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Quality Characteristics of Cookies Produced from Sweet Potato and Wheat Flour Blend Fortified with Brewer's Spent Grain Flour

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Abstract

Cookies were made from flour blends of 70% wheat and 30% sweet potato fortified with varying levels of brewers spent grain (BSG) flour. The BSG flour ranged between 0 and 9% of the flour weight. Cookies made with flour from 100% wheat served as the control. Studies were carried out on the functional properties of the flour blends, proximate composition, calorific values, physical characteristics and organoleptic quality of the cookies produced. Fortification of the blends with BSG flour reduced the bulk density from 1.24-1.08 g/mL and the water absorption capacity from 1.73-1.37g/g. Emulsion capacity increased from 76.10 – 83.45% and oil absorption from 2.20 – 3.66 g/g. The protein, fiber and ash contents of the cookies increased from 10.10-11.32%, 1.91-3.11% and 3.87-5.31% respectively. Cookies containing 9% BSG flour had the highest fibre content. Organoleptic studies revealed that cookies fortified with 3-6% BSG flour were more preferred than the control.

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Keywords

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Spent grains,
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Introduction

Cookies have been defined as snacks that are produced from unpalatable dough which when baked in an oven is transformed into an appetizing product[1]. Cookies are traditionally produced from wheat flour which possesses gluten that is known for its unique viscoelastic characteristics which is desirable in the bakery industry. Wheat is imported in tropical countries like Nigeria where the climate is unfavourable for the cultivation of this crop. The negative effect of importation of wheat on the economy of Nigeria has led to the search for locally available raw materials as substitutes for wheat flour.

Composite flours have been defined as mixtures of flours with the intent of replacing wheat totally or partially in bakery products[2]. Cookies have been reported to be one of the most consumed confectionery products in the world[3]. Okpala and Okoli[4] reported that because cookies are widely consumed and are in a ready to eat form, composite

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flours may have better applications in cookies than in other baked products. Gonzalez-Galan *et al.,*[5] reported that in order to improve their nutritive value, cookies are prepared with either fortified or composite flours. Fortification of foods has been reported to be carried out with the aim of improving the health status of consumers[6].Brewer's spent grain(BSG) is a by-product of the brewery industry. It has been reported to contain high levels of essential amino acids, minerals, fibre, essential fatty acids and polyphenols[7]. Farcas *et al.,*[8] opined that BSG in human diets had the potential of reducing the risk of diseases like diabetes, cancer, coronary heart diseases etc. The protein content also makes it good for fortification.

Various researchers have reported that cookies with acceptable quality can be produced from flour blends of sweet potato and wheat[9,10]. Nigeria grows sweet potatoes in large quantities but this crop is underutilized. The utilization of sweet potato flour for cookies production will not only increase the utilization of the crop but also reduce the dependence on wheat flour which is imported into the country at a high cost. Sweet potato being a root crop is relatively low in protein and if used in cookies production, may result in cookies of low protein content. The fortification of such cookies with BSG could possibly improve the nutritional quality of cookies being produced and thereby help in reducing the levels of malnutrition observed in many developing countries like Nigeria. The use of spent grains in cookies will also help in minimizing waste from the brewing industry. This work therefore seeks to determine the quality characteristics of cookies produced from wheat-sweet potato flour blend fortified with different levels of BSG.

Materials and Methods

Source of Raw Materials

Sweet potato roots, wheat flour and all other ingredients (sugar, fat, flavouring, baking powder, eggs etc) used for the cookies production were obtained from a local market in Abakaliki, Nigeria. Fresh BSG was obtained from Nigerian Breweries Plc, Enugu, Nigeria.

Sample Preparation

Brewer's Spent Grain (BSG)Flour

The brewer's spent grains were dried at 40 ^{o}C in an oven and milled to pass through a 100µm mesh sieve. The flour was packaged in airtight plastic containers and stored at room temperature until needed.

Sweet potato Flour

Flour from sweet potato was produced using the method described by Srivastava *et al.,*[11]. The sweet potatoes were washed, peeled and sliced. The sliced sweet potatoes were then dried at 60 ^{o}C for 6 hours in an air oven and milled to pass through a 100µm mesh sieve. The flour was packaged in airtight plastic containers and stored at room temperature until needed.

