ORIGINAL RESEARCH ARTICLE

Comparative study on effects of adding germinated and non-germinated legumes on bioactive components, antioxidant, textural and sensory characteristics of cereal flakes

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Abstract
The objective of this study was to prepare healthy breakfast cereal flakes through addition of selected germinated legumes, namely, lentils (Lens culinaris), green gram (Vigna radiata), and black gram (Vigna mungo). Flakes containing germinated legumes were compared in terms of bioactive compounds, texture, moisture content, and sensory properties with flakes made with non-germinated legumes. It was observed that flakes made with germinated legumes were higher in polyphenols, flavonoids, flavonols, and antioxidant activity with a crispier and more desirable texture. Moreover, shelf life was evaluated on the basis of moisture content and sensory characteristics for 90 days. The best flakes in terms of storage were the ones containing germinated legumes as these were low in moisture content even after 90 days of storage, which is essential for extending the shelf life of the product. These germinated legume containing cereal flakes also received higher scores in terms of sensory characteristics. Incorporation of legumes can thus provide a cheap and healthy snack for people of all ages.

KEYWORDS
bioactive compounds, cereals, flakes, germinated legumes

1 | INTRODUCTION

Ready to eat breakfast products are the processed grain formulations suitable for human consumption without further cooking. Cereals like wheat, rice, barley, maize, and oats are commonly used in these formulations (Cruzy Celis, Rooney, & Mcdonough, 1996). However, essential amino acids like threonine and tryptophan are present in limited quantities in cereal but are usually rich in lysine (Onweluzo & Nnamuchi, 2009). Legumes on other hand are rich in essential amino acid particularly the sulfur containing amino acids but poor in lysine (Radha, Kumar, & Prakash, 2008). Therefore, combination of legume and cereal products may improve the nutritional traits of breakfast cereals (Mensa-Wilmot, Phillips, & Hargrove, 2001). Though, it is a known fact that raw legumes contain anti-nutrient factors like phytic acid, phytates, enzyme inhibitors (trypsin and chymotrypsin), oxalates, saponins, tannins, protease inhibitors, lectins, alpha amylase inhibitors, phenolics, phytates, and alpha-galactosides, which affect the bioavailability of minerals and trace elements (Honke, Kozlowska, Vidal-Valverde, Frias, & Görecki, 1998). These anti-nutritional compounds could be reduced through germination, and thus, germinated legumes
were chosen for incorporation in cereal flakes. Germination is the simplest and cheapest method used to reduce anti-nutritional properties of legumes (Sattar, Ali, & Hasnain, 2015). During this process, enzymatic activity is triggered, which subsequently converts major components, that is, protein, carbohydrates, and lipids into simpler forms (Nout & Ngoddy, 1997). Also, reserve materials in seeds are degraded and used for respiration and synthesis of new cell constituents for developing embryo, thus causing significant changes in the biochemical, nutritional, and sensory characteristics of these legumes (López-Amorós, Hernández, & Estrella, 2006). Consequently, this research was an attempt to formulate a germinated legume-based product, which is suitable to be consumed by children, adults and old aged people.

To this date, no research has been published that used germinated legumes in breakfast cereal flakes so as to improve bioactive components of flakes. Thus, the main objective of this study was to produce legume enriched cereal flakes using lentils, green gram, and black gram. The flakes were evaluated in terms of moisture content, textural properties, total phenols, flavonols, flavonoids, antioxidant activity, and sensory properties.

2 | MATERIALS AND METHODS

2.1 | Raw materials

Three legumes, green gram (Vigna radiata), black gram (Vigna mungo), and lentils (Lens culinaris), were obtained from Pakistan Agriculture Research Council, Karachi, Pakistan. All-purpose wheat flour, rice flour, sugar, and salt were purchased from the local market.

2.2 | Germination

Seeds (100 g) were soaked in distilled water for 12 h and were then spread on a cleaned water-soaked jute bag for 24 h to germinate at 25°C and humidity was 70%. The seeds were rinsed after 6 h to reduce fungal contamination (Uwaegbute, Iroegbu, & Eke, 2000) followed by drying at 40°C for 3 days. The legumes were dried using convection-based “Constant Temperature Chamber” (Model LCT-1035C, Lab Tech, Daihan Labtech Co. Ltd, Korea). Dried beans were ground to a fine powder using hammer mill and were subsequently passed through 0.5-mm sieve (Sattar et al., 2015).

