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Growth stage effect on proximate composition, minerals and sugar profile of the aerial parts of some candidate cultivars of mung bean (*Vigna radiata* L. Wilczek)

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Abstract

Aim of this study to analyze the effect of maturity or growth stages effect on proximate contents (moisture, ash, crude fat, crude fiber, total dietary fiber, crude protein, total carbohydrate and caloric energy) and nutritional (sugar and mineral) composition of aerial parts (seeds, leaves and straw) of mung bean lines. Maturity caused significant variation in studied contents and increase was observed in all proximate contents except moisture and crude and total dietary fiber contents among aerial parts. Ranges of moisture contents (2.13-12.73), ash (1.08-11.4), crude fat (0.03-1.39), crude fiber (5.32-32.45), total dietary fiber (7.32-34.47), crude protein (6.34-21.05), total carbohydrate (4.31-55.67)g/100g of dry weight (DW) and caloric energy contents (71-358)kcal/100g were found in studied aerial parts. According to the index of nutritional quality, mung bean aerial parts were proved good sources of protein, fiber, carbohydrate, caloric energy, sugar and minerals especially Na (0.98-22.29), K (31-1439), Ca (56-2481),mg (19-333), P (41-374.3), Fe (0.09-12.01), Mn (0.02-6.52), Zn (0.04-1.81), Cu (0.08-1.88) and Pb (0.03-2.71)mg/100g of DW were found. Due to maturity significant variation were recorded in minerals contents among aerial parts while non-significant variation was observed for sugar contents as well as in lines of selected mung beans. Results of present study convinced that mung bean aerial parts are also rich in balanced nutrients and minerals and they should be considered as potential sources of these minerals in human and animal's diet.

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Introduction

Mung bean [*Vigna radiata* (L.) Wilczek] belongs to family *Leguminosae*, also called *Fabaceae*, is one of the major pulse crops, supplementing the cereal-based diet of the poor in Asia today. *V. radiata* is the second major cash crop of Pakistan. It is also known as green gram and tropical legume (Habib *et al.*, 2014). There are 2000 varieties of *V. radiata*, among them yellow, gold and black are famous ones.

Legume seeds are of prime importance in human and animal nutrition due to their low fat and high protein contents (20-50%), which is twofold higher than the levels found in cereal grains and are significantly greater than that reported for conventional root crops (Guo *et al.*, 2012). Legumes serve as a low-cost protein to meet the needs of the large section of the people. They have, therefore, been justifiably described as 'the poor man's meat. Since animal proteins are more expensive and scarce than protein from plant sources, so the pulses are being commonly used by vegetarians as a substitute for meat (Zhang *et al.*, 2013).

In addition to carbohydrate and proteins, *V. radiata* are also rich source of calories, crude fibers, dietary fibers, certain minerals and vitamins (C & K). It is also rich source of essential amino acids especially lysine and bioactive compounds like phenolics, flavonoids and peptides, attracts food consumer towards it. These phytochemicals play a significant vital role in the healthy growth of body as well as provide an effective defense mechanism against the harmful fatal diseases. These phytochemicals also have strong antimicrobial, anti-inflammatory and anticarcinogenic effects and these effects are mainly due to phenolics (Caliskan and Polat, 2011). However the and radio resistance and the antineoplastic activity by the flavonoids. So the main bioactivity of *V. radiata* is chiefly due to the presence of phenolics and flavonoids, the cheap source of natural antioxidants (Shi *et al.*, 2016). Aroma extracts of mung bean, adzuki bean and kidney bean inhibit the oxidation of aldehydes.

From decade's *V. radiata* is broadly being used as a conventionally resourceful food and look at for its valuable components with the perfection of systematic skills (Khang *et al.*, 2016). Along with seeds, the leaves and straw (haulms) also have multipul uses like other cereals and legumes. Their mixture with rice and wheat straw is being used as the component of sheep and goat diets, that was found palatable to both species with no deleterious effects on their health. Its reported digestibility's was 56 and 61% in sheeps and goats respectively (Khatik *et al.*, 2007). The immature raw pods and young leaves are being used as vegetable. Several mung bean products are useful for livestock feeding. Mung bean is also being grown for fodder as hay, straw or silage. It is particularly valued as early forage as it outcompetes other summer growing legumes such as cowpea or velvet bean in their early stages (Lambrides *et al.*, 2007). Fresh mung bean forage has (13-21%) based on dry masses in protein content while the straw has (9-12%).

