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Mineral composition and sensory evaluation of buckwheat cookies supplemented with wheat flour

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Abstract
This research work was carried out in Pakistan Council of Scientific and Industrial Research, Skardu Gilgit Baltistan to developed the buckwheat cookies in combination with wheat flour and then examine for mineral composition and sensory evaluation. The wheat flour at 10, 20, 30, 40 and 50% ratio was integrated with buckwheat flour to make composite flour and analyzed for quality evaluation. Supplementation of wheat flour significantly influenced the sensory evaluation and mineral composition of buckwheat flour based cookies. Mineral contents (Fe, Ca, K, Zn and Mg) of developed buckwheat cookies decreased with the increased in wheat flour supplementation levels. Sensory characteristics of supplemented cookies were increased with the increased of supplementation levels of wheat flour and are acceptable by judges in term of test, color, texture and overall acceptability. Cookies developed from (T5) 50 % supplementation level of wheat flour got maximum scored points while (T0) control was found more nutritious and gluten free having more crude protein and mineral contents as compared to supplemented cookies and are best for gluten sensitive individuals (celiac disease) who having difficulties in mastication, swallowing and digestion of gluten containing foods.

Keywords: buckwheat, supplemented buckwheat cookies, mineral and sensory quality

1. Introduction
The common buckwheat *Fagopyrum esculentum* moench (sweet buckwheat) belongs to the family Polygonaceae and its seeds structurally and chemically look like to wheat grains. This native crop was originated from East Asia and then promoted into Europe countries; the cultivation of this crop was spread in many other countries of the world such as The United States of America, Canada, China, Latin America and Africa, with an annual production of about one million tons. First, to encourage its cultivation in different regions agriculture is characterized mainly semi-wild buckwheat crop does not need any specific soil and fertilizer, it is cultivated in the high altitude areas of above 3,000 meters in Bhutan and Nepal. (Pomeranz and Robbins.1972, and Eggum *et al*, 1980) [23, 6].

Buckwheat grown throughout the world there are different species of buckwheat mostly two types of buckwheat (Common buckwheat and Tartary buckwheat) used as a source of food throughout the world and other nine of them only has nutritional and agricultural value (Krkoskova and Mrazova, 2005) [19]. In Gilgit Baltistan these two species of buckwheat cultivated at the area of 948 hectares with an annual production of 1798 metric tons. (Agri. Stat. 2007) [2]. Due to the high medicinal value and nutritional as well the production of this crop has been increased, being a gluten free it has medicinal value and used in gluten free food preparation for those who has gluten allergy (celiac patients) (Bonafaccia *et al*., 2003) [4].

The term cookies are Dutch word koekje and its means a little cake and the name biscuit is the Latin word which mean bis coctum (Macrae *et al.,* 1993) [22]. It is a bakery product and usally consumed by all age group mostly school going childrens. (Shahzad *et al*., 2006) [24]. Cookies are prepared by supplementing different low priced sources like pulses and legumes flour with wheat flour (Akubor and Onimawo, 2003) [3].

Buckwheat is an excellent source of micronutrients (Ikeda and Yamashita, 1994) [10]. As compare to other cereal crops it has more crude protein and lysine content and gluten free that why it is more important medicinal and nutritional crop. Therefore, it used to prepare an alternate gluten free food for celiac patients (Javornik and kreft, 1984 and Eggum, 1980) [13, 7]. Buckwheat foodstuffs are considered as a good nutritional and medicinal value food (Bonafaccia and Kreft, 1998) [5]. They found that there was a well concentration of amino acid in buckwheat (Kato *et al.*, 2001) [15]. Among them needed amino acids like lysine, threonine and tryptophan are in high value (Liu *et al.*, 2001) [21]. It is naturally gluten free and contains various kinds of essential nutrients including easily digestible protein, starch, essential minerals (Zn, Fe, K, Ca, Mg, Mn, and Cu), amino acids (lysine) and rutin. It is low in saturated fat, sodium, and cholesterol. (Bonafaccia *et al*., 2003) [4]. Common buckwheat mostly consumed as compared to other species because it is sweet in taste and easy to dehul as compared to tartary buckwheat because it has bitter taste, small in seed size and tough seed coat for that reason it is hard to dehull (Jiang *et al*., 2007) [12].

The present research was to evaluate a suitable supplementation level of buckwheat and wheat flour to build up a healthful and gluten free biscuits for celiac patients.

