wheat flour at different blends are shown in Table 2. The moisture content (%) of the cookies ranged between 3.34 and 4.06 %. Cookie sample (T4) had the highest value. However, increased substitution level with WF caused significant ($p < 0.05$) reduction in the moisture content values. The moisture content of the cookies was low (<10%) to reduce the chances of spoilage by micro-organisms and consequently guarantee good storage stability (Ayo *et al*., 2007). The moisture content of the cookie samples decreased with increasing level of WF substitution. Gernah *et al*, (2010) reported higher moisture content (5.20–9.30%) for cookies made from sorghum grain flour blends. Ash content of the cookies ranged from 1.88 to 1.41%. The addition of sorghum flour significantly ($p < 0.05$) increased the ash content of the cookies. Ash content of a food material is an indication of the mineral constituents' present (Adebowale, Olayiwola, & Maziya-Dixon, 2008). It aids the metabolism of other compounds such as fat, protein and carbohydrate (Okaka and Ene, 2005, Omeire and Ohambele 2010, Giwa and Abiodun, 2010). Cookie sample (T1) had the highest protein content (15.64%) while (T5) had the lowest (11.21%). Increase SSF substitution caused significant ($p < 0.05$) increase in the protein content of the cookies. The findings conform with previous reports (Giwa and Ikujenlola (2010, Giwa & Abiodun., 2010, Ayo, Mkama and Adeworie, 2006; Adebowale *et al*.,2012) that observed significant increase in the protein content of sorghum-based cookies.

The fat content of the cookies ranged between 29.86 and 32.36%. Cookie sample (T5) had the highest fat content (29.86%) while (T1) had the least value (32.36%). The fat content of the cookies increased significantly ($p < 0.05$) as the substitution level increased. The finding agrees with Omeire and Ohambele (2010) and Gernah et al. (2010) on their reports for the increasing trend in the fat content of cookies produced from wheat-defatted cashew nut and wheat-brewers spent flour blends, respectively. The high fat content in the cookies means high calorific value and also improves the flavor and texture of the cookies (Giwa & Abiodun ,2010). The crude fibre content of the cookies ranged from 1.32 to 6.38%, with T1 having the highest crude fiber value while T4 had the lowest value. The increase in the crude fiber content of the cookies with increasing SSF level could be attributed to higher crude fiber content of SSF which caused addition effect in the blend. This result is in line with those of Gernah *et al*. (2010) for cookies prepared from wheat-brewers spent grain flour blends. 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 (Satinder et al., 2011). Carbohydrate content of the cookies ranged between 40.05 and 52.79%. Sample (T1) had the lowest carbohydrate content (40.05%) while the sample (T5) had the highest value (52.79%). The increase in substitution proportion of wheat flour brought about decrease in the carbohydrate content of cookies.
Similarly, a decreasing trend in the carbohydrate contents (73.46– 46.20%) and (70.45– 23.71%) of cookies made from wheat-brewers spent grain flour blends and whole wheat- full fat soya flour blends was reported by Gernah *et al* (2010).

The low carbohydrate content and increased fibre content of the composite cookies have several health benefits, as it aids digestion in the colon and reduces constipation often associated with products from refined grain flours (Elleuch et al., 2011). The energy value of the cookies ranged between 509.98 and 525.05 kcal/100 g; cookie sample (T2) had the lowest energy value, while the reference sample (T5) had the highest value. The energy values of the composite cookies were significantly at ($p < 0.05$). Similarly, a decreasing trend in the energy value (443.89–431.95 kcal) for cookies made from wheat and quality protein maize was reported by Giwa and Ikujenlola (2010).

Table 3 shows results of the sensory properties of cookies *p*repared from wheat and sprouted sorghum flour blends. The colour, taste, flavor, palatability and overall acceptability scores of the cookie samples were significantly different ($p < 0.05$) from one another. The control sample (T0) had the highest scores for all the attributes observed, except for colour and crispiness. The mean score for the cookies colour ranged between 7.1 and 8.4. Cookie sample (T1) had the lowest value while sample (T4) had the highest value. Generally, the scores for colour attribute increased with increasing SSF substitution level. The intense brown colour of the composite cookies could be due the presence of high amount of carbohydrate in the flour blends, thus resulting in caramelized product. In addition, this could be an indication that substitution of sorghum flour with wheat flour for cookie making actually provides more protein for Maillard reaction to take place, which is normally encountered and desirable in baked goods. Similar results were reported by other authors (Giwa and Abiodun, 2010; Akpapannan and Darbe, 1994). Texture and palatability scores of cookies increased with increasing level (up to 20 %) of SSF which later decreased.

