

Effect of Blending Ratio of Soybean and Sorghum Flour on the Proximate Composition and Sensory Quality of Cookies Produced from Soft Wheat

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Abstract

Cookies are flat, dry, sweet biscuits and represent the largest category of snack items among the baked food all over the world. Cookie production is currently limited to wheat and few cereal seeds in many countries. This study was initiated with the objectives of investigating the possibility of producing cookies from blends of durum wheat, sorghum and soybean flours. The experiment was carried out in two ways of ANOVA with duplications by using SAS (version 9) software.

The cookies made from the composite flours of wheat and sorghum supplemented with soybean flour resulted in a significant increase in fat, and ash contents whereas ash content in the control (wheat) decreased significantly. Sensory acceptability evaluation based on color, taste, and crispness showed that sorghum and soybean can be incorporated in wheat 5% sorghum and 10% soybean to give cookies of acceptable quality. The supplementation of wheat-sorghum composite flour with up to 20% soya gave cookies of acceptable sensory quality.

Keywords: Durum wheat flour; Soybean; Sorghum; Composite flour

Introduction

Background

Wheat is a major staple crop to billions of people around the world and is used in a wide variety of food products such as bread, breakfast cereal, flatbreads, tortillas, cookies, pie crusts, soup thickeners, noodles, and gravies. It is generally agreed that wheat was one of the first grains to be cultivated as it has been commercially cultivated around the Eastern Mediterranean and Mesopotamia for at least 5000-6000 years. In addition to being a fundamental source of calories and nutrients, wheat is an economically important crop around the world. For 10,000 years, wheat (*Triticum*) has been an object of particular interest, owing to its specific taste and nutritional value, as well as its ease of cultivation and storage.

Unleavened bread, baked on heated stones, was first made in the Neolithic era. The early Egyptians were developers of bread and the use of the oven and developed baking into one of the first large-scale food production industries. Nowadays, wheat constitutes about one-third of the global production of cereals, and its yearly production in the mid-1990s reached 600-10⁶ tones. Wheat has a predominant role in the grain trade and is utilized as food (67%), feed (20%), seed (7%), and industrial products (6%). Wheatmeal used for human consumption provides 20% of all the energy consumed by the human population.

World average annual sorghum production for the years 2009-2011 was 59.2 million tons, of which Ethiopia produced about 3.8 million tons [1]. Taylor et al. [2] describe sorghum as generally the most drought-tolerant cereal grain crop that requires little input during growth and with increasing world populations and decreasing water supplies, represents important crop for future human use. According to Taylor JRN [3], sorghum is vitally important cereals for the maintenance of food security in Africa due to its high level of adaptation to African conditions. Sorghum is of great nutritional significance in the diets of millions of rural poor people in the semi-arid and arid tropics because it constitutes the major source of energy and protein [4] but with reduced protein digestibility as compared to other cereals. Functional advantages for sorghum include a white, light color and bland flavor that has excellent processing properties similar to rice for use in snacks,

breakfast cereals and an array of flours, grits, meals, and porridges (Figures 1 and 2).

Malnutrition has been prevalent in many developing countries like Ethiopia. To produce nutritious products, cereals are usually fortified with lysine or pulse proteins. Legumes are an important source of food protein and other nutrients [5]. Soybeans are also widely recognized their health benefits. Blending sorghum with soybean will enhance the protein content of sorghum and give a product with high energy

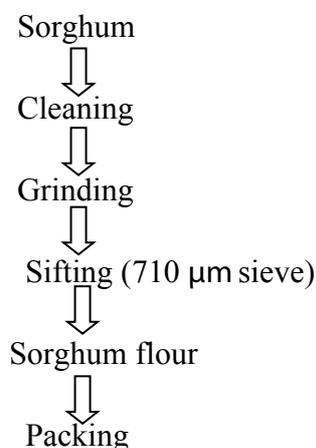


Figure 1: Flow diagram for sorghum flour preparation. (Source Taylor, J.R.N., Dewar, J)

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value and proteins which could be used to combat Protein-calorie Malnutrition but have no gluten content. The ready-to-eat feature of these blends suggests many possibilities for new food products for both here and abroad. Probably the most obvious product is a protein-fortified snack or breakfast food item. The purpose of this study will be carried out how to develop cookies from the composite flour of soybean, sorghum, and wheat in order to eradicate malnutrition as well as decrease cost.