Though the studies available about the nutritional quality of *V. radiata* but its assessment in comparison with its arial parts (seeds, leaves and straw) with respect to maturity level is not reported yet. Studies depicts variation in the nutrtional composition in seed, leaves and straw in relation with the considering protein, dietary profile including mineral profile, carbohydrate or sugar level as well as characteristics related phenolic compounds.

In view of important uses of aerial parts of *V. radiata* in light of their high promising nutritional values and possession of important bioactive compounds, as well as its use as a part of diet this study was designed. Due to lack of findings about nutritional quality of different aerial parts of *V. radiata* native to Pakistan, especially the maturity level effect. The objective of this research was to study aerial parts (seeds, leaves and straw) interaction with the maturity levels (Immature and mature one) of five newly developed cultivars of mung bean. The findings of study will provide useful information for researcher working in food and nutrition field.

Materials and methods

Collection of Samples

Five advance lines of *V. radiata* named 08009, 14001, 14002, 14003, and 14004 were selected from already grown experimental lines in Ayub Agricultural research institute Faisalabad (AARI). The collection of samples was done in kharif season (autumn) grown upto at two growth stages before ripening (immature stage) and at maturity after ripening.

Collection of immature seeds only full green pods were collected, while for collection of fresh leaves top most leaf was selected and for green stems top most part was selected. While for collection of seed samples at maturity, fully dark brown or black pods were collected, while for mature leaves, the oldest green leaves from bottom were selected. While for fully mature stem the dried straw was collected in specific amount. All specimens were identified and authenticated by Dr. Qasim Ali, Assistant Professor Department of Botany, Government College University Faisalabad, Pakistan.

Pretreatment and storage of samples

Mature and immature mung bean seeds were seperated from their black and green pods. All samples were washed with water in order to remove dust particles, remaining water was removed using paper towel. Than the samples under shad were air dried till constant weight was achived. Dried samples of seeds, leaves and straw were ground separately to semi powder using vibratory sieve shaker (Octagon sieve (OCT-DIGITAL 4527-01) and seived to 65 micron mesh size. The ground samples were than stored in air tight polythene bags till further use. All chemicals and reagents used in research work were purchased from E.Merck or Sigma- Aldrich., (Darmstadt, Germany).

Proximate analysis and estimation of valuable nutrients

All the collected samples were evaluated for proximate attributes like (moisture, ash, crude fat, crude fiber, totally dietary fiber, protein, total carbohydrate (NFE, nitrogen free extract) and caloric energy) and also for some valuable nutrients (sugar and minerals) and values expressed on dry matter basis according to methods described (AOAC, 2012). Ash and moisture contents were estimated according to the standard reported methods (AOAC, 2012; Dini *et al.*, 1994). The crude fat contents was extracted gravimetrically using the Soxhlet extraction with n-hexane and ether and the crude fiber was estimated according to the standard methods (AOAC, 2012; Paul *et al.*, 2011). Total dietary fiber was assessed following method (Van Soest *et al.*, 1991).

The Nitrogen content estimated in all selected part was following micro-kjeldahl method and the crude protein content was calculated by using the formula (N x 6.25) as prescribed in standard methods (AOAC, 1990). (NFE) total carbohydrate was estimated by following methods (AOAC, 1990), while the total energy was calculated by using Bomb calorimeter (Model no. SDAC6000) as described by methods (AOAC, 1990).

Estimation of minerals

The minerals from all selected samples were estimated by different techniques. Spectrophotometer (Hitachi, U-1800 Spectrophotometer, Japan) for the estimation of phosphorus, flame photometer (FP-640) for sodium and potassium, while the Atomic Absorption Spectrophotometer (AAS) Perkin Elmer (A. Analyst 300) equiped with hollow cathode lamp was used for iron, copper, zinc, manganese, calcium, lead and magnesium (AOAC, 1990). For the estimation of minerals the dry sample (0.1g) from all samples was digested following method presented by (Wolf, 1982).

Sugar Profile

Preparation of extracts

The extracts of seeds were prepared after defatting by using absolute ethanol as solvent following the method described (Siddhuraju and Becker, 2003; Chatha *et al.*, 2006). Extracts were concentrated under reduced pressure using rotary evaporator and preserved in refrigerator (-4ºC), until used for further analysis (Abdolrasoul *et al.*, 2010).

Preparation of sample for HPLC

The crude ethanolic extract (20mg) blended with 5 mL double distilled water for 3 minutes and filtered through Whatman No. 1 filter paper. The method described by (Mahmood, 2011) was employed for the preparation of sample for sugar estimation. The filtrate was de-mineralized by passing the sample through cation and anion resins, before injecting to HPLC. The samples were filtered through syringe fited with filter paper of 0.22µm for the removal of microbes. All samples were prepared in triplicate and analyzed within 24 hours of preparation.

