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Comparative nutritional analysis between *Vigna radiata* and *Vigna mungo* of Pakistan

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Vigna radiata (mung bean) and *Vigna mungo* (mash bean) of the family Fabaceae are among staple food in Pakistan. The experiments were conducted on these beans to determine the proximate composition such as moisture, ash, fibre, fat and protein content. The protein isolates from *V. radiata* and *V. mungo* was prepared and their functional properties (foaming, nitrogen solubility index and SDS gel electrophoresis) were also analyzed. All biochemical constituents were analyzed using official methods of analysis of the Association of Official Agricultural Chemists (2005). Results show that they have high protein content and play significant role in human nutrition. These beans have high nitrogen solubility and less fat content; which is a characteristic generally needed for healthy food. This research concluded that *V. radiata* has high percentage of moisture (9.74 ± 0.19), fat (1.35 ± 0.048) and protein content (22.5 ± 0.24) as compared to *V. mungo* (7.9 ± 0.06 , 1.01 ± 0.01 , 21.3 ± 0.24 , respectively). 54 and 33% of protein isolates were made from *V. radiata* and *V. mungo*, respectively. The functional properties analysis enhances their acceptability in food industry.

Key words: *Vigna radiata*, *Vigna mungo*, protein isolate, foam stability.

INTRODUCTION

Vigna radiata and *Vigna mungo* are important pulse crops belonging to the family Fabaceae. These beans have worldwide productivity and commonly cultivated in Asia (Poehlman, 1991; Jansen, 2006). They are the summer pulse crops with short duration and high nutritive value (Karamany, 2006). Among legume, these are more useful because they are the main sources of amino acid as well as protein (Imrie, 2005; Kulsum et al., 2007). They are also considered more valuable due to their high digestibility and less flatulence effect (Fery, 2002). *V. radiata* and *V. mungo* are also highly used for therapeutic purposes. Due to the antidotal activity of these beans, they have been used as medicinal or cosmetic material since ancient times (Jo et al., 2006; Sharma and Mishra, 2009). They are known to possess antihypertensive and antidiabetic properties (Lin et al., 2006; Gary, 2006; Yang et al., 2008). *V. radiata* is also reported for the treatment

of various ailments like hepatitis, gastritis, heat rash etc. (Leung, 2007; Huijie et al., 2003) and recently in 2009, Kumar and Singhal classified it as an anticancer. While *V. mungo* is well known for its hypolipidemic action (Indira and Kurup, 2003).

Many recent studies have been conducted on the nutritional quality of *V. radiata* and *V. mungo* (Hussain et al., 2010; Blessing and Gregory, 2010). These studies suggested that these beans are good source of protein, carbohydrate and minerals (Agugo and Onimawo, 2009; Suneja et al., 2011). The nutritional analysis revealed that these beans possess rich protein content, hence their protein isolates can be easily made. Moreover, *V. radiata* and *V. mungo* are locally cultivated in Pakistan and so it will be less expensive (Akaerue and Onwuka, 2010; Udensi and Okonkwo, 2006). This protein isolate can serve as nutritional supplements because protein malnutrition is one of the major problems in the developing countries and animal proteins are more expensive as compared to plant protein, and so people are more dependent on plant protein (Butt and Batool, 2010;

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Figure 1. *Vigna radiata* (mung bean).

Arulbalachandran and Mullainathan, 2009).

Functional properties are physical and chemical characteristics that influence the protein behavior in food system during processing, storage, cooking and consumption (Butt and Batool, 2010). The knowledge about their functional properties enhances their chances to be used as food supplement in food industry (Dua and Mahajan, 1996).

This research aimed to investigate in detail the nutritional value of locally available *V. radiata* and *V. mungo* (mung and mash bean) in Pakistan, and to compare and draw differences as well as similarities between the concluded proximation values in the present research work with the previous findings. Moreover, preparation of protein isolates from these beans and investigation of functional properties of these protein isolates were also aimed.

MATERIALS AND METHODS

V. radiata and *V. mungo* (Figures 1 and 2) were purchased from the local market and brought to the laboratory. The beans were cleaned, washed and dried to remove the extraneous material. Both of them were separately ground to form fine flour. The flour of each of these beans was analyzed for moisture, ash, fibre, fat and protein according to their respective methods as described in Table 1.