Statement of the problem

Food insecurity has been a problem in the country. Many Ethiopians live in conditions of chronic hunger with both a low average daily energy supply (kcal/capita/day or DES) of 1880 and a very high (44%) prevalence of under-nourishment [6]. The problem of food shortage in sub-Saharan Africa is to a large extent due to the fact that much of the region is characterized by semi-arid and sub-tropical climatic conditions. Due to its drought tolerance and adaptation to semi-arid, sub-tropical and tropical conditions, sorghum can still be produced where agricultural and environmental conditions are unfavorable for the production of other cereal crops. This is of particular importance as Global Warming and the growth of the world's population will require that more marginal lands be used for food production [7]. Wheat is so expensive as a result substitute sorghum should be one that is readily available and cheap to produce a different product.

The inclusion of soybean flour into the composite flour of durum wheat and sorghum could enhance the protein content of the cookies to be produced. Unfortunately, animal sources of proteins, which are used to compliment the starchy diets are expensive and out of reach for low-income families. Protein quality is a critically important problem

in many developing countries, where human diet consists mainly of cereals. Therefore, supplementation of the cereals with low cost and easily available protein source is in need to improve their nutritional quality. Blending wheat and sorghum with soybean could be used as a way of enhancing its protein quality and combating PCM as well. The advances in soybean production and soy protein processing technology give soy protein a broader and more versatile utilization in human foods. Soybean products are frequently incorporated into products used for the treatment or prevention of malnutrition as described by Khalil [8]; in developing countries, there is an urgent need of nutritious foods to meet the nutritional requirements of ever-increasing populations. The product of cookies from composite flour of soybean, wheat, and sorghum are exceedingly required for those populations in Ethiopia affected by protein-energy malnutrition and for those who have constraints to the inclusion of animal source foods in their diets (Figures 3 and 4)[9].

Materials and Methods

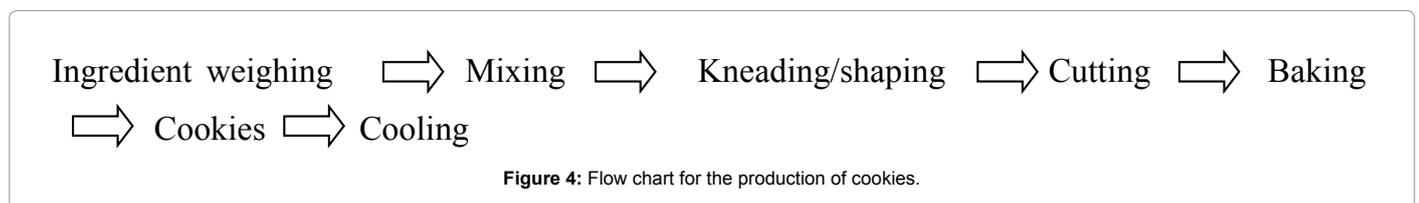
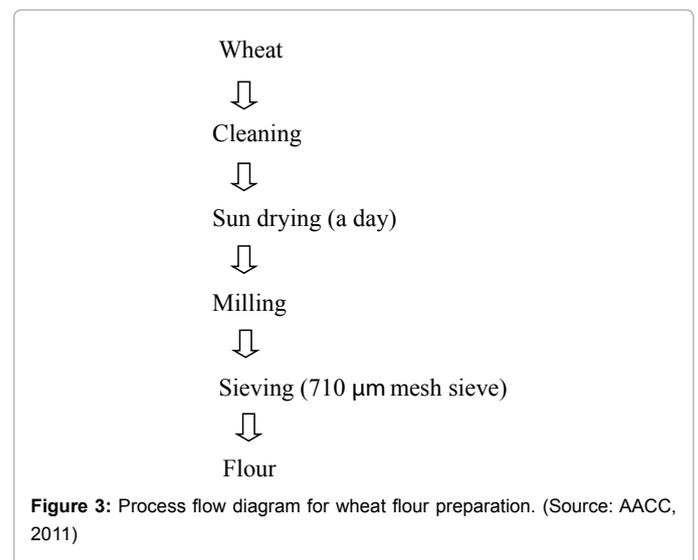
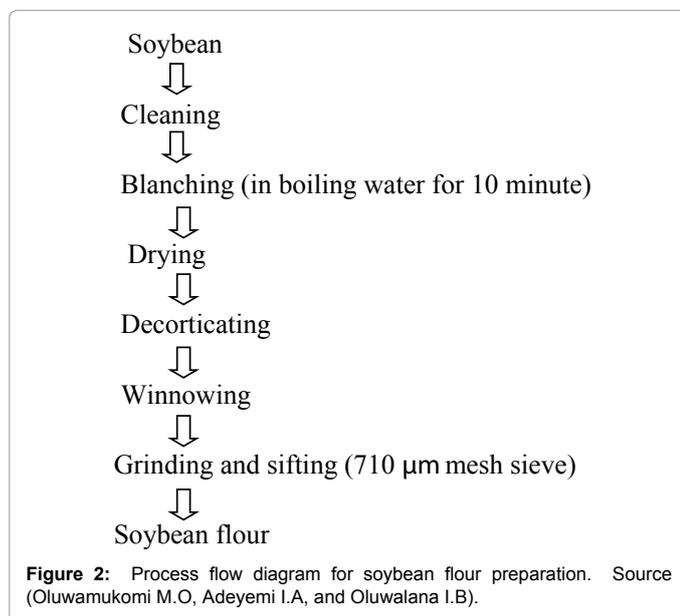
Raw materials

