Physicochemical and Sensory Properties of Durum Wheat Cookies Blended With Sweet Potato and Fermented Soybean Flour

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Abstract

The purpose of this paper is determining the effects of sweet potato and fermented soybean flour blends on nutritional quality and sensory attributes of durum wheat composite cookies. Fermented soybean flour 5, 10, 15, 20% and sweet potato 2.5%, 5%, 7.5% and 10% flours was blended with partial substitution of durum wheat for cookies production. Proximate and minerals of the samples were carried out using by AACC and AOAC. Sensory evaluation was carried out by a panel of 50 consumers. Data were tested at $P \leq 0.05$ and differences between means were compared using least significance (LSD). The results were expressed as mean ± SE. The quality of cookies produced from durum wheat flour substituted with 5, 10, 15 and 20 percent of fermented soybean and 2.5, 5, 7.5 and 10 percent of sweet potato flour was determined. The cookies made from the composite flours of wheat and sweet potatoes supplemented with fermented soybean flour resulted in significant increase in protein, fat, and energy contents whereas crude fiber and carbohydrate contents were decreased significantly. Iron, zinc and calcium contents were significantly increased ($p \leq 0.05$) with increasing sweet potato and fermented soybean flours in the formulations. The supplementation of durum wheat- sweet potato composite flour with up to 20% soya gave cookies of acceptable sensory quality. This study raveled that the durum wheat flour used in making cookies could be supplemented up to 10 percent sweet potato and 20 percent soybean flours without compromising its nutritional quality, with only a few reductions in sensory quality.

Keywords: durum wheat flour, fermented soybean, sweet potato, composite flour, nutritional composition

1. Introduction

Snack food consumption has been on the increase all over the world as a result of urbanization and increase in the number of working women. Food based industry can exploit this development by fabricating nutritious snack foods. Cookies have become one of the most desirable snacks for both youth and elderly people due to their low manufacturing cost, more convenience, long shelf-life and ability to serve as a vehicle for important nutrients (Honda and Jood, 2005). It represents the largest category of snack item among baked food products throughout the world (Pratima and Yadava, 2000). Cookies are not considered as staple food as bread, but are feasible fiber carriers because of their long shelf life, provide energy and thus enable large scale production and widespread distribution.

Cookies are small, flat dessert treats, commonly formed into a circular shape. They constitute an important component of the diet (Mishra et al., 2012). Most of bakery products are used as a means for incorporating different nutritionally rich ingredients for their diversification (Sudha et al., 2007). Such enrichment may be attained through the incorporation of protein rich non-wheat flours (Sharma and Chauhan, 2002).

Legumes or pulses (including soybeans) are rich and low-cost sources of ietary proteins and nutrients for a large part of the world’s population (Egounlety and Aworh, 2003). These grain legumes contribute significantly towards protein, mineral and B-complex vitamin needs of people in developing countries (Dhingra and Jood, 2002) and play an important role in the traditional diets of many regions throughout the world. Soybeans is an excellent source of protein (about 35-40%), hence the seed is the richest in food value of all plant foods consumed in the world. It is a very rich source of vegetable protein for all including growing children (Dandago and Igwe, 2006); and it has been identified as a suitable protein rich crop that could improve the nutritional and economic status of the general population in developing countries (Babajide et al., 2003).

Sweet potato (Ipomoea batatas L.) flours can serve as a source of energy and carbohydrates, beta carotene (pro-vitamin A), minerals (Ca, P, Fe and K) and dietary fiber which can add natural sweetness, colors and flavor to processed food products. Addition of various proportion of sweet potato flour in wheat flour can increase the nutritive values in terms of fiber and carotenoids. This also helps lower the gluten level and prevents celiac disease (Tilman et al., 2003).

In Ethiopia the consumption of sweet potato is limited to boiling or open fire roasting. The potential of long existing and newly improved sweet potato varieties for different modes of use must be studied. The addition of soybean flour into the composite flour of durum wheat and sweet potato could enhance the protein content of the cookies to be produced.