Preparation of protein isolates

Protein isolates were made by the method described by Johnson and Brekke (1983). Briefly, 100 g of defatted sample was weighed and 500 ml of alkaline water (pH 9) was added to it. This sample was placed on the orbital shaker at room temperature for 1 h. Afterward, the sample was subjected to centrifugation at 5000 rpm for 15 min. Due to the presence of protein in the supernatant, precipitation occurred after the adjustment of pH at 4 with 1 N HCl. While the lower layer, which is of high density, serve as the residue. The precipitates formed in supernatant were allowed to settle down. All the proteins were settled at the lower layer, while the upper layer was discarded. The lower layer was taken in a silk cloth and was placed for overnight drying. The next day, dried isolate and residue were weighed separately and were placed in packets for storage/usage. Mung and mash bean protein isolates were made by this same procedure except that mash bean sample required again centrifugation at 5000 rpm for 15 min after the pH adjustment for the isolation of proteins.

RESULTS AND DISCUSSION

Proximate analysis of whole *V. radiata* and *V. mungo*

The present project was designed to explore, as well as to compare the proximate composition of *V. radiata* and *V. mungo*. Proximate analysis is important in determining quality of food and often the basis for establishing the nutritional value and overall acceptance of the consumer.



Figure 2. *Vigna mungo* (mash bean).

Table 1. Methodology for proximate analysis;

S/N	Analysis	Method	Methodology
1	Moisture	Official method AOAC (2005)	For determination of moisture content, the weight of loss of a 5 g sample was measured in triplicate
2	Ash	Official method AOAC (2005)	The total ash is the inorganic matter of a sample. The organic matter of a sample is removed by heating at 550°C overnight. The remaining residue is the ash.
3	Fibre	Official method AOAC (2005)	Crude fiber was determined by fibre apparatus which is locally designed by PCSIR
4	Fat	Official method AOAC (2005)	For the determination of total fat, 2 g dried sample was used to ensure that all the moisture is escaped. The Soxhlet extractor was used with the hexane as extraction reagent.
5	Protein	Official method AOAC (2005)	Weigh 1 g test portion into Kjeldahl digestion flask and determine N, and then multiply with 6.25

The investigated parameters and their respective results are given in Table 3. The moisture content of *V. radiata* ($9.74 \pm 0.19\%$) was significantly different from the *V. mungo* ($7.9 \pm 0.06\%$). There were no sharp differences observed in ash and fibre content between these two beans (2.91 ± 0.072 , 3.1 ± 0.04 , 2.9 ± 0.061 , 3 ± 0.06 ,

respectively). The results obtained for fat content demonstrated significantly higher amount ($1.35 \pm 0.048\%$) in *V. radiata* as compared to *V. mungo* (1.01 ± 0.01). *V. radiata* exhibited the maximum protein content (22.5 ± 0.24) in contrast to *V. mungo* (21.3 ± 0.24).

The results of the present research corroborated with

the investigations of other scientists. From the present findings, 9.74% moisture content of *V. radiata* was obtained. However, Blessing and Gregory (2010) reported higher values for moisture content (10.25%) of *V. radiata*, while other researchers had earlier reported lower values (8.25%) for moisture (Bhatty et al., 2000). Nevertheless, Mubarak (2005) reported 9.75% for *V. radiata* moisture which is very close to the present findings. Furthermore, 7.9% moisture content for *V. mungo* was observed in the present study in contrast to Shah et al. (2011) who reported a lower value (6.9%). The estimated value of ash (2.91%) for *V. radiata* in this present attempt is in close agreement to the value (3%) described by Blessing and Gregory (2010). The results of Pasha et al. (2011) for *V. radiata* ash content (2.97%) is nearly similar to present concluded value (2.91%) for ash. For *V. mungo* recorded ash content is 3.1% to us and also comparable to the data (3.12%) given by Tresina et al. (2010). The ash content results showed that both of these beans contain nutritionally important minerals. In addition, the calculated value for *V. radiata* fibre content (2.9%) in this study is supported by the data (2.2%) given by Hussain et al. (2010), while Agugo and Onimawo (2009) reported much higher values (8.95%) for *V. radiata* fibre. The recorded fibre content of *V. mungo* according to our result is 3%, and this was supported by Shah et al. (2011) whose result can be correlated to our present findings. The slight variations were probably due to varying extent of dehulling. Dehulling may reduce the fibre content of these beans. Moreover, high fibre content makes beans a good digestive food. Due to their high fiber content, legumes are digested very slowly, thus low on the glycemic index, and help maintain stable blood glucose level and healthier glucose metabolism. Eating more beans helps to reduce the effect of high glycemic index foods by lowering the glycemic value of meals. The estimated fat content (1.35%) for *V. radiata* in this study had shown variation from the value (1.24%) observed by Butt and Batool (2010), as well as from the concluded value (1.12%) of Pasha et al. (2011). *V. mungo* fat content (1.01%) investigated in present attempt varied from the data (2.94%) presented by Tresina et al., (2010). All these variation may be due to variety differences. As shown in Table 2, the protein content (22.5%) of *V. radiata* fell between the range of 20.97 to 31.32% as reported by Anwar et al. (2007). However, the result for *V. mungo* protein content (22.51) extracted by Arulbalachandran and Mullainatha (2009) is slightly higher than the present findings (21.3), while significantly differ to the value (25.1) given by Jansen (2006).