Healthy sorghum, durum wheat and soybean of were bought from Hawassa agricultural research center. Milk powder, edible oil, sugar, and salt were purchased from Hawassa Supermarket.

Sample preparation

Flour preparation from sorghum: Sorghum was cleaned manually to remove foreign materials and was ground into a fine flour using the commercial mill. The flour was sifted using sieve 710 µm.

Flour preparation from soybean: Soybean was cleaned by hand picking and manual aspiration to remove dirt, stones, chaff, broken and spoil seeds, and other foreign materials. Then beans were then blanched



in boiling water for 10 minutes to inactivate enzyme activity and to make decortications easier. Then the soybean was dried at 60°C for overnight in a drying oven. The dried soybean was then decorticated. Winnowing was done manually to separate the hull. Following winnowing, milling was conducted using laboratory scale grinder and finally, the flour will be sifted using 710 µm mesh sieve [10-12].

Flour preparation from durum wheat: Durum wheat was cleaned by manually in order to remove extraneous matter. Then the clean durum wheat will be sun-dried. Finally, wheat grains were milled into a fine flour using attrition grain mill (disc Mill).

Experimental design

Two ways ANOVA was used for proximate determination and RCBD design was used for sensory evaluation of cookies. Blending proportions are displayed in Table 1.

Cookie preparation procedures

Cookies were prepared according to the method AACC [12] with some modification in the recipe. Flour (200 g) from each sample of different flour blended and 75 ml of water was added. The dry ingredients (composite flour, sugar, salt, milk powder, and egg) were mixed until uniform mixtures of the ingredients were obtained. Then the dough was rolled and cut with a knife. The cookies were placed in baking trays, leaving 25 mm space in between and were baked at 180°C for 10 minutes in the baking oven and cooled for 30 minutes then sensory evaluate.

Sample analysis

Proximate analysis:

Moisture content determination: Moisture content of samples were determined described by AOAC [13] using the official method 925.09. Cleaned Petri dish was dried in an oven at 105°C and placed in desiccators to cool. Dry Petri dish (W_1) was weighed. About 5-gram sample was weighed in the dried Petri dish (W_2) and then put into a drying oven at 105°C for 2 hr. Finally, samples were transferred to desiccators and weighed (W_3) after cooling. Then moisture content was calculated from the equation:

$$m \% = \frac{W_2 - W_3}{W_2 - W_1} * 100$$

Where: Mc-The moisture content (%)

W_1 -Weight of Petridish (g)

W_2 -Weight of the fresh sample and Petridish (g)

W_3 -Weight of dry sample and Petridish (g)

Crude fat determination: Crude fat content was determined according to AOAC official method 4.5.01 [13]. A clean and dry thimble containing 2 g of dried sample covered with fat-free cotton at the bottom and top will be placed in the extraction chamber. The extraction was carried out by using Soxhlet. Diethyl ether was used to extract the oil from cookies flour for about 4 hr-6 hr. The crude fat content was determined by the following equation:

$$\text{Crude Fat by weight} = (W_2 - W_1 / W) * 100$$

Where:

W_1 =Weight of the extraction flask (g)

W_2 =Weight of the extraction flask plus the dried crude fat (g), and

W =Weight of dried samples after moisture determination (g)