2. Materials and Methods
For the of this research work common buckwheat (sweet) Fagopyrum esculentum and wheat flour was selected to developed the cookies, so the buckwheat was for the local area and the wheat flour and other ingredients was purchase by the local market and brought to PCSIR (Pakistan Council of Scientific and Industrial Research) Laboratory Skardu, Gilgit Baltistan and after the development of the cookies the product were packed in sealed polyethylene bags and stored in refrigerator. The formulation of cookies were at at 10, 20, 30, 40 and 50 % levels of wheat flour by supplementing with buckwheat flour according to the official method of AACC (2000). The recipes used to prepare buckwheat cookies are flour 500gm, sugar 250gm, industrial fat 250gm, baking powder

6.50gm, salt 0.040gm and egg 1.

Treatments

Co = (Control) 100 % common buckwheat flour.
C1 = (90% buckwheat + 10% wheat flour)
C2 = (80% buckwheat + 20% wheat flour)
C3 = (70% buckwheat + 30% wheat flour)
C4 = (60% buckwheat + 40% wheat flour)
C5 = (50% buckwheat + 50% wheat flour)

2.1 Mineral estimation

The developed buckwheat cookies were analyzed for minerals (Ca, Fe, Zn, K and Mg) through wet digestion. Iron, calcium, magnesium and zinc content was calculated by using atomic absorption spectrophotometer while potassium was estimated through flame photometer according to the recommended method of AOAC, (2000) [1].

Minerals (Fe, Zn, Ca and Mn) in cookies were calculated. About 1 gm of grinded fine trial was kept in digestion tube, 10ml concentrated nitric acid added and kept it at room temperature for overnight. Then the mixture was treated with 4ml concentrated perchloric acid and sample was kept on magnetic hot plate for digestion. The process was completed in about 1-2 hours. The sample was than allow to cooled up to room temperature, shifted in to 200ml volume flask, filtered by using filter paper. The volume of sample in flask prepared up to 100 ml with distilled water and absorbance was estimated through atomic absorption spectrophotometer (Model GBC 932 PLUS, UK). For determination of K (Potassium) content in developed cookies same procedure was applied but it was calculated by using flame photometer (Model PEP, JENWAY, UK).

Sensory evaluation

Supplemented buckwheat cookies were sensory evaluated in terms of test, color, texture, and overall acceptability by presenting developed cookies to a panel of six judges using 9 points hedonic scale, recommended by (Larmond, 1977) [20].

2.2 Statistical analysis

The data of current research work were statistically evaluated by using (CRD) completely randomized designed while (LSD) least significant difference test at 5% level of significance was used to separate means according to the described method by Steel and Torrie (1997) [27].

3. Results and Discussion

The cookies were developed with various ratios of ingredients in various traits then the products were analyzed for mineral content and sensory evaluation.

3.1 Mineral composition of different Treatments of developed buckwheat cookies

Potassium content

Supplementation of wheat flour significantly ($p<0.5$) effect potassium (K) content of common buckwheat flour based cookies. Data disclosed that potassium content of wheat flour supplemented buckwheat cookies decreased with gradual increase of wheat flour incorporation. The mean potassium content results of test cookies were as mg/100g C_O (695.33), C_1 (661.67), C_2 (634.33), C_3 (593.67), C4 (564.00) and C_5 (535.67). The highest mean value (695.33 mg/100g) was recorded in C_0, while lowest mean value (535.67 mg/100g) in C_5 (Table 1). High potassium content of supplemented cookies may be credited to high potassium content of buckwheat flour contrasted to wheat buckwheat flour.

3.2 Calcium content

Supplementation of wheat flour significantly ($p<0.5$) effect calcium (Ca) content of common buckwheat flour based cookies. Data disclosed that calcium content of wheat flour supplemented buckwheat cookies decreased with gradual increase of wheat flour incorporation. The mean calcium content results of test cookies were as mg/100g C_O (50.89), C_1 (48.19), C_2 (46.70), C_3 (44.95), C4 (44.27) and C_5 (43.77). The highest mean value (50.89 mg/100g) was recorded in C_0, while lowest mean value (43.77 mg/100g) in C_5 (Table 1). Decreased in calcium content of supplemented buckwheat cookies may be credited to high calcium content of buckwheat flour contrasted to wheat flour.