Therefore, research toward durum wheat cookie product development that comprises sweet potato and fermented soya as component will address the nutrition deficiency challenges in durum wheat cookies and postharvest loss minimization of sweet potato tubers .In addition, the use of sweet potato flour with other cereals like durum wheat for different food product development will be an opportunity to enhance the use underutilized root crops with value addition. Hence this research is initiated with the objective of determining the effects of sweet potato and fermented soybean flour blends on physicochemical properties and sensory attributes of durum wheat cookies.

2. Materials and Methods

Experimental Materials

Ten kilograms of Berkume sweet potato (Ipomoea batatas L.) (TIS 8250-2) variety was collected from Haramaya University Research center, Durum wheat (Triticum turgidumvar. durum) "Mangudo" variety was collected from Debrezeit agricultural research center and soybean (Glycine max), "Afgat" variety was collected from Awassa agricultural research center and other ingredient such as corn starch, sugar, baking powder, egg, salt were purchased from the local super market.

Experimental design

The experiment were carried out by completely randomized design (CRD) with a single factor of five blending ratio with three replications were used. The control was 100% durum wheat flour.

Table 1. Formulation of durum wheat, sweet potato and fermented soybean composite flour

Blending ratio	Fermented soybean flour (%)	Sweet potato flour (%)	Durum wheat four (%)
B0	0	0	100
B1	5	2.5	92.5
B2	10	5	85
B3	15	7.5	77.5
B4	20	10	70

Sample Preparation

The cleaned durum wheat grains were milled in to fine flour using laboratory grinder of Haramaya University. Fresh sweet potato tubers were washed, peeled, sliced, bleached, dried and ground to fine powder by using coffee miller (model 101-1A, China).

The soybean seeds were sorted in order to remove dirty material such as stone and stack and the cleaned seeds were soaked for 3hrs in distilled water. The soaked soya seeds were dehulled manually in order to remove the hull and then washed and rinsed well with clean cold distilled water, the dehulled seed soaked in clean water for 72hrs to allow for natural fermentation, washed and rinsed with clean distilled water, oven dried, milled by coffee miller (model 101-1A, China). Following milling, the flour was sifted through a 710µm mesh sieve (British Standard). The flour (FSF) was packaged in a polyethylene bag until used for analysis.

Cookie Preparation Procedures

Cookies were prepared according to the method AACC (2000) with some modification in the recipe. Flour (100 g) from each sample of different flour blends, corn starch 10g, sugar 2g, baking powder 1 g, one egg (60 g), salt 1 g and the 75ml of water were added. The dry ingredients (composite flour, sugar, salt and baking powder) were mixed until uniform mixtures of the ingredients were obtained. Egg was then added and the mixtures were kneaded. The batter were rolled and cut with cookie cutter. The cookies were placed in baking trays, leaving 25 mm space in between and were baked at 180^{O}C for 10 minutes in the baking oven. Following baking, the cookies were cooled and packed in polyethylene bags and stored in cool and dry area.

Proximate composition

The proximate composition analyses were carried out by AACC (2000) and (AOAC, 2000). Utilizable carbohydrate was determined by differences between 100 and total sum of the percentage of proximate content. The energy was calculated using Atwater factors and results were reported on dry matter basis.

Mineral Analysis - Iron, calcium and zinc were determined by dry-ashing method using atomic absorption spectrophotometer (AOAC 2000, Model 200, and Germany). The absorbance for iron, zinc and calcium were estimated from a series of 1-5 mg/kg, 0.5-2.5 mg/kg, and 2-10 mg/kg standard calibration curve prepared from analytical grade iron wire, ZnO and $CaCO_3$ respectively.

Anti-nutritional factors:-Condensed tannins was analyzed by vanillin-HCl method of Price et al., (1978) using the modified Vanillin-HCl methanol method. The Vanillin-HCl reagent was prepared by mixing equal volume of 8% concentrated HCl in methanol and 1% Vanillin in methanol. The solution of the reagent was mixed just prior to use. 0.2 g of the flour and cookies ground samples was placed in small conical flask. Then 10 mL of 1% concentrated HCl in methanol was added. The conical flask was capped and continuously shaken for 20 minutes and the content then centrifuged at 2500 rpm for 5 minutes. About 1.0 ml of the supernatant was pipette into a test tube containing 5 ml of Vanillin-HCl reagent. Absorbance at 450 nm will be read on spectrophotometer after 20 minutes incubation at 30^{o}C. A blank sample was carried out with each run of sample and its absorbance was subtracted from sample absorbance. A standard curve also prepared from catechin (1mg/ml). Tannins content was expressed as catechin equivalent as follows:

$$\text{Tannin (\%)} = \frac{\text{C} \times 10 \times 100}{200}$$

Where:

C= Concentration corresponding to the optical density.