Estimation of isolated proteins

Initially, protein was difficult to isolate (from *V. radiata* and *V. mungo*) by the method given by Krusemann and Dan

(1976) as this method was not reliable to obtain the protein (isolates) from these beans. A different method was then applied, as described by Johnson and Brekke (1983). This method was rather successful since 54% of *V. radiata* and 33% of *V. mungo* protein isolates were prepared for further estimation (Table 4; Figures 3 and 4). Table 4 also shows the comparative analysis between the percentage protein content of the mung and mash isolates. The t- test helped us to explain that the t-calculated value is greater than the t-table value which indicates that there is a significant difference between the percentage protein content of both of them.

Proximate analysis of *V. radiata* and *V. mungo* residue

After the isolation of proteins, the remaining material in the sample is termed as 'residue'. The proximate analysis of residue of mung and mash is mentioned in Table 5 (Figures 5 and 6; Graphs 1 and 2). Through this analysis we observed that in comparison with the whole bean flour where moisture and fibre content of residue get increased, protein content remarkably decreased although the value of ash content had not shown significant difference. Also, the proximate analysis of residue showed lower protein content values in contrast to that of whole bean (*V. radiata* and *V. mungo*) flour; this is because most of the protein content is already extracted from it. Here, the defatted sample had been used which consequently gave us a minimum fat content of residue.

Functional properties of protein isolates

Determination of nitrogen solubility index

Nitrogen solubility index is a useful indicator for the performance of protein isolates incorporated in the food system and to determine the extent of denaturation as a result of heat or chemical treatment at different pH (Horax et al., 2004). Nitrogen solubility index at pH 7 for *V. radiata* and *V. mungo* was 1.39 ± 0.06 and 2.36 ± 0.09 , respectively. The comparative analysis between the nitrogen solubility indexes of these beans is shown in Table 6. By the t-test application, it is found that nitrogen solubility of *V. mungo* was higher than the *V. radiata*. Succinylation and acetylation significantly improved the nitrogen solubility indexes of mung and mash (Adway, 2000).

Determination of foam stability

The foaming properties are used as indices of the whipping characteristics of protein isolates (Mwasaru et

Table 2. Functional properties of mung and mash protein isolates.

S/N	Functional property	Method
1	Nitrogen solubility index	<p>It was determined using the method of American association of Cereal Chemist (2003). About 200 ml of distilled water was added to 0.5 g of the protein isolate and mixed for 45 min. The mixture was adjusted to pH 7. Then, the suspension was transferred to a 250 ml flask and water was added to full capacity. Next, 40ml from the suspension were withdrawn and centrifuged at 1500 rpm for 10min. The supernatant was filtered and 25ml from the filtrate were transferred to a Kjeldahl digestion flask.</p> $\text{Solubility (\%)} = \frac{\text{Amount of nitrogen in the supernatant}}{\text{Amount of nitrogen in the sample}} \times 100$
2	Foaming properties	<p>It was determined according to the slightly modified method of Lin et al. (2006). One gram of the protein sample was added to 33.3 ml of distilled water and adjusted to pH 7. The suspension was mixed r for 45 min; The sample was than transferred to a 200 ml graduated cylinder as quickly as possible. The total volumes of foam were read at 0, 10, 30, 60 and 120 min after mixing. The % age foam stability can measure by the following formula:</p> $\text{Foam stability \%} = \text{Foam volume after time (t)} / \text{Initial foam volume} \times 100$
3	Sodium dodecyl sulphate (SDS) Gel Electrophoresis	<p>Electrophoresis was conducted according to Sambrook and Russel's (2001) procedure. Equal weights (0.001 g) of the samples were mined with 200 μL of reducing SDS loading buffer and heated for 10 min at 90°C for each sample. Then 5 μL (25 μg protein) were loaded onto a 12% gel.</p>

Table 3. Proximate analysis comparison of whole *V. radiata* and *V. mungo*.