Total ash determination: Ash content was determined by using the official method 923.03 [13]. Clean porcelain crucible, dried at 120°C in an oven was cooled in desiccators and weighed (W_1). Then 2 g sample was weighed (W_2) into the crucible. The crucible with the sample was placed in a Muffle furnace set at 550°C for 4 hr to ignite until ash was completed. After this, the crucible with its content was removed and cooled in desiccators. The crucible with the ash was being weighed (W_3). The weights of the ash were expressed as a percentage of the initial weight of the samples using the equation:

$$\text{Total ash \%} = \frac{W_3 - W_1}{W_2 - W_1} * 100$$

Where:

W_1 -Weight of the empty crucible (g)

W_2 -Weight of the sample with crucible (g)

W_3 -Weight of the crucible with ash (g)

Sensory analysis: Sensory evaluation was done by 18 untrained panels comprising of students and members of Hawassa University school of Nutrition Food science and technology and The panelist were asked to evaluate cookies for color, taste, flavor, texture and overall acceptability using seven-point hedonic scale (1 dislike very much, 2=dislike, 3=dislike moderately, 4=neither like nor dislike, 5=like, 6=like moderately and 7=like very much). The panelists were not informed about the project objectives. A quiet room, with adequate light, was used for the sensory analysis. Samples were coded using three-digit random numbers and served. Panelists were provided with a glass of water and instructed to rinse and swallow water between samples. Product samples, about 5 cm lengths, from each selected product were arranged in random order on white plates and served to the sensory judges. Just before test session, orientation was given to the judges on the procedure of sensory evaluation.

Statistical analysis: The data collected from proximate composition Means of panelist scores for sensory evaluation were computed and subjected to analysis of variance (ANOVA) to test for significant differences ($P < 0.05$). Comparisons were made using the Fisher's least significant difference (LSD) test to determine which means were significantly different. All statistical analyses were performed using SAS (version, 9).

Result and Discussion

Proximate composition of cookies from wheat flour and composite flour at different sorghum and soybean flour blends

The proximate composition of cookies from flour and composite

Treatment	Durum wheat flour (%)	Sorghum flour (%)	Soybean flour (%)
T	100	0	0
T ₁	85	15	0
T ₃	85	0	15
T ₄	85	2.5	12.5
T ₅	85	12.5	2.5
T ₆	85	10	5
T ₇	85	5	10
T ₈	85	7.5	7.5

Source .Adeyeye [9], Mir et al. [10] and Chinma, C.E and D.I Gernati [11] with a little modification.

Table 1: Blending proportion table for sensory evaluation of cookies.

flour of soybean and sorghum at different blending ratio are given in Table 2. The proximate composition (moisture, ash, and fat of cookies developed from wheat flour (control) were 7.59 ± 0.55 , 1.94 ± 0.14 , 14.21 ± 0.08 respectively, while that of the cookies developed from composite flour of wheat and sorghum at blending ratio 85 to 15 percent were 7.06 ± 0.19 , 2.27 ± 0.17 and 12.70 ± 0.35 respectively, cookies developed from composite flour of wheat and soybean at blending ratio of 85 to 15 percent were 7.10 ± 0.14 , 2.57 ± 0.03 and 17.30 ± 0.21 . The proximate composition (moisture, ash, and fat) of cookies from composite flours of wheat, sorghum and soybean with different levels of blending ratio ranged from 5.9 ± 0.14 to 6.48 ± 0.16 , 2.37 ± 0.03 to 2.65 ± 0.21 , 13.77 ± 0.38 to 15.75 ± 0.35 .

The moisture content of substitution T₂ (85:15 % wf/srf) was lower compared to other treatments. This might be due to the low content of soybean than the T₃ (85:15% wf/sf) and T₆ (85:7.5:7.5% wf/srf/sf), T₄ substitution. Addition of soybean flour increases the moisture and water holding capacity due to a protein found in soybean flour. Increase in moisture content has been associated with an increase in fiber content. The crude fat content of substitution four (T₃) had a high content of crude fat than the other treatments due to the fact that the high amount of soybean proportion of the other treatments. Crude fat values of substitution T₂ lower values when compared to other treatment. The crude fat content of the substitution had increased as the level of soybean in composition flour. The result of the moisture and fat contents shows moisture content increases up to 8.75% and fat content increases up to 14.82% in different commercially available biscuits.