10= Volume of the extract (ml).

200=Sample weight (mg)

The phytic acid content of samples was determined by the method described by Wheeler and Ferrel (1971). Raw flour sample and cookies sample (0.250 g) were weighed in 125 ml conical flask. The sample was extracted with 50 ml of 3% tri chlorlacetic acid (TCA) for 3 hours with mechanical shaking. The suspension was centrifuged at 3000 rpm for 5 minutes and 10 ml aliquot of the supernatant was transferred to 40 ml boiling tube and 4 ml of $FeCl_3$ solution (made to contain 2 mg ferric ion per ml in 3% TCA) was added to the aliquot. The tube was heated in a boiling water bath for 40 minutes. Two drops of 3% sodium sulphate in 3% TCA was added. The tube was cooled and centrifuged for 10- 15 minutes. The clear supernatant was decanted.

The precipitate was washed twice by dispersing well in 20 ml distilled water and 3 % TCA, was heated for 10 minutes in a boiling water bath, and then it was centrifuged again. Washing was repeated once more with distilled water, the washed precipitate was dispersed in a few ml of distilled water and 20 ml of 0.2 N HCl was added and the volume was completed to approximately 30 ml with distilled water. Then the tube was heated in a boiling water bath for 25 minutes and was hot filtered. The precipitate was washed with 60 ml hot water, the washing was decanted volume. Concentrated sulphuric acid (98 %) (1 mL) was added into the sample and heated gently at 350 ^{O}C until digestion was completed. Two drops of H_2O_2 (2 %) were added to hit test tube wall just above acid level and the mixture was mixed well.

When the solution became clear, the sample tube was boiled for about 1 minute in water bath and allowed to cool. Distilled water (5 mL) was added down washing the tube inner wall into a mixture. To the sample sodium sulfite.7H_2O (33%) (0.4 mL) solution was added to the digested sample to acidify. Then, 3 mL $(NH_4)_6Mo_7O_{24}.4H_2O$ (2%) was added directly into the sample. L-ascorbic acid (2 mL, 2%) was added and heated (at 100^0C) in boiling water bath (for 10 minutes). The blue colour was developed after cooling to ambient temperature was adjusted to volume of 20 mL and absorbance was measured at 822 nm with UV-VIS spectrophotometer. Standard solution 0.2-1.2 µg P/mL was prepared from analytical grade K_2HPO_4. The blank sample was run and subtracted from sample P was estimated from the calibration curve. The amount of phytic acid was estimated by multiplying phytate-phosphorous with 3.55 based on empirical formula $C_6P_6O_{24}H_{18}$.

$$\text{Phytic acid (\%)} = \frac{(\text{Abasorbance} - \text{Intercept})3}{\text{slope } \times \text{density } 10 \times \text{Weight of sample}}$$

Evaluation of Functional Properties of Flours

Water absorption capacity (%) was determined according to the method used by Abdlwahab et al. (2009). Bulk density (g/cm^3) was determined by the method of Narayana and Narasinga-Rao (1984).

Dispensability

Ten gram of flour samples was weighed into 100 ml measuring cylinder and distilled water was added to reach a volume of 100 ml the set up is stirred vigorously and allowed to settle for 3hrs. The volume of settled particles was recorded and subtracted from 100. The difference was reported as % dispersibility (Kulkarni, 1997).