S/N	Name of content	Whole mung bean	Whole mash bean	t- calculated value	t-table value
1	Moisture content (%)	9.74 \pm 0.19	7.9 \pm 0.06	13.379	4.303
2	Ash content (%)	2.91 \pm 0.072	3.1 \pm 0.04	1.789	4.303
3	Fibre content (%)	2.9 \pm 0.061	3 \pm 0.06	1.704	4.303
4	Fat (%)	1.35 \pm 0.048	1.01 \pm 0.01	7.507	4.303
5	Protein content (%)	22.5 \pm 0.24	21.3 \pm 0.24	5.155	4.303

The calculated value is greater than the table value, hence there is significant difference between the two means

Table 4. Protein content in mung and mash protein isolates and their comparison.

Number of observation	Protein isolate	% Protein	t- calculated value	t-table value
1	<i>Vigna radiata</i>	54.2	629	4.303
2	<i>Vigna mungo</i>	33.23		

al., 1999). The foam stability values of mung and mash are shown in Table 7. On observing these results, we found that the foam of *V. radiata* and *V. mungo* were both stable after 30 min at a volume of 40 ml. However, the percentage foam stability of *V. mungo* was greater than the *V. radiata* (Table 8). Meanwhile, the value of foaming stability of *V. radiata* (58%) given by Butt and Batool (2010) was much lower than the recent findings. Higher values of foam stability show highly hydrated foams and lower value may be due to protein denaturation (Kaur and

Singh, 2007). The foam stability can be enhanced by acylation (Adway, 2000), and can be decreased by succinylation (Mirmoghtadaie et al., 2008).

Sodium dodecyl sulphate gel electrophoresis analysis

The electrophoretic patterns of mung and mash bean protein isolates are presented in Figure 7. The molecular



Figure 3. *Vigna radiata* protein isolates.



Figure 4. *Vigna mungo* protein isolate.

Table 5. Proximate analysis comparison of *Vigna radiata* and *Vigna mungo* residue.

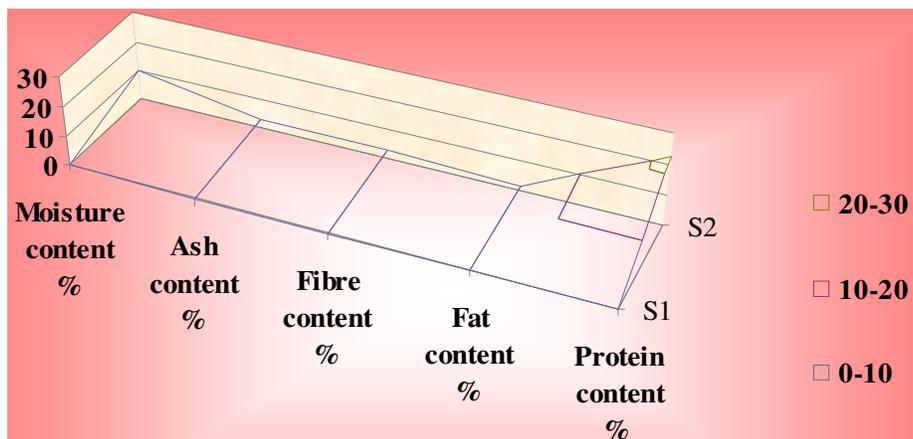
S/N	Name of contents	<i>Vigna radiata</i>	<i>Vigna mungo</i>	t- calculated value	t-table value
1	Moisture content (%)	12.5 ± 0.47	8.7 ± 0.09	7.05	4.303
2	Ash content (%)	2.24 ± 0.07	2.87 ± 0.04	11	12.706
3	Fibre content (%)	5.27 ± 0.0	5.6 ± 0.009	3	12.706
4	Protein content (%)	13 ± 0.06	8.13 ± 0.09	24	12.706