HPLC analysis

Different types of sugars from selected samples were estimated with some modification (Johansen *et al*., 1996). HPLC analysis of the sugars were performed on a Shimadzu HPLC LC-20A system (Singapore). The HPLC system was consisted of a pump (model LC20AT Prominence), a solvent degasser (model G1322A), a column oven (model CT 020A/20AC), equiped refractive index detector (model RID10A) and was controlled by Shimadzu LC Solution software. The system was also assisted by CBM 20A/20A light system controller. Carbohydrate separation was carried out on a Bio-Rad Aminex HPX-87K 300 × 7.8mm column (Cat # 1250142) with Bio-Rad guard column with ultra-pure H_2O as mobile phase at a flow rate of 0.50mL/min. A 20µL sample was injected. Refractive index detector maintained at 40°C was used for detection purposes. Maltodextrin, maltitrose, maltose, glucose and fructose were identified and quantified on the basis of retention times, peak areas and comparison with calibration curve obtained by corresponding standards.

Earlier described methods had several shortcomings and some of them methods have shown an unacceptable long retention time for raffinose and stachyose while some others had poor resolution or broad peaks. However the method presented in this paper is simple, fast, reliable, and successful in the case of high throughput screening.

Statistical analysis

Three samples of each aerial part from each line were collected crosponding in specific replicate and analyzed individually in triplicate for each activity in research work. The experimental values were expressed as mean ± SD. Coefficient of variance (CV) was computed for comparison. Data thus obtained was evaluated by Bartlett's Test of the homogeneity of variances of of SPSS version 13. Where probability of variance was P < = 0.05. Analysis of Variance (2 way ANOVA) reported (Steel and Torrie, 1980) to find out the significant differences among means, LSD test was used at 5% level of significance.

Results and discussion

Proximate and nutritional profile

Moisture

Data presented in Table 1 shows that significant ($p \leq 0.01$) variation in proximate composition of aerial parts of studied lines of mung bean was found in relation with growth stage but non-significant in relation with different lines of mung bean. Significant ($p \leq 0.01$) variation in sead moisture content was observed at different maturity stages and it was found that in immature seeds its level was high as compared to mature seeds, as reported earlier by (El-Adawy *et al*., 2003) for un-germinated and germinated mung bean seeds but dissimilar results were found by (Kavitha and Parimalavalli, 2014). The recorded moisture contents were (6.69-8.84, 4.39-5.44, 2.13-3.58g/100g) and (9.04-12.73, 6.14-8.53, 3.25-4.62g/100g), from mature and immature dry seeds, leaves and straw respectively of studied lines. Among all lines the highest moisture content in aerial parts were found in immature seeds of line 14001, followed by in leaves and the lowest was found in straw of line 14004 cultivar of mungbean. The finding comparable to previous studies (Shaheen *et al*., 2012; Padmashree *et al*., 2016) in and were higher than the finding of (Ahmad *et al*., 2016; Chandrasiri *et al*., 2016). However no earlier studies were found in the literature regarding the moisture contents in leaves and straw (aerial part) of *V. radiata* at different stages of maturity. Presence of low moisture contents is considered good in view of the quality of food, as it retards the rottening of food.

Ash contents

Significant ($p \leq 0.01$) variation was found in ash contents from different studied aerial parts at different growth stages but a non-significant variations was found among studied lines and its content was increased with maturity in all lines of *V. radiata* in different studied parts (Table 1). This increase in ash contents at maturity in present study confirms the accumulation of inorganic minerals as compared to initial growth stage as reported earlier (Paul *et al*., 2011). They found that maturity effects highly in increase of ash contents as time assorted form initial growth stage.

Ash contents were found in ranged (3.06-3.70, 1.23-2.41, 7.21-11.4g/100g) and (2.18-3.11, 1.08-2.01, 5.76-7.34g/100g) from mature and immature *V. radiata* seeds, leaves and straw accurately in different lines respectively. Overall, among aerial parts of all lines, the highest ash content was found from immature straw of line 08009, followed by seeds and lowest was found in immature leaves of line 14004. Our results are quite promising with earliear reported studies (Padmashree *et al.*, 2016) with respect to seed while lower from the findings of (Youssef, 2014; Ahmad *et al.*, 2016) and higher one from (Yasmeen *et al.*, 2017). The presence of good amount of ash content in aerial parts of studied lines indicates that differential path of these legumes can provide potential of minerals to human's as well as beneficial (Khatik *et al.*, 2007).

Table 1. Proximate Composition (g/100g DM) aerial parts of mung bean at two different maturity stages (mature and immature).