Wettability

One gram of the flour sample was dropped from a height 15 mm onto the surface of 200 cm of distilled water contained in 250 cm^3 volume of measuring cylinder at room temperature. The wetting time was regarded as the time required for all the flour to become wetted and penetrate the surface of the still water (Amstrong et al., 1979)

Sensory Evaluation

Sensory evaluation of cookies samples were conducted by a 50 member panelists. The cookies were served in random order, identified by codes. Panelists were advised to avoid strong odorous materials and to avoid eating, drinking or smoking at least 30 minutes prior to a sensory test. Consumers were asked to fill questionnaire prepared for the evaluated sensory attributes of the cookie samples, i.e., color, taste, crispness and overall acceptability using a 7- point hedonic scale (1 dislike extremely, 5 = neither like nor dislike, 7 = like extremely). A glass of drinking water was provided for rinsing the mouth between testing different samples.

Statistical Analysis

Nutritional composition, Anti-nutritional factors, functional properties and sensory evaluation were statistically analyzed using analysis of Variance (ANOVA). The statistical package used was SAS 9.1 software for windows (SAS ver, 2008). Statistical package samples were tested at $P \leq 0.05$ and differences between means were compared using least significance (LSD).The results were expressed as mean ± standard error.

1. Results and Discussion

The proximate composition of sweet potato, durum wheat and fermented soybean flours are presented in Table 2.

The moisture contents of raw flours ranged from 3.9 – 8.00 percent with significantly ($P \leq 0.05$) different from each other. The data revealed that moisture content of durum wheat flour 8.00% higher than the others. The relatively higher moisture content of the wheat flour means that it will be more prone to deterioration and mould growth than that of the cassava and sweet potato (Fennema and Tannenbaum, 1996)

Table 2. Proximate composition (%, db) and the energy values (kcal/100 g, db) of wheat, sweet potato and soybean flours

Variety	Moisture	Ash	Protein	Crude	Crude	CHO	Energy
BSP	5.60±0.00[b]	5.47±0.10[a]	6.35±0.20[c]	2.63±0.04[c]	4.51±0.04[a]	75.44 ±0.30[a]	350.81±0.74[c]
DW	8.00±0.12[a]	2.72±0.10[c]	11.10±0.16[b]	3.76±0.03[b]	1.42±0.10[c]	73.02 ±0.27[b]	370.22±0.20[b]
FS	3.90±0.06[c]	3.47±0.00[b]	35.30±0.22[a]	26.78±0.22[a]	2.83±0.06[b]	27.74 ±0.11[c]	493.12±0.60[a]
CV	2.21	3.7	1.84	2.00	3.35	0.68	0.24
LSD	0.26	0.28	0.65	0.44	0.20	0.80	1.92

Values are means ± standard error of three replicates. Values followed by same letters with in a column are not significantly different ($P>0.05$): Note: CV= Coefficient of Variance, LSD=Least Significant Difference, BSP=Barkume sweet potato flour; FS=Fermented soybean flour; DW=Durum wheat flour

The ash contents of improved sweet potato, durum wheat and fermented soybean flour had significantly ($P \leq 0.05$) different. These values found to be 2.72% for durum wheat flour, 3.47% for fermented soybean and 5.47% for Berkume sweet potato flour.

The level of crude protein in fermented soybean flour was (35.30%); higher than that of wheat (11.10%) and sweet potato (6.35%) with no significant difference among these values. The result obtained was in close agreement with those of earlier reports of protein (40%) by Abioye et al., (2011).

Crude fat contents of wheat, fermented soya and improved sweet potato variety were found to be significantly ($P \leq 0.05$) different from each other. Fermented soya had crude fat content of (26.78%) whereas the crude content of durum wheat had (3.76%) and Berkume sweet potato (2.63%).

The crude fiber contents of durum wheat, fermented soybean and improved variety were found significantly ($P \leq 0.05$) different from each other .The values of crude fiber were found to be 4.52% for Berkume sweet potato, 2.83% for fermented soybean and 1.42% for durum wheat flour. Dietary fiber has recently gained much importance as it is said to reduce colon cancer, diabetes, heart disease and level of low density lipoprotein cholesterol in blood (Felicity and Maurica, 1992).

The carbohydrate content of durum wheat, fermented soybean and Berkume sweet potato flour were 73.02, 27.74 and 75.44%, respectively and had significant ($P \leq 0.05$) differences from each other. This implies that fermented soybean flour contains lower carbohydrates than durum wheat and Berkume sweet potato flours.