2.3 | Preparation of legume flakes

To prepare legume flakes, 30-g all-purpose wheat flour, 5-g rice flour, 3.5-g sugar, 15-g legume (non-germinated/germinated), and 1-g salt were mixed together. Water (80 mL) was added followed by beating for 5 min at slow speed. The batter was sheeted using roller (thickness 0.38–0.63 mm), cut into flakes (0.35–0.65) g, which were then baked at 210°C for 2 min (Malik, Bhat, Kour, Ahmad, & Gupta, 2017).

2.4 | Determination of moisture content in legume flakes

Moisture content of legume flakes was determined using the method of Williams (1984). Flakes were packed in polyethylene bags for 90 days at room temperature (20°C ± 2°C). Moisture content was first observed after preparation on 0 day and then after 30, 60, and 90 days storage at room temperature.

2.5 | Determination of textural properties of legume flakes

The texture of legume flakes was determined using 1-mm diameter pointed probe using Universal Testing Machine (Zwick/Roell, GmbH and Co, D-89079 Ulm). The maximum force (Fmax) required to break the flake was measured using the method of Sumithra and Bhattacharya (2008).

2.6 | Preparation of legume flakes extract

Legume flakes (0.5 g) were suspended in 20-mL mixture of methanol (99.5%, v/v) and water (6:4) followed by centrifugation at 2000 g for 10 min. Flakes extract was obtained from supernatant and was used to analyze total phenols, flavonols, flavonoids, and antioxidant capacity (Ashoush & Gadallah, 2011).

2.7 | Determination of total phenols

The extracted sample (0.5 mL) was added to 0.5 mL of Folin-Ciocalteau (FC) reagent followed by addition of 7.5% (w/v) sodium carbonate solution (0.5 mL). The mixture was stirred and allowed to stand for 30 min. The sample absorbance was measured at 765 nm using UV–visible spectrophotometer (JASCO model V670, JASCO Corporation, Tokyo, Japan). Quantification was performed with respect to the standard curve of gallic acid. The results were expressed as milligram of gallic acid equivalent per gram of legumes (dry basis) (Ashoush & Gadallah, 2011).

2.8 | Determination of flavonoids

Total flavonoid content was determined according to the method described by Formagio et al. (2014). Legume extract (250 μL) was diluted with 1250 μL water and was then reacted with 75 μL of 5% (w/v) sodium nitrite solution, followed by reaction with 150 μL of 10% (w/v) aluminum chloride to form a flavonoid-aluminum complex. Subsequently, 500 μL of 1 M sodium hydroxide solution was added to the mixture. Distilled water (2.5 mL) was then added to make up the volume. Absorbance was measured against a prepared blank at 510 nm. The flavonoid
content was determined by a catechin standard curve and expressed as the mean of mg catechin equivalents per gram of legumes (dry basis).

2.9 | Determination of antioxidant activity

The 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) assay was used to determine free radical scavenging activity according to the method of Killedar et al. (2013). The extracted sample (200 μL) was placed in a test tube followed by addition of 1.0 mL of 0.1 mM DPPH solution and was stored in dark for 30 min. Absorbance was determined at 517 nm using UV-visible spectrophotometer (JASCO, Model V670, JASCO Corporation, Tokyo, Japan) against diluted blank. The results were calculated from calibration curves, prepared with ascorbic acid (AEAC—ascorbic acid equivalent antioxidant capacity). The radical scavenging activity was calculated as a percentage of DPPH discoloration using the following equation:

\[
\text{DPPH radical scavenging} \% = \left( \frac{A_0 - A_1}{A_0} \right) \times 100,
\]

where \(A_0\) is the absorbance of the DPPH solution and \(A_1\) is the absorbance of the sample.

2.10 | Sensory analysis of legume flakes

Fifty gram flakes were sealed in polyethylene bags for 90 days at room temperature (20°C ± 1°C). Sensory analysis of flakes was performed on 0 day, 30th day, 60th day, and 90th day of storage. The tests were conducted in a sensory laboratory. A laboratory with necessary facilities, viz., separate booths, provisions for adequate diffused light and air-conditioned odor-free environment, was employed for product evaluation. Sensory evaluation of legume flakes was performed by 11 trained panelists using a nine point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely). Samples were presented in cups containing 10 g of flakes and 30 mL of full fat buffalo milk. Sensory assessment was made in terms of color, odor, chewability, and overall acceptability. The acceptable criteria for flakes were crispy texture and maintenance of integrity even after soaking in milk (Košutić, Filipović, Pezo, Plavšić, & Ivkov, 2016).