Aerial Part	Cultivars	Moisture Content Mty = ** Cv. = ns	Ash Content Mty = ** Cv. = ns	Crude Fat Mty =*** Cv. = ns	Crude fiber Mty =** Cv. = ns	Total Dietary Fiber Mty =*** Cv. =***	Crude Protein Mty =*** Cv. =*	Total Carbohydrate (NFE) Mty =*** Cv. =*	Energy kcal/100g Mty =*** Cv. =ns
Seeds	08009 (M)	8.84±0.44	3.70±0.19	1.30±0.06	6.25±0.31	26.21±1.31	21.05±1.05	55.67±2.78	358±17.90
	08009 (IM)	11.41±0.57	3.11±0.16	0.73±0.04	8.35±0.42	34.47±1.72	17.44±0.87	43.61±2.18	287±14.35
	14001 (M)	8.40 ±0.42	3.36±0.17	1.14±0.06	5.63±0.28	22.91±1.15	19.65±0.98	49.99±2.50	348±17.40
	14001 (IM)	12.73±0.64	2.34±0.12	0.67±0.03	7.92±0.40	31.94±1.60	16.77±0.84	37.43±1.87	269±13.45
	14002 (M)	7.30±0.37	3.06±0.15	1.35±0.07	5.32±0.27	21.22±1.06	18.52±0.93	50.02±2.50	319±15.95
	14002 (IM)	10.81±0.54	2.61±0.13	0.72±0.04	7.14±0.36	30.43±1.52	15.03±0.75	39.41±1.97	275±13.75
	14003 (M)	6.69±0.33	3.21±0.16	1.39±0.07	5.45±0.27	20.01±1.00	18.99±0.95	51.49±2.57	331±16.55
	14003 (IM)	10.85±0.54	2.33±0.12	0.80±0.04	7.25±0.36	29.43±1.47	16.01±0.80	42.54±2.13	251±12.55
	14004 (M)	7.12±0.36	3.43±0.17	1.24±0.06	6.01±0.30	23.87±1.19	19.45±0.97	52.77±2.64	347±17.35
	14004 (IM)	9.04±0.45	2.18±0.11	0.86±0.04	7.02±0.35	32.59±1.63	17.07±0.85	44.87±2.24	296±14.80
LSD 5%		2.03	0.63	0.20	0.96	0.89	0.98	3.90	32.47
Leaves	08009 (M)	5.44±0.27	2.41±0.12	0.29±0.01	19.01±0.95	8.43±0.42	17.05±0.85	13.25±0.66	133±6.65
	08009 (IM)	7.31±0.37	2.01±0.10	0.13±0.01	24.75±1.24	12.21±0.61	13.44±0.67	9.63±0.48	97±4.85
	14001 (M)	5.21±0.26	2.16±0.11	0.24±0.01	19.51±0.98	7.32±0.37	14.65±0.73	11.22±0.56	109±5.45
	14001 (IM)	8.53±0.43	1.24±0.06	0.17±0.01	21.21±1.06	11.62±0.58	12.77±0.64	7.73±0.39	87±4.35
	14002 (M)	5.12±0.26	2.26±0.11	0.21±0.01	19.89±0.99	7.77±0.39	13.52±0.68	10.17±0.51	101±5.05
	14002 (IM)	7.51±0.38	1.31±0.07	0.12±0.01	23.43±1.17	10.19±0.51	12.02±0.60	6.23±0.31	81±4.05
	14003 (M)	4.39±0.22	2.01±0.10	0.22±0.01	20.65±1.03	7.99±0.40	14.99±0.75	8.82±0.44	114±5.70
	14003 (IM)	7.65±0.38	1.13±0.06	0.10±0.01	21.87±1.09	11.64±0.58	11.03±0.55	5.21±0.26	71±3.55
	14004 (M)	5.02±0.25	1.23±0.06	0.27±0.01	21.17±1.06	8.01±0.40	14.44±0.72	10.47±0.52	123±6.15
	14004 (IM)	6.14±0.31	1.08±0.05	0.12±0.01	22.67±1.13	12.75±0.64	12.26±0.61	7.11±0.36	84±4.20
LSD 5%		1.84	0.71	0.075	3.75	1.72	2.14	0.42	20.36
Straw	08009 (M)	3.58±0.18	11.4±0.57	0.18±0.01	25.16±1.26	12.45±0.62	11.05±0.55	9.67±0.48	158±7.9
	08009 (IM)	4.62±0.23	7.34±0.37	0.06±0.01	32.45±1.62	17.34±0.87	8.43±0.42	6.01±0.30	119±5.95
	14001 (M)	3.31±0.17	9.56±0.48	0.14±0.01	25.34±1.27	10.47±0.52	9.04±0.45	8.45±0.42	143±7.15
	14001 (IM)	4.31±0.22	6.68±0.33	0.08±0.01	28.91±1.45	15.54±0.78	7.15±0.36	6.11±0.31	109±5.45
	14002 (M)	3.21±0.16	8.11±0.41	0.12±0.01	24.57±1.23	10.63±0.53	10.03±0.50	8.15±0.41	124±6.20
	14002 (IM)	4.52±0.23	6.54±0.33	0.05±0.01	26.88±1.34	13.43±0.67	6.34±0.32	5.21±0.26	94±4.70
	14003 (M)	2.48±0.12	7.21±0.36	0.13±0.01	23.99±1.20	11.32±0.57	9.86±0.49	6.21±0.31	111±5.55
	14003 (IM)	3.74±0.19	5.76±0.29	0.03±0.01	25.72±1.29	14.79±0.74	8.14±0.41	4.31±0.22	89±4.45
	14004 (M)	2.13±0.11	9.35±0.47	0.16±0.01	28.81±1.44	10.11±0.51	10.32±0.52	7.72±0.39	135±6.75
	14004 (IM)	3.25±0.16	6.25±0.31	0.04±0.01	27.33±1.37	15.63±0.78	7.98±0.40	6.23±0.31	99±4.95
LSD 5%		1.838	0.713	0.075	3.746	1.716	2.144	0.423	20.355