3.3 Iron content

Supplementation of wheat flour significantly ($p<0.5$) effect iron (Fe) content of common buckwheat flour based cookies. Data disclosed that iron content of wheat flour supplemented buckwheat cookies decreased with gradual increase of wheat flour incorporation. The mean iron content results of test cookies were as mg/100g C_O (20.35), C_1 (18.65), C_2 (17.20), C_3 (15.77), C4 (14.02) and C_5 (12.27). The highest mean value (20.35 mg/100g) was recorded in C_0, while lowest mean value (12.27 mg/100g) in C_5 (Table 1). High iron content of supplemented biscuits may be credited to high iron content of buckwheat flour contrasted to wheat flour. The end results achieved are in complete conformation with the finding of of Khan *et al.* (2012) [16], who examined iron content decreased preparing in gluten free ready to served buckwheat product incorporating skim milk with buckwheat flour. Kashlan *et al.* (1991) [14], also reported during baking significant loss of most of minerals such as iron content was found when bread is compared to wheat flour.

3.4 Zinc content

Supplementation of wheat to common buckwheat flour based cookies had significant ($p<0.5$) effect on zinc (Zn) content. Data disclosed that zinc content decreased with gradual increase of wheat flour supplementation levels. The mean results of test cookies were as mg/100g C_O (3.36), C_1 (3.25), C_2 (3.15), C_3 (3.09), C_4 (2.97) and C_5 (2.94). The highest mean value (3.36 mg/100g) was recorded in C_0, while lowest mean value (2.94 mg/100g) in C_5 (Table 1).The decrease in zinc content with increase in supplementation of wheat flour in common buckwheat flour is the reason that, common buckwheat flour contains higher zinc (Zn) content as compared to wheat flour. Khan, *et al.* (2005), who investigated high in zinc contents as the addition of buckwheat flour in wheat flour that showed contrast in results with the present finding.

3.5 Magnesium content

Supplementation of wheat flour significantly ($p<0.5$) effect magnesium (Mg) content of common buckwheat flour based cookies. Data disclosed that magnesium content of wheat flour supplemented buckwheat cookies decreased with gradual increase in wheat flour supplementatio. The mean magnesium content results of test cookies were as mg/100g C_O (368.33), C_1 (347.67), C_2 (337.00), C_3 (315.00), C_4 (300.33) and C_5 (281.33). The highest mean value (368.33 mg/100g) was recorded in C_0, while lowest mean value found in (281.33 mg/100g) in C_5 (Table

1). High magnesium content of supplemented buckwheat cookies may be credited to high magnesium content of buckwheat flour contrasted to wheat flour when the supplementation level of wheat flour increased and buckwheat concentration decreased then the magnesium contents in cookies also decreased. The results achieved are in complete conformation with the finding of Khan *et al.* (2012) [16], who determined magnesium content decreased in gluten free ready to served buckwheat product preparing skim milk incorporation with buckwheat flour. Ikeda *et al.*, (2006) [11] and Francischi *et al*. (1994) [9] found increase in amount of magnesium content in Tartary buckwheat flour than whole-wheat flour, while in the present study it was recorded decrease in magnesium content because of the addition of wheat flour in common buckwheat flour.

3.6 Sensory / Organoleptic Evaluation

Sensory/Organoleptic Evaluation of different Treatments of developed Buckwheat cookies Organoleptic evaluated all the trials of developed cookies by presenting to a panel of six expert judges for color, texture, taste and overall acceptability according to 9 point hedonic scale. The results of sensory/organoleptic evaluation of all treatments of buckwheat cookies are explained in Table 2.

3.7 Taste

Supplementation of wheat flour significantly ($p<0.5$) effect on quality score in term of taste of common buckwheat flour based cookies. Data disclosed that quality score of buckwheat cookies increased with gradual increase of wheat flour incorporation. The mean scored points for taste of test cookies were C_O (5.26), C_1 (5.66), C_2 (5.98), C_3 (6.38), C4 (6.91) and C_5 (7.54). The minimum scored point (5.26) was recorded in C_0, while maximum point scored (7.54) recorded in C_5 (Table 2). The data shows that with the increase in wheat flour and reduction in buckwheat flour content taste of developed cookies improved. The results achieved are in close conformation with the finding of Tyagi *et al.* (2007) [28], reported same result when evaluated products of mustard flour incorporation biscuits. Eneche (1999) [8], also estimated maximum sensory scores for taste and overall acceptability for the cookies developed from 65% millet flour incorporating with 35% pigeon pea flour.