The energy contents of wheat, fermented soybean and Berkume sweet potato flours were 370.22, 493.12 and 350.81 Kcal/100g, respectively, with significant ($P \leq 0.05$) differences among wheat, fermented soybean and the sweet potatoes. The energy content difference could be due to variation in their protein, fat and carbohydrate contents (Giami et al., 2000) as presented in Table 2.

Mineral content

The mineral contents of the flours of sweet potato, Durum wheat and fermented soybean are presented in Table 3. The zinc contents of fermented soybean were significantly (P≤0.05) different from both durum and sweet potato flour with values of 1.54 mg/100g in wheat, 1.77 in fermented soybean and 1.63

in Berkume sweet potato. The iron contents also showed significance differences among the two materials with values of 4.83 in wheat and 7.1 in fermented soybean in mg/100g flour but with no significant (P≥0.05) difference between Berkume sweet potato and fermented soybean flour. Fermented soybean flour had a calcium content of 42.12 mg/100g while wheat had 18.93 and Berkume sweet potato 33.65 all being significantly (P≤0.05) different from each other.

Table 3. Mineral composition (mg/100g) of wheat, sweet potato and soybean flours

Sample code	**Zn**	**Fe**	**Ca**
BSPF	1.62 ± 0.05^{b}	8.30 ± 0.20^{a}	33.65 ± 0.97^{b}
DWF	1.54 ± 0.05^{b}	4.83 ± 0.47^{b}	18.93 ± 0.83^{c}
FSF	1.77 ± 0.02^{a}	7.81 ± 0.23^{a}	42.12 ± 0.57^{a}
CV	4.28	8.07	4.45
LSD	0.14	1.12	2.80

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different (P>0.05): Note: CV= Coefficient of Variance, LSD=Least Significant Difference, BSP=Barkume sweet potato flour; FS=Fermented soybean flour; DW=Durum wheat flour.

Anti-nutritional factor values

The anti-nutritional factors of sweet potato, durum wheat and fermented soybean flours are presented in Table 4. The phytate content of sweet potato flours were higher (2.83 mg/100g) than durum wheat (2.31 mg/100g) and fermented soybean (1.50 mg/100g) flours with significantly ($P \leq 0.05$) different from each other. Processing methods such as soaking, germination and fermentation have been confirmed to reduce the phytate level of legumes (Sandberg, 2002; Egounlety & Aworh, 2003). The tannin contents were higher in fermented soybean flours(18.14 mg/100g) as related to durum wheat (15.59 mg/100g) and sweet potato flours (9.68 mg/100g) and sweet potato flours were significantly ($P \leq 0.05$) different from both while no significant ($P \geq 0.05$) difference was noted between durum wheat and fermented soybean fours.

Table 4. Anti-nutritional factor composition (mg/100g) of wheat, sweet potato and soybean flours

Sample Code	Phytic acid	Tannin
BSP	2.83 ± 0.10^{a}	9.68 ± 0.80^{b}
DW	2.31 ± 0.04^{b}	15.59 ± 0.84^{a}
FS	1.50 ± 0.05^{c}	18.14 ± 0.67^{a}
CV	4.03	9.14
LSD	0.20	2.64

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different ($P > 0.05$): Note: CV= Coefficient of Variance, LSD=Least Significant Difference, BSP=Barkume sweet potato flour; FS=Fermented soybean flour; DW=Durum wheat flour.

Functional properties of wheat, fermented soybean and sweet potato flours

The functional properties of the raw flours are presented in Table 5. The water absorption capacity of raw flours values ranged from 2.75-5.33 ml/g with significant ($P<0.05$) difference among the values of all the raw flour. The water absorption capacity of all flour was significantly different from each others. The lower water absorption capacity of the wheat flour could be attributed to the presence of lower amount of hydrophilic constituents in wheat (Akubor and Badifu, 2001).

The results showed that the bulk density of raw flour samples ranged from 3.10-7.00 g/ml with significant $P<0.05$ difference among all values raw flour. The particle size and the density of the flour generally affect the bulk density and it is very important in determining the packaging requirement, raw material handling and application in wet processing in food industry (Ajanaku et al., 2012).