Values are mean ± SD (n=3)
Mty= Maturity level, Cv = Cultivars, M= Mature, IM: Immature

Crude fat

Data presented in (Table 1) shows that significant *(p ≤ 0.001)* variation was found in fat contents in relation with maturity stage, in all lines of *V. radiata*, and maximum was found at the maturity among various various studied aerial parts. The maximum fat contents was found in seeds (1.39%) followed by leaves (0.29%) and straw (0.18%) respectively. The represented percentage of fat contents in different aerial parts confirms that the legumes have low fat content means have low glycemic index. Crude fat contents in mature and immature parts were found in range (1.14-1.39, 0.22 - 0.29, 0.12-.018g/100g) and (0.67-0.86, 0.10-0.17, 0.03-0.08g/100g) in seeds, leaves and straw of five different lines respectively. In comparison with different mung bean lines the highest crude fat content was found in mature seeds of line 14003 and lowest was also found in immature straw part of same line.

As trend was reported in earlier study by (Hahm *et al.*, 2009) that the fat contents decreases with increase in the time of germination. This is due to fact that fatty acids are corroded to carbon dioxide and water to produce energy for growth (Hahm *et al.*, 2009). The seed fat content of mature ones are comparable with previous findings (Ahmad *et al.*, 2016; Yasmeen *et al.*, 2017) while was lower one reported as (Padmashree *et al.*, 2016; Chandrasiri *et al.*, 2016) and the higher ones were found in (Shi *et al.*, 2016). This difference might be reason due to because the earliear studies are conducted in different ecological regions and on different varieties. Regarding the fat contents in different aerial parts are not reported till now except in seeds at different growth stage. However, the findings regarding the fat content in leaf at different growth stages are lower in comparison with earlier study on *Acalypha* species. Overall, among aerial parts of all studied lines, highest fat content 1.39% was observed in the mature seeds of line 14003 and the lowest 0.03% was found in the immature straw of same line. The lower value of fat in different studied parts compared to other earliear studies suggests that our legumes lines are ideal as diet for obese people (Bains *et al.*, 2006) because these legumes containing low fat lessen the binding of fat in the arteries and blood vessels put a stop to with a low risks of vessel blocking (Bains *et al.*, 2006).

Total Carbohydrate/Nitrogen free extract (NFE)