2.11 | Statistical analysis

Analyses were performed in triplicate. The data were analyzed by analysis of variance (ANOVA) using SPSS (Version 17.0, Inc., Chicago, USA) statistical program. Duncan’s multiple range tests were carried out to test any significant differences among the treatments employed. Significant levels were defined at \(P < 0.05\).

3 | RESULTS AND DISCUSSION

3.1 | Moisture content of flakes

Moisture content could be critical to the quality and safety of foods. Preferably, food industries develop products in a particular moisture content range to produce a safe product with optimum shelf-life. Quality and safety factors that the producer must consider are microbial stability, physical properties, sensory properties, and the rate of chemical changes leading to loss of shelf-life. These factors usually depend on the amount of moisture present in food (Labuza & Hyman, 1998). Therefore, moisture content of cereal flakes containing legumes was assessed to determine storability of the products. The flakes were stored for 90 days at room temperature. The results indicated that the moisture content of flakes containing germinated legumes was significantly less than their non-germinated counterparts on zero day. The results indicated that the moisture content of each germinated legume was significantly different from its non-germinated counterpart on 0 day. However, moisture content of each legume flake increased with the passage of time. The increase of moisture content has a negative impact on the product (Sumithra & Bhattacharya, 2008). As shown in Table 1, the percent increment in moisture content after 90 days of storage was insignificantly different among different flakes containing germinated legumes. The maximum increased percent moisture content after 90 days was observed in flakes with non-germinated green gram (251.7%) followed by flakes with non-germinated lentils (194.4%) and non-germinated black gram (121.4%). The reduced percent increase in moisture content after storage of cereal flakes containing germinated legumes could be due to hydrolysis of hygroscopic compounds during germination which in turn reduces water uptake. The water uptake by low moisture products can have negative effects on texture and could result in loss of quality (Roudaut, Poirier, Simatos, & Le Meste, 2004). The low moisture content of the products is important for extending the shelf life (Ahmed & Abozed, 2015), which is shown in flakes with germinated legumes.

3.2 | Texture of flakes

Texture of germinated and non-germinated legume containing cereal flakes measured in terms of \(F_{\text{max}}\) (maximum force required to break the flakes) is shown in Table 2. Results revealed that the higher \(F_{\text{max}}\) was observed for flakes containing germinated green gram and black gram, that is, 1910 and 1947 g, respectively, which was significantly different from their non-germinated counterparts, that is, flakes with non-germinated green gram (1647 g) and black gram (1828 g), which could be attributed to their lower moisture content range to produce a safe product with optimum shelf-life.
least force was observed for flakes made with non-germinated lentil (1167 g), which was significantly lower than germinated lentil (1660 g). Thus, the results point to the fact that germinated legumes could be used in flakes for crispier texture.

### 3.3 Total phenolic content of flakes

As shown in Figure 1a, nonsignificant differences were observed for the total phenolic content (TPC) of flakes containing germinated legumes (P < 0.05). Also, there was no significant difference in flakes made with non-germinated lentils, green gram, and black gram. The endogenous enzymes of the legumes, which are directly related with the phenolics, are hydrolyses and polyphenol oxidase. The activity of these aforementioned enzymes increased during germination (Rao & Deosthale, 1987). The observations revealed that flakes with germinated legume demonstrated significantly higher total phenolic content than the flakes incorporating non-germinated legumes. Thus, incorporation of germinated legume in flakes could increase the health benefits by increasing phenolic compounds. Phenolic compounds could act as strong antioxidants and metal chelators. These are also reported to be anti-inflammatory, antiallergic, hepatoprotective, antithrombotic, antiviral, and anticarcinogenic (Tapas, Sakarkar, & Kakde, 2008).