The dispersibility of the flours values ranged from 23.2 - 65.33% with significant differences among all the flours value. Finally, the wettability of the flour ranged from 138.5 seconds of fermented soya to 203.50 seconds of Berkume sweet potato flour with significant ($P<0.05$) differences among the values of all the flour materials. The wettability results implied that, sweet potato flour required much longer time than the other flour samples before it became completely wet.

Table 5. Functional properties of flours

S.Code	WAC (ml/g)	DS (%)	BD (g/ml)	W (secs)
BSP	5.33±0.00[a]	23.20±0.85[c]	5.20±0.03[b]	203.50±1.00[a]
DW	2.75±0.03[c]	65.33±0.90[a]	7.00±0.02[a]	173.00±1.73[c]
FS	3.31±0.02[b]	58.20±0.93[b]	3.10±0.04[c]	138.50±1.00[b]
CV	0.89	3.15	1.08	1.26
LSD	0.06	3.07	0.11	4.33

CV = coefficient of variation; values are mean ± standard error of three replicates. Means followed by the same letter in the column are not significantly different at 5% level of significance; LSD = least significance difference; DW = Durum wheat flour; BSP = Berkume sweet potato flour; WAC = water absorption capacity; DS = Dispersibility; BD = bulk density; W = Wettability.

Effects of fermented soybean and sweet potato flours on proximate composition of cookies

The proximate composition of composite cookies produced from sweet potato, durum wheat and fermented soybean flours are presented in Table 6. Many of the moisture contents of the cookies exhibited significant ($P<0.05$) differences among them, the highest (4.00%) belonging to samples with 15% soya addition. Samples with 0, 10 and 20% soya supplementation each had 3.70% moisture content, whereas the least (3.30%) was of sample having 5% soya (table 6). The values do not seem to be associated with supplementation ratio. These values are in close agreement with those 11 to 15% reported by (Shahzadi et al., 2005).

The ash content of cookies ranged from 4.04 (0% soybean supplementation) to 5.30 percent in 20% soya supplementation. Significantly ($P\leq0.05$) higher ash content in cookie samples (20% soya blend), in comparison with the ash content of the control sample with no soya. The ash content increased with the increase in the proportion of soybean flour cookies which is in agreements with (Olaoye et al., 2006) titled by Quality characteristics of bread produced from composite flours of wheat, plantain and soybean.

The highest crude protein content (15.44 percent) in the 20% soybean supplementation and the lowest protein contents (10.10 percent) in the control cookies sample. The protein contents of all cookies supplemented with soya were found to be significantly higher than the one without. The results of this study are in close agreement with the earlier studies by Oluwamukomi et al. (2005) who were able to increase the protein content of "gari" from less than 3.0% to as high as 15.9% by supplementing with legume protein sources.

Table 6. Proximate composition (%, db) and the energy values (kcal/100 g, db) of cookies produced from composite flour wheat, fermented soybean and Berkume sweet potato

Cookies	Moisture	Ash	Protein	Fat	Fiber	Carbohydrate	Energy
0%	3.70±0.06[b]	4.04±0.05[e]	10.10±0.04[c]	6.44±0.02[d]	2.01±0.00[b]	73.76±0.20[a]	393.21±0.31d[c]
5%	3.30±0.06[c]	4.64±0.11[d]	11.32±0.20[b]	6.70±0.10[d]	2.45±0.02[a]	71.60±0.13[b]	391.93±0.73[d]
10%	3.70±0.06[b]	4.92±0.02[c]	11.60±0.20[b]	8.13±0.20[c]	2.41±0.11[a]	69.24±0.30[c]	396.54±1.10[c]
15%	4.00±0.00[a]	5.01±0.00[b]	14.90±0.05[a]	9.30±0.31[b]	2.00±0.10[b]	64.80±0.15[d]	402.21±2.34[b]
20%	3.70±0.06[b]	5.30±0.03[a]	15.40±0.50[a]	10.50±0.20[a]	1.70±0.10[b]	63.50±0.30[e]	409.80±0.60[a]
CV	2.43	1.98	3.33	3.80	9.00	0.51	0.54
LSD	0.20	0.17	0.80	0.60	0.34	0.64	3.90

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different (P>0.05): Note: CV= Coefficient of Variance, LSD=Least Significant Difference.