Data presented in (Table 1) shows that a significant ($p \leq 0.001$) variation was found in NFE contents in different studied aerial parts at different maturity level as well as in different mung bean lines. A significant ($p \leq 0.001$) increase in NFE was found at maturity in comparison with immature stage in all studied lines. The maximum NFE content were found in seeds followed by leaf and minimum was found in straw. NFE contents in different aerial parts were found in range (49.99-55.67, 8.82-13.25, 6.21-9.67g/100g) and (37.43-44.87, 5.21-9.63, 4.31-6.01g/100g) from mature and immature parts of *V. radiata* lines respectively. Overall, among studied aerial parts of all studied lines, the highest NFE content was obtained from immature seeds of line 08009, followed by straw and the lowest was found in mature leaves of line 14003. Increase in NFE at maturity might be due to the storage of food in mature seeds (Nonogaki, 2010). Our values presented in present study for NFE are similar with in literature cited (Padmashree *et al.*, 2016; Chandrasiri *et al.*, 2016) and were lower as reported (Ahmad *et al.*, 2016; Tiansawang *et al.*, 2016). This variation is due to different varieties used in those studies under different agro-ecological zone. However, the NFE values in other aerial parts other than seeds in mung bean were not found in earliear studies as well as at different maturity level. The results of present study suggest that the glycemic index of selected *V. radiata* lines in different aerial parts is very low nearly glycemic index 55 as reported earliar (Sathe, 2002; Jay, 2012). This low value of GI actually serves as an advantage for people suffering from diabetes (Sathe, 2002) due to slow release of sugar with diets of low GI value. It also helps in bringing down the triglycerides present in the body; hence, reducing the deposition of fat in the body (Zhang *et al.*, 2013).

Crude Fiber

Fiber contents in different studied aerial parts were also differ significantly ($p \leq 0.001$) in all studied mung bean lines at different maturity level and significantly ($p \leq 0.05$) varied among lines of mung bean seeds but a non-significant variations was found among other aerial parts (leaves and straw) of studied lines of *V. radiata*. Data in Table 1 shows that the crude fiber contents in all studied aerial parts decreased at maturity level in all lines. Crude fiber contents in seed, leaf and straw were found in range (5.32-6.25, 19.01-21.37, 23.99-28.81g/100g) and (7.02-8.35, 21.21-24.75, 25.72-32.45g/100g) in mature and immature parts of all studied *V. radiata* lines respectively. Overall, among aerial parts of all lines, the highest crude fiber content was found from immature straw of line 08009, followed by the leaves, and the lowest was found in mature seed of line 14002. The decrease in fiber contents with maturity could be explained as, at maturity due to its use in the synthesis of structural carbohydrates such as celluloses and hemicelluloses (Arif *et al.*, 2011). Results of present study can be correlated with earlier study by (Khatik *et al.*, 2007) and the higher ones from the studies of (Ahmad *et al.*, 2016; Yasmeen *et al.*, 2017) while the lower ones was from the findings of (Banusha and Vasantharuba, 2013; Chandrasiri *et al.*, 2016). These results show that the *V. radiata* straw and leaves are rich in fiber contents that suggests its use in livestock feed while the mung bean seeds can be used as a beneficially part of diet due to its high fiber contents with increased ability to digest food (Paul *et al.*, 2011).

Total Dietary Fiber (TDF)

TDF contents were significantly *($p \leq 0.001$)* varied among different studied aerial parts of mung bean seed lines in realtion with the maturity levels and among mung bean lines. (Punna and Paruchuri, 2004) also examined TDF (soluble and insoluble) in green leafy vegetables and suggest that TDF play an important role in the nutritional value in any food. Table 1 showed that TDF contents among aerial parts decreased at maturity in all lines of *V. radiata* and significantly varied among aerial parts. The maximum TDF was recorded in lines seeds followed by straw and minimum was found in leaves. TDF contents in seeds, leaf and straw were found in a promising range (20.01-26.21, 7.32- 8.43, 10.11- 12.45g/100g) and (30.43-34.47, 10.19-12.75, 13.43- 17.34g/100g) from mature and immature mung bean parts respectively. Overall, among aerial parts of all lines, highest TDF contents were recorded from immature seeds of line 08009 and the lowest was found in mature leaves of line 14001. The decrease in TDF at maturity could be explained as, in view of the studies reported by (El-Adawy *et al.*, 2003) that the decrease in TDF might be due to its use in the synthesis of carbohydrates such as celluloses and hemicelluloses (Banusha and Vasantharuba, 2013). The obtained values for TDF are in good agreement with values reported by (Yasmeen *et al.*, 2017) and are slightly lower than that reported by (Chandrasiri *et al.*, 2016) while the higher ones reported by (Youssef, 2014). However the reports about in other leaf and straw with respect to maturity levels till not found. The results presented for TDF in different aerial parts shows that *V. radiata* straw and leaves along with seeds are rich in crude and dietary fiber that can be used in animal feed as reported earliar (Lopez *et al.*, 2005) and the mung bean seeds are being used frequently in human diet because of high TDF contents that make food more digestive, prevents the Irritable bowel syndrome (IBS) symptoms such as constipation, eliminate the stomach pains and also helpful in weight loss (Paul *et al.,* 2011).