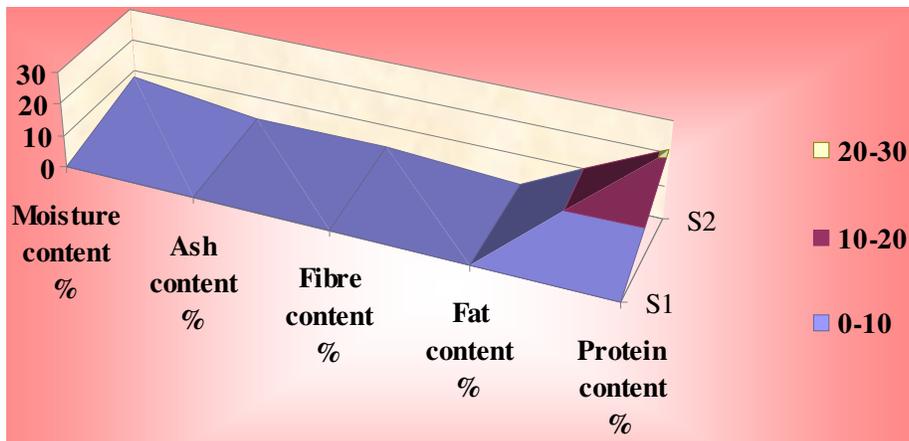
Figure 5. *Vigna radiata* residue.



Figure 6. *Vigna mungo* residue.



Graph 1. Proximate analysis of *Vigna radiata*.



Graph 2. Proximate analysis of whole *Vigna mungo*.

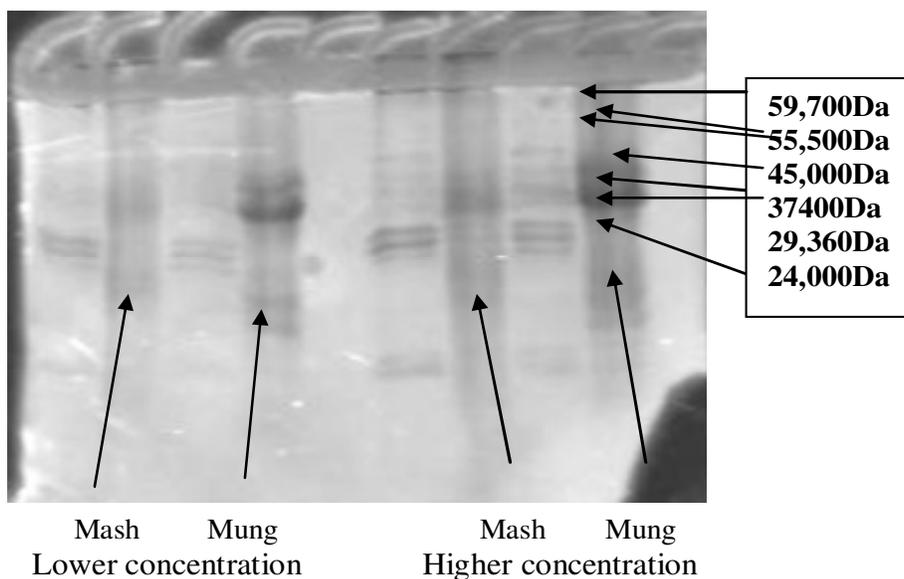


Figure 7. Gel electrophoresis of mung and mash protein isolates.

weights obtained from the SDS-PAGE electro-phoretogram are very close to the data presented by Rahma et al. (2000) who had reported high molecular weight oligomeric storage proteins as major component protein of beans being studied. However, there were no specific variations in the electrophoretogram of the total proteins content of these (mung and mash) beans (Figure 7).

Conclusion and recommendation

The proximate analysis of mung and mash bean indicates that both of these beans are very close with respect to their nutritional value. Johnson and Brekke (1983) method for protein isolation is more successful for preparation of mung bean protein isolate rather than the

mash. The study of their functional properties emphasizes the same behavior.

The presented data of proximation represents the nutritional value of that mung and mash bean which grows in Punjab. The following proposal in this area can be considered for further research:

- (1) The proximation of other varieties found all over Pakistan can also be analyzed and compared by same manner to determine the best variety.
- (2) Since the analysis of chemical composition and functional properties are also helpful for the food industry, other methods to isolate the desired components can be sought.

The method applied in this research for protein isolates preparation is suitable only for mung bean. Hence, a

different method is to be explored for the mash bean protein isolate preparation.

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