The crude fat content (6.44-10.50 percent) of composite cookies sample increased significantly with increase in soybean with exception of 5% soya blend the increase of which was not significantly higher than that of the control. As the fat content of the soya flour was 26.78% (Table 2) this is not surprising to see those increments due to the blending

Regarding crude fiber content those cookies samples with 5 and 10% soya blend exhibited significantly higher values 2.45 and 2.4% respectively. The rest of the cookies including the control sample did not show differences in fiber content among themselves but all were of lower values than those of the sample with 5 and 10% soya supplementation.

Total carbohydrate content of the cookies samples ranging from 63.50% (20% soybean supplementation) to 73.76% of control cookies samples. Significant differences ($p<0.05$) were detect with decreased with increase in the soya flour component dropping. This trend supports the claim of Akpapunam and co-workers (1997) titled by "Production and quality characteristics of Nigerian Agidi supplemented with soy flour".

The energy contents (393.21-409.80 Kcal/100g) of composite cookies of durum wheat, sweet potato and fermented soybean varied among the cookies samples. An increase in the level of soybean supplementation resulted increasing of energy level.

Mineral compositions of cookies

Mineral contents of cookie samples are presented in Table 7. Results showed that the Zn content which ranged (1.55-1.91 mg/100g) which was agreed to Zn value (1.61-1.84 mg/100g) of wheat based bread supplemented with cassava and soybean flour (Ayele et al., 2017). On the other hand, the Fe content which ranged from 5.35 mg/100g of whole wheat cookie to 5.77 mg/100g of the cookie sample with 20% soybean supplementation. The iron content increased as the proportion of soybean increases due to the high content of iron (7.10 mg/100g) in soybean than in wheat flour (4.83 mg/100g) (Table 3).

Table 7. Mineral contents (mg/100g) of cookies produced from composite flour of wheat and sweet potato blended with soybean

Soybean blending ratio	Zn	Fe	Ca
0%	1.55±0.04^{d}	5.35±0.05^{d}	21.12±0.03^{e}
5%	1.64±0.03^{dc}	5.45±0.04^{dc}	23.24±0.14^{d}
10%	1.73±0.05^{bc}	5.56±0.03^{bc}	25.35±0.17^{c}
15%	1.81±0.00^{ab}	5.66±0.04^{ab}	27.45±0.20^{b}
20%	1.91±0.03^{a}	5.77±0.02^{a}	29.56±0.08^{a}
CV	3.65	1.24	0.94
LSD	0.11	0.12	0.43

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different (P>0.05): Note: CV= Coefficient of Variance, LSD=Least Significant Difference

The calcium content ranged from 21.12 - 29.56 mg/100g with significant (P<0.05) differences among each other. The calcium content increased as the proportion of soya added increased, which is due to the high calcium content (42.12 mg/100g) of soybean compared to wheat flour 18.93 mg/100g and Berkume sweet potato flour 33.65 mg/100g (Table 3).

Anti-nutritional factors of cookies

The Anti-nutritional factors of composite cookies produced from sweet potato, durum wheat and fermented soybean flours are presented in Table 8. The phytic acid contents decreased with increase in proportion of soybean flour added with no significant (P<0.05) differences among 0, 10 and 20% soya blend cookies. This clearly indicated the impact of the soybean addition on the phytic acid content of the cookies produced. Similarly, the tannin content of cookies produced from composite flours of wheat and Berkume sweet potato having 0, 5, 10 and 20% proportion of soya exhibited significant (P<0.05) differences; the highest (15.24 mg/100g) being sample with 20% soya supplementation and lowest (14.65 mg/100g) control sample without soya flour. The tannin content increased with increase in the mixing ratio of soya in the composite flours. This came about because of high tannin content (18.14 mg/100g) of soya (Table 4).