### 3.4 Flavonoid content

The major bioactive components in plants are flavonoids (Lobo, Patil, Phatak, & Chandra, 2010), which are secondary plant products and include pigments (anthocyanins) and are either colorless or yellow colored compounds (flavanones, flavones, and flavonols) (Gould & Lister, 2005; Okawa, Kinjo, Nohara, & Masateru, 2001). These act as strong antioxidants and metal chelators (Nijveldt et al., 2001) in plants. Germination plays a prominent role in increasing flavonoid content. As shown in Figure 1b, flakes with germinated green gram showed the highest flavonoid content, which was insignificantly different from flakes containing germinated black gram. However, the least was observed for flakes with non-germinated lentils. Thus, the results revealed that incorporating germinated legumes in diet could increase bioactive components in the product. It is due to the biochemical metabolism of seeds during germination which leads to production of secondary plant metabolites such as anthocyanins and flavonoids or release of aglycones from conjugated glycosides from seed coats and cotyledons due to increased enzymatic activity (Randhir, Lin, & Shetty, 2004).

#### TABLE 1

| Samples | Storage period (days) | Percent increase in moisture content after 90 days |
|---------|----------------------|-----------------------------------------------|
| NL      | 0.73 ± 0.11<sub>c</sub><sup>1</sup> | 194.4 ± 47.2<sup>c</sup> |
| GL      | 0.62 ± 0.02<sub>ab</sub><sup>1</sup> | 50.8 ± 7.4<sup>h</sup> |
| NG      | 0.64 ± 0.03<sub>b</sub><sup>1,2</sup> | 251.7 ± 36.2<sup>d</sup> |
| GG      | 0.55 ± 0.05<sub>k</sub><sup>1</sup> | 61.6 ± 16.7<sup>h</sup> |
| NB      | 0.58 ± 0.10<sub>b</sub><sup>1</sup> | 121.4 ± 57.1<sup>b</sup> |
| GB      | 0.53 ± 0.04<sub>a</sub><sup>1</sup> | 62.4 ± 6.0<sup>b</sup> |

Note: All values are mean of triplicate determinations. Different lower case letters within a column and different numbers within a row are significantly different at P < 0.05.

#### TABLE 2

| Samples | F<sub>max</sub> (g) |
|---------|------------------|
| NL      | 1167.5 ± 41.0<sup>a</sup> |
| GL      | 1660.93 ± 41.5<sup>b</sup> |
| NG      | 1647.2 ± 33.1<sup>b</sup> |
| GG      | 1910.1 ± 73.7<sup>d</sup> |
| NB      | 1828.3 ± 58.5<sup>b</sup> |
| GB      | 1947.6 ± 50.6<sup>d</sup> |

Note: All values are mean of triplicate determinations. Means within a column with different superscripts letters are significantly different at P < 0.05.

#### 3.5 Antioxidant activity of flakes

Antioxidant activity was determined by stable free radical assay using 2,2-diphenyll-picrylhydrazyl (DPPH), which forms a deep purple solution. As shown in Figure 2, addition of germinated legumes significantly increased the antioxidant capacity and was measured in terms of free radical scavenging activity of methanolic extract of flakes. Among flakes made with germinated legumes, the antioxidant capacity followed the order GL > GB > GG. Interestingly, it was observed that NL containing flakes had higher antioxidant capacity compared to...
flakes made with GG, NG, and NB. Total phenolic contents exhibit an increased antioxidant activity because these worked synergistically, and also, secondary plant metabolites such as anthocyanins and flavonoids are produced by the germination process from seed coats and cotyledons due to enzymatic reactions (Bartolomé, Estrella, & Hernandez, 1997). Apart from phenolic content, thermal stability of nutraceutical or functional component after cooking, baking, or frying is also crucial in determining its ultimate role in improving health after consumption. Antioxidant potential in plant food is due to the properties of phenolic compounds that act as reducing agents, free radical scavengers, and hydrogen donors. These play an important role in preventing development of oxidative stress related chronic diseases such as cardiovascular diseases, cancers, and inflammatory bowel syndrome (Lobo, Patil, Phatak, & Chandra, 2010).