3.8 Color

Supplementation of wheat flour significantly ($p<0.5$) effect on quality score in term of color of common buckwheat flour based cookies. Data disclosed that quality score of buckwheat cookies increased with gradual increase of wheat flour incorporation. The mean scored points for color of test cookies were C_O (5.11), C_1 (5.75), C_2 (6.31), C_3 (6.88), C4 (7.53) and C_5 (8.15). The lowest scored point (5.11) was recorded in C_0, while maximum point scored (8.15) recorded in C_5 (Table 2). The data shows that with the increase in wheat flour supplementation levels and reduction in buckwheat flour content color of developed cookies improved. The results achieved are in close conformation with the finding of Tyagi *et al.* (2007) [28], reported maximum color score of 7.70 biscuits containing 15% defatted mustard flour. Our finding also similar with the findings of Singh *et al.* (2005) [26], who indicated maximum scored points for color at 15 % supplementation of green gram and bengal gram from composite flours. Khouryieh *et al.* (2006) [18], also reported highest score points for color in noodles formulated with soy flour and whole eggs.

3.9 Texture

Supplementation of wheat flour significantly ($p<0.5$) effect quality score in term of texture of common buckwheat flour based cookies. Data disclosed that quality score of buckwheat cookies increased with gradual increase of wheat flour incorporation. The mean scored points for texture of test cookies were CO (5.41), C1 (5.62), C2 (6.00), C3 (6.74), C4 (7.00) and C5 (7.84). The maximum point scored (7.84) was recorded in C5, while lowest point scored (5.41) recorded in C0 (Table 2). The data shows that with the increase in wheat flour and reduction in buckwheat flour content taste of developed cookies improved. The results achieved are in close conformation with the finding of Tyagi *et al.* (2007) [28], who reported same result when evaluated the end product of mustard flour incorporation biscuits. Eneche (1999) [8], also indicated maximum sensory score points for texture and overall acceptability for the biscuits developed from incorporation of 65 percent millet flour with 35 percent pigeon pea flour.

3.10 Overall acceptability

Supplementation of wheat flour significantly ($p<0.5$) effect quality score in term of overall acceptability of common buckwheat flour based cookies. Data disclosed that quality score of buckwheat cookies increased with gradual increase of wheat flour incorporation. The mean scored points for overall acceptability of test cookies were CO (5.26), C1 (5.67), C2 (6.10), C3 (6.67), C4 (7.15) and C5 (7.85). The maximum point score (7.85) was received in C5, while lowest point scored (5.26) recorded in C0. (Table 2). The data shows that with the increase in wheat flour and reduction in buckwheat flour content overall acceptability of developed cookies improved. The results achieved are in close conformation with the finding of Tyagi *et al.* (2007) [28], reported same result when evaluated end product of mustard flour incorporation biscuits. Singh *et al.* (1993) [25], also observed maximum mean score points for overall acceptability at 30% incorporation level of soy flour.

Table 1: The products prepared with different supplementation level of wheat flour were analyzed for proximate mineral composition.

Treatments	Iron (fe) mg/100 g	Zinc (Zn) mg/100 g	Calcium (Ca) mg/100 g	Potassium (K) mg/100 g	Magnesium(Mg) mg/100 g
C_O	20.35 A	3.36 A	50.89 A	695.33 A	368.33 A
C_1	18.65 B	3.25 B	48.19 B	661.67 B	347.67 B
C_2	17.20 C	3.15 C	46.70 C	634.33 C	337.00 B
C_3	15.77 D	3.09 C	44.95 D	593.67 D	315.00 C
C_4	14.02 E	2.97 D	44.27 E	564.00 E	300.33 D
C_5	12.27 F	2.94 D	43.77 F	535.67 F	281.33 E

Table 2: Color, taste, texture and overall acceptability of different treatments of developed buckwheat cookies

Treatments	Color	Taste	Texture	Overall acceptability
C_O	5.11 F	5.26 E	5.41 D	5.26 F
C_1	5.75 E	5.66 E	5.62 D	5.67 E
C_2	6.31 D	5.98 D	6.00 C	6.10 D
C_3	6.88 C	6.38 C	6.74 B	6.67 C
C_4	7.53 B	6.91 B	7.00 B	7.15 B
C_5	8.15 A	7.54 A	7.84 A	7.85 A

4. Conclusion and Recommendation

It is concluded that the combination of wheat flour with buckwheat flour could produce high nutritional value product and the supplementation of wheat flour significantly influenced the mineral contents (Fe, Ca, K, Zn and Mg) of developed buckwheat cookies decreased with the increased in wheat flour supplementation levels. Sensory evaluation of buckwheat cookies in terms of color, texture, test, and overall acceptability increased with the increase in wheat flour supplementation levels. It is recommended further research work on development of nutritious baked products supplementing buckwheat flour with other cereals, and also investigated the different varieties of this valuable crop.

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