Based on taste, the scores for the cookies ranged from 4.1 to 7.6; cookie sample (T4) had the lowest value while the reference sample (T0) and sample

(T1) had the same high value (7.6). The astringent taste observed among the cookie samples could be attributed to the development of bitter substances, owing to the presence of tannin in sorghum. From the result, it could be deduced that up to 20% substitution level wheat flour could be acceptable by consumers with a mean score of 7.6. The mean scores for flavor ranged between 4.3 and 8.3 for cookie sample (T4) and the reference sample (T0) respectively. However, there was a decrease in the aroma scores of the cookie samples with increase in the substitution level of WF. No significant differences ($p > 0.05$) exist between cookie samples; T2 and T3. The scores for the texture of cookies ranged from 5.0 to 8.2; cookie sample (T5) had the lowest value while sample (T1) had the highest value. The mean scores (5.4–8.8) for the overall acceptability of the cookies were above the average (4.5), indicating

The control sample (To) had the lowest overall acceptability score, while cookie sample (T5) had the highest value. The mean scores (5.5–7.8) for the overall palatability of the cookies were above the average (4.5), indicating high palatability of the cookie samples. The reference sample (T4) had the highest value, while cookie sample (T5) had the least value. The possible reason for low palatability of the cookie's samples produced with WF substitution level above 20% could be due to the observed dark brown coloration and bitter taste. It is therefore clear according to the result that substitution of wheat flours up to 100% substitution level could produce good quality cookies that are palatable, acceptable and suitable heath wise.

Table 1 Proximate composition of raw and sprouted sorghum flour

	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)	Total Energy (Kcal/100g)
Raw	7.46	1.55	9.28	2.27	2.34	85.20	376.9
Sprouted sample	7.54	1.33	11.63	2.33	4.84	81.91	372.4

Table 2: Proximate composition of cookies made from wheat and sprouted sorghum flour blends

	Moisture (%)	Ash (%)	Crude protein (%)	Fat (%)	Fibre (%)	Carbohydrate (%)	Energy value Kcal/100g
100% WF	3.34^{e}	1.41^{e}	11.21^{e}	29.86^{d}	1.32^{e}	52.79^{a}	525.02^{a}
20SSF:80WF	4.06^{a}	1.53^{d}	11.86^{d}	30.76^{c}	3.41^{d}	48.41^{b}	517.79^{b}
40SSF:60WF	3.78^{b}	1.62^{c}	13.17^{c}	30.76^{c}	4.24^{c}	46.43^{c}	515.24^{c}
60SSF:40WF	3.75^{c}	1.75^{b}	14.68^{b}	30.78^{b}	5.48^{b}	43.56^{d}	509.98^{e}
80SSF:20WF	3.65^{d}	1.88^{a}	15.63^{a}	32.36^{a}	6.38^{a}	40.05^{e}	514.00^{d}

Mean value with different superscript on the same column are significantly different ($p \leq 0.05$); SSF–Sprouted sorghum flour; WF– wheat flour; WF– wheat flour; To=100%SSF: 0%WF; T1= 80%SSF:20%WF; T2= 60% SSF:40% WF; T3=40% SSF–80% WF; T4–20% SSF–100% WF; T5- WF-100%WF; T4–20% SSF–100% WF; T5- WF-100%

Table 3: Sensory properties of cookies prepared from wheat and sprouted sorghum flour blends

Sample	Sensory attributes of cookies					
	Taste	Aroma	Colour	Texture	Palatability	Overall acceptability
100% WF	7.8^{a}	8.5^{a}	7.0^{e}	5.0^{f}	5.3^{f}	5.2^{f}
20SSF:80WF	7.6^{b}	8.3^{b}	7.3^{d}	7.7^{b}	7.8^{a}	8.8^{a}
40SSF:60WF	7.6^{b}	7.8^{c}	7.1^{e}	8.2^{a}	7.4^{b}	8.2^{b}
60SSF:40WF	7.1^{b}	6.5^{d}	7.5^{b}	5.3^{d}	7.0^{c}	7.3^{c}
80SSF:20WF	6.3^{c}	6.5^{d}	7.4^{c}	5.7^{c}	6.1^{d}	6.3^{d}
100SSF:0WF	4.1^{e}	4.3^{d}	8.4^{a}	5.2^{e}	5.5^{e}	5.4^{e}

Mean value with different superscript on the same column are significantly different ($p \leq 0.05$); SSF–Sprouted sorghum flour;
WF– wheat flour; WF– wheat flour; To=100%SSF: 0%WF; T1= 80%SSF:20%WF; T2= 60% SSF:40% WF; T3=40% SSF–80% WF; T4–20% SSF–100% WF; T5- WF-100%
WF; T4–20% SSF–100% WF; T5- WF-100%

CONCLUSION

Sprouting increased the protein, fat and crude fiber content of sorghum flour while ash and carbohydrate content decreased. On the other hand, substitution of wheat flour with sprouted sorghum flour increased the protein, ash, crude fiber and fat content of the prepared cookies compared to control. Acceptable cookie was prepared by substituting wheat flour with 20 % sprouted sorghum flour.

REFERENCES

Adebowale, A. A., Adegoke, M. T., Sanni, S. A., Adegunwa, M. O., & Fetuga, G. O. (2012). Functional properties and biscuit making potentials of sorghum–wheat flour composite. American Journal of Food Technology, 7, 372–379.