3.6 | Sensory analysis

Color, odor, chewability, and overall acceptability attributes of the samples were evaluated as shown in Table 3. Flakes were presented for sensory analysis by adding into a bowl filled with measured quantity of full fat milk. The liquid uptake by flakes affects their internal matrix which subsequently influences sensory perceptions (Medina, Quevedo, & Aguilera, 2013). The color parameter of flakes is important for the sensory evaluation of the product and plays an essential role in the consumer acceptability. The results indicated that the color of flakes made with germinated lentils was given the highest score by the panelists. This suggested that green gram and black gram slightly reduced the esthetics of flakes in terms of appearance. However, all samples were observed to have scores more than 5 on 0 day. Interestingly, even after 90 days no change in color was observed by panelists and again cereal flakes made with germinated lentils received the highest score. Results also revealed that in terms of odor, the panelist gave significantly higher scores for flakes made with germinated green gram and germinated black gram on 0 day. However, other legumes containing flakes received scores greater than 7. Second, it was observed that statistically there was no significant difference in odor scores for all the flakes after 90 days of storage. One of the most important quality parameter of the legume flake is its chewability when soaked in milk for consumption. Almost no significant difference was observed in terms of chewability of flakes at (0, 30, 60, and 90) days on addition of different legumes. In terms of overall acceptability, a key attribute which ultimately dictates the marketability of the product, it was observed to be the highest for flakes made with GB and GG followed by NL and GL flakes. The least acceptability at 0 day was observed for NG and NB containing flakes. Interestingly, high Fmax values were objectively measured for GG and GB and these were also given higher scores by panelists. This shows that crispiness or hardness of flakes is an important contributor toward the overall acceptability of the product. NL and GL being more appealing in terms of color received second highest score whereas NG and NB flakes received the least score for overall acceptability. This point to the conclusion that germination not only improves the phenolic and antioxidant benefits of the legumes but also improves the sensory characteristics of the product in which it is incorporated.
CONCLUSION

Results demonstrated that flakes incorporated with germinated legumes led to development of an innovative product suitable for consumption by people of all ages. These ready to eat flakes showed superior bioactive properties compared to flakes made with non-germinated legumes. It was also observed that flakes made with germinated black gram and green gram demonstrated higher sensory scores. Thus, a combination of cereals and legumes in breakfast cereal flakes can improve nutritional profile in terms of essential amino acids, phenols, flavonoids, and flavonols.

CONFLICT OF INTEREST

There is no conflict of interest to declare.

ETHICS STATEMENT

This article does not contain In-Vivo studies with human participants or animals except sensory analysis of cereal flakes which included 11 panelists. All materials used in preparation of cereal flakes were food grade.

AUTHOR CONTRIBUTIONS

Dur-e-Shahwar Sattar conducted lab work in addition to write up of Manuscript. Ayesha-tul-Fauqia and Mona Sittie Muhammad conducted lab work for this research paper. Tahira Mohsin Ali designed the whole study and framed objectives, whereas overall manuscript revision was conducted by Dr. Abid Hasnain.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.

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### Table 3 Effect of non-germinated and germinated legumes on sensory analysis of cereal flake

| Storage period (days) | Samples | 0  | 30  | 60  | 90  |
|-----------------------|---------|----|-----|-----|-----|
| **Color**             |         |    |     |     |     |
| NL                    | 7.4 ± 1.6<sup>a,b</sup> 7.0 ± 1.1<sup>a,b</sup> 6.4 ± 0.9<sup>b</sup> 6.2 ± 0.7<sup>b</sup> |
| GL                    | 8.2 ± 0.7<sup>a,b</sup> 7.2 ± 1.1<sup>a,b</sup> 7.0 ± 1.1<sup>a</sup> 7.0 ± 1.1<sup>a</sup> |
| NG                    | 7.4 ± 1.1<sup>a,b</sup> 5.2 ± 2.1<sup>a</sup> 5.7 ± 0.7<sup>a</sup> 5.8 ± 0.6<sup>a</sup> |
| GG                    | 7.7 ± 0.9<sup>a</sup> 7.4 ± 1.3<sup>a</sup> 5.8 ± 0.6<sup>a</sup> 5.8 ± 0.6<sup>a</sup> |
| NB                    | 6.7 ± 1.8<sup>a</sup> 6.8 ± 1.0<sup>a</sup> 5.2 ± 1.7<sup>a</sup> 5.7 ± 1.3<sup>a</sup> |
| GB                    | 7.3 ± 1.5<sup>a</sup> 6.7 ± 1.7<sup>a</sup> 6.0 ± 1.5<sup>a</sup> 5.6 ± 1.9<sup>a</sup> |