Table 8. Effects of soybean blending ratio on anti- nutrient composition (mg/100g) of cookies produced from composite flours of wheat and Berkume sweet potato

Soybean Blending Ratio	Phytic acid	Tannin
0%	2.13 ± 0.05^{a}	14.65 ± 0.08^{d}
5%	2.01 ± 0.03^{ab}	14.79 ± 0.05^{dc}
10%	1.89 ± 0.06^{bc}	14.97 ± 0.06^{bc}
15%	1.77 ± 0.06^{dc}	15.12 ± 0.05^{ab}
20%	1.64 ± 0.05^{d}	15.24 ± 0.07^{a}
CV	4.86	0.77
LSD	0.20	0.21

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different (P>0.05): Note: CV= Coefficient of Variance, LSD=Least Significant Difference

Sensory Evaluation of cookies

The mean sensory score of composite cookies are shown in table 9. Mean score of color, taste, crispness and overall acceptability ranged from 5.22 to 6.88, 5.18 to 6.06, 1.74 to 4.36 and 4.99 to 5.44 respectively on a seven point hedonic scale. All the sensory score of a composite cookie samples had gradually decreased with an increase in both fermented soybean and sweet potato flour supplementation.

The color of cookies exhibited significant (P≤0.05) differences due to soya proportion in the mixture. Maillard browning is an important cause of both desirable changes in food color and in the development of off-colors. In addition, the values of taste of cookies produced from composite flour of wheat and Berkume sweet potato supplemented with soybean were decreased significantly (P<0.05) as the soya proportion increased up to 20% beyond which there was no change.

Table 9. Effects of soybean blending ratio on sensory acceptability of cookies produced from composite flours of wheat and Berkume sweet potato

Soybean blending Ratio	Color	Taste	Crispness	Overall acceptability
0%	5.88±0.10^{b}	5.24±0.06^{b}	4.36±0.11^{a}	5.36±0.13^{a}
5%	6.80±0.06^{a}	6.06±0.08^{a}	4.34±0.16^{a}	5.18±0.20^{a}
10%	6.00±0.10^{b}	5.78±0.18^{a}	3.58±0.13^{b}	5.44±0.12^{b}
15%	5.28±0.20^{c}	5.62±0.28^{ab}	2.54±0.13^{c}	5.06±0.23^{a}
20%	5.22±0.06^{c}	5.18±0.25^{b}	1.74±0.14^{d}	4.90±0.30^{a}
CV	12.45	23.97	15.07	23.03
LSD	0.29	0.53	0.20	0.47

Values are means ± standard error of three replicates. Values followed by same letter with in a column are not significantly different (P>0.05): Note: CV= Coefficient of Variance, LSD=Least Significant Difference

The crispness of the cookies also reduced as can be seen in by the falling scores as the percentage of fermented soya supplementation increased up to 15% significantly (P<0.05) differences were noted among the scores but the crispness score of cookies having 20% fermented soybean supplementation were not significant different from others.

The overall acceptability scores of the cookies of composite flours of wheat and Berkume sweet potato were strongly affected with increases in the proportion of the soya in the mixture but, all had no significant difference from each other except 10% mixing of soya from the other. The data showed that soya mix ratio of up to 20% can give cookies of positive overall acceptability. This indicates that both fermented soybean and sweet potato flour is promising potential resource in alleviating the problem of escalating cost of durum wheat in order to use in bakery products with an optimum level of supplementation.

4. Conclusions and recommendation

Conclusions

The finding of this research clearly showed that use of fermented soybean in combination with sweet potato and durum wheat improves the nutritional composition of cookies. The soya and sweet potato supplementation into durum wheat based cookie production can improve the nutritional values such as some mineral, fiber, crude protein and crude fat of the cookies. Cookies of composite flours supplemented with up to 20% fermented soya were acceptable in terms of sensory attributes. Generally, the use of sweet potato flour in cookie making in the composite flour may give new insight for the promotion and wider utilization of the underutilized sweet potato in various food applications which may help to reduce the rising price of cookie processed from 100 percent durum wheat flour.

Recommendations

Based on the present study results, the following recommendations are made;

- ✓ A comprehensive study on, optimization of other ingredients, baking condition, amino acid profile and shelf life Stability of the cookies should be conducted to come up-with complete and usable information.

- ✓ Other study shall be made to incorporate sweet potato and soybean flour in other recipes of locally available cereal crops.
- ✓ Encouraging the use of sweet potato and fermented soybean blended cookies.

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