Cookies Preparation

Based on preliminary work carried out by the authors, a blend of 70% wheat and 30% sweet flour was used to produce the cookies. Brewer's spent grain flour at levels of 0, 3, 6 and 9% was used to fortify the sweet potato: wheat flour blend. Cookies were prepared as described by Okpala *et al.,*[12]. 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; 25 g of white granulated sugar; 0.3 g of nutmeg; 1 g of baking powder and 1 g of salt were used. The sugar and fat were creamed with the aid of an electric mixer (Kenwood) for 5 min at medium speed. Thereafter, milk and eggs were added and further mixed for about thirty minutes. Other ingredients were added and thoroughly mixed to form a dough. The dough was kneaded and cut into circular shapes. Baking was done at a temperature of 185 ^{o}C for 15-25 mins. After cooling, the cookies were kept in plastic airtight containers and stored at room temperature until when required for further analysis. Cookies made with flour from 100 % wheatwas used as the control.

Proximate Composition of Samples

The proximate composition (ash, protein, fat, moisture, crude fibre and carbohydrates)of the BSG flour and the cookies produced was determined

using methods described by AOAC[13]. The Atwater method described by Osborne and Voogt[14] was used to calculate the calorific values of the cookies where calorific value = carbohydrates x 4 +fat x 9 + protein x 4 kcal.

Functional Properties of Flour Blends

The water and oil absorption capacities of the flour blends were determined by using the methods described by Nwosu *et al.,*[15]. One gram of the sample flour was weighed into a dry centrifuge tube and the weight of the flour and centrifuge tube were noted. Ten mililitres of water/vegetable oil were added to the sample for determination of water/oil absorption capacity respectively. After proper mixing, the suspension of flour and water/oil was centrifuged at 3500rpm for 15 minutes. The supernatant was discarded and the tube together with its contents were reweighed, the water/oil absorption capacity was calculated as the gain in weight observed. The emulsion capacity and bulk density were determined as described by Onwuka[16].

Physical Analysis of Cookie Samples

Vernier calipers were used to measure the thickness and diameter of the cookies. The spread ratio of the cookies was determined from the formula of diameter/thickness[17]. The procedure described by Okaka and Isieh[18] was used in determining the break strength of the cookies. Cookies of the same average weight from each batch of cookies were used for this. Each cookie was centrally placed on two wooden bars while another wooden bar was positioned on top of the cookie. Known weights were incrementally put on top of the wooden bar until the cookie broke. The least weight responsible for the breaking of the cookie was regarded as the break strength of the cookie.

Organoleptic Evaluation of Cookies

The organoleptic quality of the cookies was determined twenty four hours after the cookies were produced. Twenty semi-trained panelists were recruited from students and staff of the Department of Food Science and Technology, Ebonyi State University, Abakaliki, Nigeria. Students and staff of the Department were chosen due to differences in their backgrounds. The panelists individually evaluated the appearance, taste, crispiness and general acceptability of the cookies using a 9-point hedonic scale where 1 = dislike extremely, 5= neither like nor dislike and 9 = like extremely. The coded samples were presented to the panelists in a randomized sequence.

Statistical Analysis

Generated data were subjected to one way analysis of variance (ANOVA). Means were separated using the Duncan's Multiple Range Test with the aid of the Statistical Package for the Social Sciences (SPSS) version 20 (IBM SPSS Statistics). The level of significance was set at $p<0.05$.

Results and Discussion

Functional Properties of Flour Blends

The functional properties of the flour blends of wheat, sweet potato and BSG are shown in Table 1. The bulk density ranged from 1.08 to 1.24 g/ cm^3. The blend of wheat and sweet potato that contained 0% BSG had the highest bulk density of 1.24 g/cm^3 while the blend with 9% BSG had the lowest value of 1.08 g/ cm^3. No significant difference ($p>0.05$) was found among the blends containing BSG. It was observed that the control (wheat flour) was not significantly different ($p>0.05$) from samples containing 3 and 6% BSG while the wheat: sweet potato blend with 0% BSG was significantly higher ($p<0.05$) than all the other samples. The value of 1.12 g/cm^3 obtained for wheat flour was slightly higher than 0.91 g/cm^3 reported by Okpala and Egwu[19] for wheat flour. The water absorption capacity ranged from 1.37 to 1.73 g/g. Wheat flour (100%) and the blend of wheat and sweet potato containing 0% BSG had the same value of 1.73 g/g and they were significantly higher ($p<0.05$) than all the other samples. The blends containing 6 and 9% BSG had the same value of 1.37 g/g. The addition of BSG seemed to have reduced the water absorption capacity of the flour blends. It has been reported that high water absorption is useful in bakery products as this reduces moisture loss thereby preventing staling of the products[12]. The oil absorption capacity of the flour samples ranged between 2.15 and 3.66 g/g. Wheat flour had the lowest value of 2.15 g/g while the blend containing 9% BSG had the highest value of 3.66 g/g. Contrary to what was observed with the water absorption capacity, it appeared that the addition of spent grains to the blends increased the oil absorption capacity. This tends to suggest that the constituents of BSG flour