Crude protein

Protein are one of the major required nutrients in diets and present in access amounts in all legumes. In present study significant ($p \leq 0.001$) variation was found in crude protein contents in different studied aerial parts at different maturity stages but a non-significant variations was found observed among studied lines of *V. radiata* and an increas was observed in contents of protein at maturity in all aerial parts of *V. radiata* lines. Among all studied aerial parts the maximum protein content was found in seeds followed by leaves and straw respectively. The protein content in seed, leaf and straw were in range (18.52-21.05, 13.52-17.05, 9.04-11.05g/100g) and (15.03-17.44, 11.03-13.44, 6.34-8.43g/100g) from mature and immature parts respectively in all studied lines of mung bean as represented in (Table 1). From represented data, it is clear that *V. radiata* and its aerial part are rich reservoir of proteins that are very essential for normal growth of both human and animal. Overall, among studied aerial parts of all lines the highest crude protein content was found from mature mung bean seeds of line 08009 followed by its leaves and the lowest was found in immature straw of line 14002 but present results for crude protein appears much closer to findings reported by (Yasmeen *et al.*, 2017) but higher than reported as in (Shaheen *et al.*, 2012; Banusha and Vasantharuba, 2013) while the lower ones as reported by (Shi *et al.*, 2016). Thus, variation in contents might be due to the different ecological area, varied soil conditions, nitrogen fertilization or some other environmental factors, effects of harvesting on crop or due to sample preparation. Till now, no report is available regarding the crude protein in different aerial parts with respect to maturity stage. However, our findings regarding crude protein contents from leaves are found similar to protein contents reported in leaves of sweet potato (Sun *et al.*, 2014).

Caloric energy

Energy values are important of any food items and which determines their importance in legumes. This value is promising exhibitied to the presence of complex macromolecules such as fats, starch and proteins, on active decomposition during respiration. These compounds are rich source of energy for the running of active metabolic works in the body. Significant ($p \le 0.001$) variation was found in relation energy contents in different aerial parts at different levels but nonsignificant variation was observed among lines of *V. radiata* and energy amount in percentage was increased with maturity stage in all lines of *V. radiata*. The maximum content was found in seed followed by straw and the minimum was leaves respectively. The values of studied aerial parts are in range (319-358, 101-133, 111-158kcal/100g) and (251-287, 71-97, 89-119kcal/100g) from mature and immature mung bean lines for all studied lines respectively as presented in (Table 1). From results, it is clear that different mung bean aerial parts are rich source of energy as per demand for diet. Overall, in comparison among aerial parts of all studied lines the highest energy content was recorded in mature seeds of line 08009 followed by straw and lowest was found in immature of line 14003 leaves. The values found for energy in present study are similar with respect to findings as reported by (Khatik *et al.*, 2007) in mung bean seed and lower than that reported by (Paul *et al.*, 2011; Kavitha and Parimalavalli, 2014) while the higher ones from (Padmashree *et al.*, 2016). These differences might be due to the study on different varieties, in earlier studies, experimental areas and soil conditioning.

Mineral profile

Mineral content values of selected lines of mung bean in aerial parts (seeds, leaves and straw) at different maturity stages of maturity are shown in (Table 2) that varied significantly ($p \le 0.001$) at different maturity as well as in intervaritial relation of *V. Radiata* lines. All studied minerals (Na, K, Ca,mg, P, Fe, Mn, Zn, Cu and Pb) increased significantly with maturity (Abbas and Shah, 2007) but their concentration was adversely decreased except to that of calcium, highly increased in leaves and straw than seeds. Overall minimum mineral contents were recoreded in leaves as compared to other aerial parts (Khatik, *et al.*, 2007). While overall contents of minerals were found in seeds at maturity as compared to younger (immature) stage were different and varied significantly. Minerals contents were in ranged as Na (0.98-22.29), K (31-1439), Ca (56-2481),mg (19-333), P (41-374.3), Fe (0.09-12.01), Mn (0.02-6.52), Zn (0.04-1.81), Cu (0.08-1.88) and Pb (0.03-2.71)mg/100g of DW were found in all areial parts (Seeds, leaves and straw) of *V. radiata during both stages*. Our values very similar with those reported by (Bhardwaj and Hamama, 2016) for *V. radiata* seeds as (Khatik, *et al.*, 2007) reported in different aerial parts of *V. radiata*. Overall in present study the obtained mineral contents values are higher than the findings of (Youssef, 2014) while some specific minerals contents as Zn was in higher amount from individuals previous findings (Abbas and Shah, 2007; Youssef, 2014). Mn contents also found in elevated amount in present study as compared with reported by (El-adawy, 2003, Abbas and Shah, 2007) and Na, K, Fe, Ca, Cu,mg, P and Zn contents reported for mung bean seeds by (Paul *et al.*, 2011) while Na and Ca were found in lower amount from later reported worker Paul *et al.*, 2011). In the same way, Mn and Zn were found lower than the findings of (Bhardwaj and Hamama, 2016). Present study results revealed that leave and straw parts can also be used as source of mineral supply in animal foods due to possessing a considerable contents of minerals (Ishida, *et al.*, 2000). Overall, among aerial parts of all cultivars, highest mineral contents were found in mature mung bean seeds of line 08009, except to calcium that highest obtained from same cultivar leaves while followed by leaves of other cultivars the mineral contents were found in lowest amount (mg/100g) in immature straw of line 14003. Potassium and Ca^{2+} contents were found in promising amount from studied aerial parts of all cultivars followed by contents of other minerals while the lead contents were found in low concentration at both maturity levels in all parts. Portrayed reported that the increased K/Na ratio might be helpful for avoidance of hypertension and arteriosclerosis and Ca for bone metabolism. Presents findings revealed that all aerial parts of *V. radiata* are good reservoir of iron contents and these mineral contents play an important significant role in the nutritional profile for any food (Bothwell *et al.*, 1989). After the potassium and Calcium and Magnesium was found the third highest mineral in all aerial parts and minimum was found in straw part followed by seeds to leaves composition as reported (Ouchi, 1990).