| **Odor**              |         |    |     |     |     |
| NL                    | 7.8 ± 2.2<sup>a</sup> 7.4 ± 1.2<sup>a</sup> 6.8 ± 1.5<sup>a</sup> 6.9 ± 1.4<sup>a</sup> |
| GL                    | 7.5 ± 1.2<sup>a</sup> 7.2 ± 1.4<sup>a</sup> 6.8 ± 1.4<sup>a</sup> 5.8 ± 2.2<sup>a</sup> |
| NG                    | 7.4 ± 1.9<sup>a</sup> 7.5 ± 1.6<sup>a</sup> 6.0 ± 0.9<sup>a</sup> 7.1 ± 0.8<sup>a</sup> |
| GG                    | 8.1 ± 0.8<sup>a</sup> 7.8 ± 1.7<sup>a</sup> 7.1 ± 0.8<sup>a</sup> 7.1 ± 0.8<sup>a</sup> |
| NB                    | 7.4 ± 1.3<sup>a</sup> 6.7 ± 0.9<sup>a</sup> 6.4 ± 2.0<sup>a</sup> 6.0 ± 1.1<sup>a</sup> |
| GB                    | 8.0 ± 1.0<sup>a</sup> 7.9 ± 0.8<sup>a</sup> 7.9 ± 1.0<sup>a</sup> 7.9 ± 1.1<sup>a</sup> |

| **Chewability**       |         |    |     |     |     |
| NL                    | 7.2 ± 1.0<sup>a,b</sup> 6.5 ± 1.9<sup>a,b</sup> 6.2 ± 1.8<sup>a</sup> 6.4 ± 0.9<sup>a</sup> |
| GL                    | 7.4 ± 1.1<sup>a</sup> 6.8 ± 1.9<sup>a</sup> 6.5 ± 0.9<sup>a</sup> 6.5 ± 1.9<sup>a</sup> |
| NG                    | 6.0 ± 1.1<sup>a</sup> 5.4 ± 1.9<sup>a</sup> 6.2 ± 1.1<sup>a</sup> 6.2 ± 1.6<sup>a</sup> |
| GG                    | 7.8 ± 1.2<sup>a</sup> 7.5 ± 0.9<sup>a</sup> 6.2 ± 1.6<sup>a</sup> 6.2 ± 1.6<sup>a</sup> |
| NB                    | 7.2 ± 1.1<sup>a</sup> 6.8 ± 1.3<sup>a</sup> 6.2 ± 1.3<sup>a</sup> 6.5 ± 1.2<sup>a</sup> |
| GB                    | 7.8 ± 1.3<sup>a</sup> 7.2 ± 2.4<sup>a</sup> 7.6 ± 1.1<sup>a</sup> 6.5 ± 1.4<sup>a</sup> |

| **Acceptability**     |         |    |     |     |     |
| NL                    | 7.1 ± 1.0<sup>a</sup> 6.4 ± 2.2<sup>a</sup> 6.5 ± 1.3<sup>a</sup> 6.4 ± 1.1<sup>a</sup> |
| GL                    | 7.0 ± 1.2<sup>a</sup> 7.0 ± 1.4<sup>a</sup> 5.7 ± 1.8<sup>a</sup> 5.7 ± 1.8<sup>a</sup> |
| NG                    | 6.2 ± 1.1<sup>a</sup> 5.2 ± 1.1<sup>a</sup> 5.8 ± 1.3<sup>a</sup> 5.7 ± 1.8<sup>a</sup> |
| GG                    | 7.9 ± 1.0<sup>a</sup> 7.5 ± 1.1<sup>a</sup> 7.5 ± 1.1<sup>a</sup> 6.0 ± 0.9<sup>a</sup> |
| NB                    | 6.4 ± 1.1<sup>a</sup> 6.0 ± 0.8<sup>a</sup> 6.1 ± 0.8<sup>a</sup> 6.8 ± 0.6<sup>a</sup> |
| GB                    | 8.0 ± 1.1<sup>a</sup> 8.2 ± 1.7<sup>a</sup> 7.1 ± 1.3<sup>a</sup> 8.0 ± 2.2<sup>a</sup> |

Note: All values are mean of triplicate determinations. Different lower case letters within a column and different numbers within a row are significantly different at P < 0.05.

Abbreviations: GB, germinated black gram; GG, germinated green gram; GL, germinated lentil; NB, non-germinated black gram; NG, non-germinated green gram; NL, non-germinated lentil.
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