may be lipophilic in nature. The emulsion capacity of the blends ranged from 53.88 to 83.45%. The wheat flour had the lowest value while the blend containing 3% BSG had the highest value. The blend of sweet potato: wheat flour with 0% BSG had an emulsion capacity of 76.10%. All the blends containing BSG had emulsion capacities of more than 80%. It has been reported that when a flour has a high emulsion capacity, it suggests that the sample could be an excellent emulsifier[12]. It has also been reported that in order to improve dough handling and overall product quality, emulsifiers are often used[20]. This suggests that dough containing BSG flour is likely to have good dough handling and product quality.

Table 1: Functional properties of flour samples

WF:SPF: BSGF	Bulk density (g/mL)	Emulsion capacity	Water absorption capacity (g/g)	Oil absorption capacity (g/g)
70:30:0	1.24^{a}±0.01	76.10^{d}±0.06	1.73^{a}±0.12	2.20^{b}±0.06
70:30:3	1.10^{bc}±0.01	83.45^{a}±0.49	1.53^{b}±0.06	2.21^{b}±0.05
70:30:6	1.10^{bc}±0.01	82.27^{b}±0.19	1.37^{c}±0.06	2.34^{b}±0.06
70:30:9	1.08^{c}±0.01	81.34^{c}±.0.09	1.37^{c}±0.06	3.66^{a}±0.11
100:0:0 (control)	1.12^{b}±0.02	53.88^{e}±0.06	1.73^{a}±0.12	2.15^{b}±0.06

Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different from each other (p>0.05)
Key: WF= wheat flour; SPF= sweet potato flour; BSGF=Brewer's spent grain flour

Proximate Composition of BSG Flour and Cookies

The proximate composition of the BSG flour and cookies produced areshown in Table 2. The results revealed that the BSG flour had 18% protein and 14.83% ash. This confirms reports that spent grains are good sources of protein and ash[21]. It was observed that the fortification of the wheat: sweet potato flour blend with BSG flour resulted in cookies with increased ash, fibre and protein contents. This should be as a result of the high level of these nutrients in the BSG flour. The control had lower values of nutrients (with the exception of fat which was higher in the control). Considering the importance of these nutrients to human health, the addition of BSG to the cookies is likely to have immense benefits to the consumers. The control (cookies made with 100% wheat flour) had the highest calorific value (442.75 kcal/ 100 g). Cookies fortified with BSG flour had calorific values that were significantly lower (p<0.05) than cookies without BSG flour.

Table 2: Proximate composition of Brewer's spent grain flour and cookie samples

Samples	Moisture	Ash	Fat	Protein	Fibre	Carbohydrates	Calories (kcal)
Brewer's spent grain flour	12.23^{a}±0.21	14.83^{a}±0.21	3.22^{e}±0.20	18.00^{a}±0.10	11.97^{a}±0.05	39.78^{f}±0.08	259.98^{e}±1.56
WF:SPF:BSGF Cookies							
70:30:0	8.64^{b}±0.02	3.87^{d}±0.04	18.09^{c}±0.10	10.10^{e}±0.09	1.91^{e}±0.03	57.75^{b}±0.05	433.47^{b}±0.57
70:30:3	8.66^{b}±0.07	4.41^{c}±0.02	16.03^{d}±0.11	10.74^{d}±0.10	2.18^{d}±0.03	57.99^{a}±0.05	419.15^{d}±0.56
70:30:6	8.67^{b}±0.04	4.67^{b}±0.04	19.07^{b}±0.11	11.09^{c}±0.10	2.63^{c}±0.04	53.92^{d}±0.19	431.63^{c}±0.93
70:30:9	8.73^{b}±0.05	5.31^{b}±0.03	20.05^{a}±0.08	11.32^{b}±0.10	3.11^{b}±0.13	51.47^{e}±0.11	431.62^{c}±0.53
100:0:0 (control)	8.64^{b}±0.02	3.87^{d}±0.04	20.06^{a}±0.09	10.10^{e}±0.09	1.87^{f}±0.01	55.46^{c}±0.11	442.75^{a}±0.53

Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different from each other (p>0.05)
Key: WF= wheat flour; SPF= sweet potato flour; BSGF= Brewer's spent grain flour

Physical Properties and Organoleptic Quality of Cookies Produced

Table 3 shows the physical properties of the cookies produced. The controlhad a spread ratio that was not significantly different control had ($p>0.05$) from the cookies fortified with BSG flour. It appeared that the break strength of the cookies increased with increasing levels of BSG flour. However, there was no significant difference ($p>0.05$) in the break strength of the cookies. The organoleptic evaluation ratings (Table 4) revealed that cookies made from wheat: sweet potato flour with 0% BSG flour were preferred more than the control. It was also observed that for most of the parameters studied, cookies containing 3 and 6% BSG were better than those made from 100% wheat flour. The addition of BSG generally reduced the scores for almost all the attributes with cookies containing 9% BSG receiving least ratings. All the cookies made from wheat: sweet potato flour containing 0 – 6% BSG received high scores (>7) for all the sensory attributes studied (with the exception of crispiness).

Table 3: Physical properties of cookies produced

WF:SPF: BSGF	Diameter (cm)	Thickness (cm)	Weight (cm)	Spread ratio	Break strength (g)
70:30:0	5.43^{a}±0.25	1.07^{a}±0.06	25.02^{a}±0.05	5.10^{b}±0.16	2040^{a}±158.21
70:30:3	5.13^{a}±0.12	0.87^{c}±0.06	18.31^{c}±0.44	5.90^{a}±0.54	2058^{a}±56.47
70:30:6	5.13^{a}±0.12	0.90^{c}±0.10	16.26^{d}±0.08	5.70^{ab}±0.54	2079^{a}±167.11
70:30:9	5.17^{a}±0.15	1.03^{ab}±0.06	22.28^{b}±0.24	5.01^{b}±0.41	2164^{a}±130.00
100:0:0 (control)	5.13^{a}±0.23	0.93^{bc}±0.06	15.62^{e}±0.52	5.52^{ab}±0.50	1827^{a}±221.89

Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different from each other ($p>0.05$)
Key: WF= wheat flour; SPF= sweet potato flour; BSGF= Brewer's spent grain flour

Table 4: Sensory quality of cookies produced

WF:SPF: BSGF	Appearance	Taste	Texture	Crispiness	General acceptability
70:30:0	7.30^{b}±0.00	7.72^{a}±0.20	7.38^{a}±0.10	7.10^{a}±0.17	7.80^{a}±0.10
70:30:3	7.57^{a}±0.03	7.38^{b}±0.33	7.15^{b}±0.15	6.28^{c}±0.03	7.43^{b}±0.06
70:30:6	7.03^{c}±0.06	7.20^{b}±0.17	7.07^{c}±0.06	6.70^{b}±0.17	7.40^{b}±0.00
70:30:9	6.85^{d}±0.05	6.20^{c}±0.09	6.38^{d}±0.10	6.10^{c}±0.17	6.57^{c}±0.06
100:0:0 (control)	6.43^{e}±0.03	7.28^{b}±0.03	6.78^{c}±0.03	7.15^{a}±0.15	7.43^{b}±0.06

Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different from each other ($p>0.05$)
Key: WF= wheat flour; SPF= sweet potato flour; BSGF=Brewer's spent grain flour

Conclusion

This study has shown that fortification of sweet potato: wheat cookies with BSG flour hold a lot of promise. The fortified cookies had high holds nutritional and organoleptic quality. Cookies fortified with 3-6% BSG flour were better than cookies made from 100% wheat flour with respect to the protein, ash and fibre contents as well as most of the sensory parameters studied. Fortification of the cookies with BSG flour will not only help to reduce malnutrition but also minimize wastes from the brewing industry.

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Conflict of Interest
There was no conflict of interests.