In the current study ash values increase significantly due to an increasing amount of soybean flour. The increase in the ash content of the cookies from substituted to wheat-sorghum composite is due to

Ratio of wheat: sorghum: soybean flour	Moisture (%)	Ash (%)	Fat (%)
T ₁ (100% wf)	7.59 ± 0.55^a	1.9 ± 0.14^d	14.21 ± 0.08^{dc}
T ₂ (85:15 % wf/srf)	5.06 ± 0.19^b	2.27 ± 0.17^{bc}	12.70 ± 0.35^e
T ₃ (85:15% wf/sf)	7.1 ± 0.14^a	2.57 ± 0.03^a	17.30 ± 0.21^a
T ₄ (85:2.5:12.5% wf/srf/sf)	6.1 ± 0.14^{bc}	2.65 ± 0.21^a	15.75 ± 0.35^b
T ₅ (85:12.5:2.5% wf/srf/sf)	5.59 ± 0.26^{cd}	2.22 ± 0.03^c	13.77 ± 0.38^d
T ₆ (85:7.5:7.5% wf/srf/sf)	6.48 ± 0.16^b	2.5 ± 0.07^{bac}	15.32 ± 0.10^b
T ₇ (85:5:10% wf/srf/sf)	5.97 ± 0.01^{bc}	2.52 ± 0.10^{ba}	15.72 ± 0.17^b
T ₈ (85:10:5% wf/srf/sf)	5.9 ± 0.14^c	2.37 ± 0.03^{bac}	14.62 ± 0.24^c

All data are means of duplicate results expressed on dry weight basis and Values are means \pm standard deviations of the duplicate determinations. Values in the same column with same superscripts (a,b,c,d,e) are significantly different at (P<0.05)

Key: WF: Wheat Flour; Srf: Sorghum flour; Sf: Soybean flour

Table 2: The proximate compositions of cookies from wheat flour and composite flour of soybean and sorghum at different blends ratio.

Ratio of wheat: sorg: soya flour	Taste	Color	Flavor	Texture	Crispiness	Appearance	Over all acceptability
Wf (100%)	4.73 ± 1.70^{dc}	4.30 ± 1.68^{dc}	4.9 ± 1.53^{ab}	4.56 ± 1.65^c	4.86 ± 1.56^b	4.83 ± 1.57^{bc}	5.06 ± 1.43^{bc}
85:15% wf/srf	4.6 ± 1.63^d	3.86 ± 1.52^d	4.6 ± 1.52^b	4.7 ± 1.56^{bc}	4.76 ± 1.56^b	4.33 ± 1.64^c	4.66 ± 1.44^c
85:15% wf/sf	5.36 ± 1.32^{ab}	5.60 ± 0.89^a	5.3 ± 1.08^a	5.3 ± 1.17^{ab}	5.43 ± 1.16^{ba}	5.30 ± 1.02^{ba}	$5.36 \pm 1.27^b^a$
85:2.5:12.5wf/srf/sf	5.6 ± 1.18^{ab}	5.70 ± 1.11^a	5.36 ± 1.4^a	5.3 ± 1.34^a	5.76 ± 1.16^a	5.63 ± 1.09^a	5.60 ± 1.35^{bac}
85:12.5:2.5wf/srf/sf	5.3 ± 0.98^{bac}	4.6 ± 1.27^{bc}	5.1 ± 1.3^{ab}	5.0 ± 1.18^{bac}	5.16 ± 1.31^{ba}	5.23 ± 1.22^{ba}	5.26 ± 1.25^{bac}
85:7.5:7.5wf/srf/sf	5.1 ± 0.84^{bac}	5.20 ± 0.99^{ab}	5.0 ± 1.3^{ab}	5.2 ± 1.06^{bac}	4.9 ± 1.29^b	5.06 ± 1.20^{ba}	5.26 ± 0.98^{bac}
85:5:10 wf/srf/sf	5.76 ± 0.85^a	5.63 ± 1.18^a	5.56 ± 1.1^a	5.36 ± 1.03^a	5.43 ± 1.52^{ba}	5.53 ± 0.97^a	5.76 ± 1.07^a
85:10:5 wf/srf/sf	5.26 ± 0.9^{bac}	5.1 ± 1.12^{ab}	4.9 ± 1.2^{ab}	$4.93 \pm 1.1b^{bc}$	4.86 ± 1.30^b	5.03 ± 1.29^{ba}	5.13 ± 1.27^{bac}

All data are means of duplicate results expressed on dry weight basis and Values are means \pm standard deviations of the duplicate determinations. Values in the same column with different superscripts (a,b,c,d,e) are significantly different at (P<0.05)

Key: WF: Wheat Flour; Srf: Sorghum flour; Sf: Soybean flour

Table 3: Mean sensory evaluation of cookie samples from wheat flour and composite flour of soybean and sorghum at different flour substitution.

soybean is a source of minerals such as potassium and adequate source of magnesium, iron zinc, copper, calcium, and phosphorus [14].