Adebowale, I.O, Sanni, S.A., A.R.A. Olayiwola and B. Maziya-Dixon, 2008. Chemical composition and pasting properties of iron fortified maize flour. *J. Food, Agric. Environ*., 6: 172-175

Akpapannan, M. A., & Darbe, J. W. (1994). Chemical composition and functional properties of blends of maize and Bambara groundnut flours for cookie production

Aremu MO, Olaofe O, & Akintayo ET. (2007) Functional properties of some Nigerian Varieties of Legume seed flours and flour concentration effect on foaming and gelation properties. Journal of food techonology.5:109 -115

Ascroft J., (1973). The overall evaluation of the special rural development plan. Geneva. Institute for Social Development.

A.O.A.C. (2000). Official method of analysis. 16th edition. Association of Official Analytical Chemists. Washington, DC. pp. 1008 - 1009.

A.O.A.C. (2005). Association of Official Analytical Chemists [AOAC]. Official methods of analysis (18th Ed.). Washington, DC: Author.

Ayo, J. A., Ayo, V. A., Nkama, I., & Adeworie, R. (2007). Physiochemical, invitro digestibility and organoleptic evaluation of acha-wheat biscuit supplemented with soybean flour. *Nigerian Food Journal, 25, 15–17.*

Chavan, J. K., & Kadam, S. S. (1993). Nutritional enrichment of bakery products by supplementation with non-wheat flours. Critical Reviews in Food Science and Nutrition, 33, 189–226. http://dx.doi.org/10.1080/1040839930952 7620 Chemistry, 124, 411– 421.

Elleuch, M., Bedigian, D., Roseaux, O., Besbes, S., Blecker, C., & Atta, H. (2011). Dietary fibre and fibre-rich by-products of food processing: Characterization, technological functionality and commercial applications. Review of Food

FAO (Food and Agricultural Organization of the United Nations) and ICRISAT (International Crops Research Institute of the Semi-Arid Tropics) (1996). The world sorghum economies: facts, trends and outlook. FAO, Rome, Italy and ICRISAT.

Marero, L. M., Payumo, E. M., Librando, E. C., Laine, W. N., Gopez, M. D., & Homma, S. (1998). Technology of using food formulations prepared from germinated cereals and legumes. *Journal of Food Science, 53*, 1391–1395.

Malomo, S. A., & Aluko, R. E. (2015). Conversion of a low protein hemp seed meal into a functional protein concentrate through enzymatic digestion of fibre coupled with membrane ultrafiltration. *Innovative Food Science & Emerging Technologies*, 31, 151– 159.

Mir, N. A., Gul, K., & Riar, C. S. (2015). Techno functional and nutritional characterization of gluten-free cakes prepared from water chestnut flours and hydrocolloids. *Journal of Food Processing & Preservation,*39, 978–984. doi:10.1111/jfpp.12311

Nagaraj N, Basavaraj G, Parthasarathy Rao P, Bantilan C, Halder S, (2013). Sorghum and pearl millet economy of India – future outlook and options. *Econum Political weekly XLVIII (52): 74 – 81.*

Okaka, J. C., & Ene, G. L. (2005). *Food microbiology: Method in food safety control* (p. 262). Enugu: OCJANCO Academic.

Olapade, A., & Ogunade, O. (2014). Production and evaluation of flours and crunchy snacks from sweet potato (Ipomeabatatas) and maize flours. *International Food Research Journal, 21*, 203–208.

Omeire, G. C., & Ohambele, F. I. (2010). Production and evaluation of biscuits from composite wheat/deffated cashew nut flours. *Nigerian Food Journal, 28*, 401–406.

Onabanjo, O. O., & Ighere, D. A. (2014). Nutritional, functional and sensory properties of bread biscuit produced from wheat-sweet potato composite. *Journal of Food Technology Research.*

Retapol, T. N., & Hooker, H. (2006). Consumer evaluation and preference heterogeneity for a novel functional 41–46

Gernah, D. I., Senger, I. A., & Audu, J. O. (2010). Physico-chemical and sensory evaluation of cookies produced from wheat and brewers spent grain composite flour. *Nigerian Food Journal, 28*, 440–447

Giwa, E. O., & Abiodun, I. V. (2010). Quality characteristics of biscuits produced from composite flours of wheat and quality protein maize. *African Journal Food Science, 1, 116–119.*

Giwa, E. O., & Ikujenlola, A. V. (2010). Quality characteristics of biscuits produced from composite flours of wheat and quality protein maize. *African Journal of Food Science and Technology, 1, 118–119*

Hallen E, Ibanoglu S, Ainsworth P. (2004). Effect of fermented /germinated cowpea flour addition on the rheological and baking properties of wheat flour. Journal of food Eng. Properties. 63;177 -184

Houssou, P., & Ayemor, G. S. (2002). Appropriate processing and food functional property of maize flour. *African Journal of Science and Technology, 3*, 126–131.

Wikipedia, (2006/2017). Sorghum. Wikipedia, the Free Encyclopedia.

Zohary, D., and M. Hoof. 2000. Domestication of Plants in the Old World, 3rd edition. Oxford: University Press. ISBN 0198503571 http://dx.doi.org/10.3923/ajft.2012.372.379