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References

1. Olaoye, O. A., Onilude, A. A. & Oladoye, C. O. Breadfruit flour in biscuit making. *African Journal of Food Science,**2***:20–23: (2007)
2. Milligan, E. D., Amlie, J. H., Reyes, J., Garcia, A. & Meyer, B. Processing for production of edible soy flour. *Journal of American Oil Chemistry Society, **58***: 331: (1981)
3. Krystyjan M. & Korus A. The fortification of biscuits with bee pollen and its effect on physicochemical and antioxidant properties in biscuits. *LWT- Food Science and Technology, **63***(1): 640-646: (2015)
4. Okpala, L. C. & Okoli, E. C. Nutritional evaluation of cookies produced from pigeon pea, cocoyam and sorghum flour blends. *African Journal Biotechnology, **10***(3): 433-438: 2011
5. Gonzalez-Galan, A., Wang, S. H., Sgarberi, V. C. & Moraes, M. A. C. Sensory and nutritional properties of cookies based on wheat-rice soybean flours baked in a microwave oven. *Journal of Food Science,**56***(6): 1699-1701: (1991)
6. Waters, D. M., Jacob, F., Titze, J., Arendt, K. E. & Zannini, E. Fiber, protein and mineral fortification of wheat bread through milled and fermented brewer's spent grain enrichment. *European Food Research and Technology,**235***: 767-778: (2012)
7. de Camargo, A. C., Vidal, C. M., Canniatti-Brazaca, S. G. & Shahidi, F. Fortification of cookies with peanut skins: effects on the composition, polyphenols, antioxidant properties, and sensory quality. *Journal of Agricultural and Food Chemistry, **62***(46): 11228-11235:(2014)
8. Farcas, A., Tofana, M., Socaci, S., Mudura, E., Scrob, S., Salanta, L. & Muresan, V. Brewer's spent grain- A new potential ingredient for functional foods. *Journal of Agroalimentary Processes and Technology,**20***(2): 137-141: (2014)
9. Singh, S., Riar, C.S & Saxena, D. C. Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. *African Journal of Food Science,**2***: 65-72:(2008)
10. Saeed, S., Muammad, M, A., Humaira, K., Saima, P., Sharoon, M. & Abdus, S. Effect of sweet potato flour on quality of cookies. *Journal of Agricultural Resources,**50***(4): 525-538:(2012)
11. Srivastava, S., Genitha, T. R. & Yadav, V. Preparation and quality evaluation of flour and biscuit from sweet potato. *Journal of Food Processing and Technology,**3***: 192 DOI: 10.4172/2157-7110.1000192: (2012)
12. Okpala, L.C., Okoli, E. C. & Udensi, E. A. Physicochemical and sensory properties of cookies made from blends of germinated pigeon pea, fermented sorghum and cocoyam flours. *Food Science and Nutrition,**1***(1): 8–14: (2013)
13. AOAC. Official Methods of Analysis, 17th ed. Association of Official Analytical Chemists, Washington D. C. 70–83: (2000)
14. Osborne, D. R. & Voogt, P. The analysis of nutrients in foods. Academic Press, London. Pp. 166–182:(1978)
15. Nwosu, J.N., Onuegbu, N. C., Kabuo, N. O. & Okeke, M. O. The effect of steeping with chemicals (alum and trona) on the proximate and functional properties of pigeon pea (Cajanus cajan) flour. *Pakistan Journal of Nutrition, **9***(8),762-768: (2010)
16. Onwuka, G. I. Food Analysis and Instrumentation, Theory and Practice. Naphtali Prints, Surulere, Lagos 63–75: (2005)
17. McWatters, K.H., Ouedraogo, J. B.,

Resurreccion, A.V.A., Hung, Y & Phillips, R. D. Physical and sensory characteristics of sugar cookies containing mixtures of wheat, fonio (*Digitaria exilis*) and cowpea (*Vigna unguiculata*) flours. *International Journal ofFood Science and Technology,* ***38***: 403–410: (2003)

18. Okaka, J. C., & Isieh, M. I. Development and quality evaluation of cowpea-biscuits. *Nigerian Food Journal,* ***8***:56–62:(1990)
19. Okpala, L. C. & Egwu, P. N. Utilisation of broken rice and cocoyam flour blends in the production of biscuits. *Nigerian Food Journal,* ***33***: 8–11:(2015)
20. Hoque, M. Z., Hossain, K. M. & Akter, F. The effect of lecithin – a non-absorbing emulsifying agent on cookie production. *Pakistan Journal of Nutrition,* ***8***:1074–1077: (2009)
21. Ajanaku, K. O., Dawodu, F.A., Ajanaku, C. O. & Nwinyi, O. C. Functional and nutritional properties of spent grain enhanced cookies. *American Journal of Food Technology,* ***6***(9): 763-771: (2011)