Sensory evaluation of cookies

Mean score for sensory evaluation of cookies samples containing different level of sorghum and soy-flour substitution as compared to the control is shown in Table 3. The cookies from composite flour of wheat, sorghum and soybean at blending ratio of 85 to 5 to 10 percent had the value of 5.76 ± 1.07 rated the highest in terms of overall acceptability while the cookies from wheat and sorghum flour at 85 to 15 percent blending ratios had the least overall acceptability value of 4.66 ± 1.44 . The results also showed that cookies from wheat, sorghum and soybean flour had high overall acceptability but the value decreases have the percentage of substitution sorghum increases.

Texture has been described as one of the most important characteristics affecting consumer acceptance of cookies products. The score for the texture with the substitution of 85:15wf/sf (5.3 ± 1.17) and 85:2.5:12.5wf/srf/sf (5.36 ± 1.03) were high mean value while the score with substitution 85:15% wf/srf were shows least mean score of texture. The scores for texture (softness and chewiness) of the composite cookies samples, increased with increase in soybean flour and with decreasing sorghum substitution when compared to whole wheat cookies (control sample). Textural properties of cookies are one of the most important quality parameter, which affects the demand for cookies. The state of the cookies components, such as ash, starch, fat weather damaged or undamaged and the amounts of absorbed water during dough mixing, all contribute to the final texture of the cookies. Soybean has been reported to contain an appreciable amount of minerals and fat. Also fat acts as flavors returner and help to improve sensory qualities of baked products.

Crispiness is one of the textural properties of a food product in which attributes of a food material resulting from the combination of physical and chemical properties, perceived largely by the sense of touch, sight and hearing are also one of the most important quality parameters of a food product. The highest mean value score T₄ (5.76 ± 1.16), while the least mean score T₂ (4.76 ± 1.56) were highly significant at (P<0.05).

Appearance is one of the most criteria for consumers visualizes human perception. In the composition of wheat, sorghum and soybean cookies have the highest mean score of T₇ (5.53 ± 0.97) and T₄ (5.76 ± 1.16), while mean score of T₁ (4.83 ± 1.57) and T₂ (4.33 ± 1.64) were the lowest which shows there is highly significant at (P<0.05). The current study in agreement with (Pareyt, B. and Delcour, JA. 2008) who were reported on sugar-snap cookies.

In the treatments of T_3 (5.3 ± 1.08), T_4 (5.3 ± 1.08) and T_7 (5.56 ± 1.10) have high mean value score of flavor, while T_1 (4.9 ± 1.53) and T_2 (4.6 ± 1.52) have least mean value. The incorporation of sorghum flour into wheat and soybean flour cookies resulted in poor flavor scores. Increasing blend ratio sorghum was a negative impact on flavor acceptance as the color acceptance of the products Chimna and Gernati [11]. The results showed a decrease in the scores as the whole-wheat flour was substituted with sorghum-flour. The current study is in line with similar results were reported by Mir et al. [10] for cakes by increasing non-wheat flour in the formulation. In the present study on increasing the soybean flour up to 12.5% level indicating better odor rating, which is acceptable. Therefore the current study indicates that Odour of biscuit increase in flavor attributes on increasing the soybean flour up to 15% level indicating better dour rating.

Conclusion

In conclusion, this study has revealed that cookies of acceptable and desirable proximate composition chemical composition comparable to 100% wheat flour cookies could be produced from sorghum, soybean, and wheat composite flour. Blend ratio seems to have an effect on the proximate composition of the cookies products Ash values increase significantly due to an increasing amount of soybean flour which is 85:5:10% wf/srf/sf, 85:2.5:12.5% wf/srf/sf, T_3 85:15% wf/sf, is an important source of minerals that are located in pericarp, aleurone layer, and germ. It is a good source of potassium and an adequate source of magnesium, iron zinc, copper, calcium and phosphorus and whereas increasing the blend ratio decreases the moisture content in treatment T_2 .

Substitution of wheat flour with pearled sorghum flour and soybean affected the physical textural, and sensory characteristics of cookies in general. However, the study showed that sorghum flour can be utilized for making acceptable quality cookies up to 12.5% levels with 2.5% soybean but the best sensory acceptability of cookies with highest mean sensory scores for taste (5.76), color (5.63), texture (5.36) and flavor (5.56) and overall acceptability (5.76) of the cookies was observed for the cookies containing 5% sorghum and 10% soybean flour.

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