Table 2. Mineral profiles (mg/100g DM) of mung bean seeds, leaves and straw at two different maturity stages (mature and immature).

Aerial Parts	Cultivars Name	Na Mty=*** Cv. = *	K Mty= *** Cv. =**	Mg Mty =*** Cv. =**	Ca Mty = ** Cv. = ns	P Mty = *** Cv. =*	Fe Mty = * Cv. = ns	Mn Mty = * Cv. = ns	Zn Mty = ** Cv. = ns	Cu Mty = ** Cv. = ns	Pb Mty = *** Cv. = ns
Mung Bean Seeds	08009 (M)	22.92±1.1	1439±72	205±10.2	216±11	374.3±19	12.01±0.6	1.16±0.1	1.81±0.1	1.88±0.1	2.71±0.1
	08009 (IM)	12.21±0.6	928±46	105±5.3	94±5	288.7±14	7.41±0.4	0.09±0.0	1.14±0.1	0.44±0.0	1.01±0.1
	14001 (M)	20.00±1.0	1387±69	188±9.4	202±10	344±17	10.4±0.5	1.04±0.1	1.64±0.1	1.61±0.1	2.53±0.1
	14001 (IM)	11.54±0.6	912±45	97±4.9	90±4	271.2±13	6.41±0.3	0.07±0.0	1.11±0.1	0.37±0.0	0.08±0.0
	14002 (M)	17.20±0.9	1281±64	164±8.2	165±8	311±15	7.6±0.4	1.01±0.1	1.37±0.1	1.71±0.1	2.51±0.1
	14002 (IM)	10.33±0.5	871±43	81±4.1	73±4	244.7±12	6.2±0.3	0.05±0.0	0.08±0.0	0.29±0.0	0.06±0.0
	14003 (M)	14.91±0.7	991±49	161±8.1	111±6	309±15	5.82±0.3	0.08±0.0	1.22±0.1	0.81±0.0	2.38±0.1
	14003 (IM)	7.29±0.4	621±31	63±3.2	56±3	198.9±10	4.7±0.2	0.02±0.0	0.04±0.0	0.16±0.0	0.03±0.0
	14004 (M)	18.30±0.9	1321±66	179±9.0	148±7	331±16	8.8±0.4	1.03±0.1	1.51±0.1	1.74±0.1	2.64±0.1
	14004 (IM)	10.89±0.5	892±44	86±4.3	63±3	259±13	7.6±0.4	0.06±0.0	1.09±0.1	0.39±0.0	0.09±0.0
LSD 5%		2.96	108.28	13.16	51.181	34.45	3.318	0.82	0.77	0.64	0.67
Mung Bean Leaves	08009 (M)	5.90±0.3	581±29.1	333±16.7	2481±124	61±3.1	5.56±0.3	6.52±0.3	0.78±0.04	1.21±0.06	2.11±0.11
	08009 (IM)	3.70±0.2	265±13.3	131±6.6	1492±74	48±2.4	3.77±0.2	4.47±0.2	0.44±0.02	0.56±0.03	0.83±0.04
	14001 (M)	5.40±0.3	543±27.2	303±15.2	2344±117	57±2.9	5.34±0.3	6.46±0.3	0.72±0.04	1.12±0.06	2.03±0.10
	14001 (IM)	3.45±0.2	233±11.7	102±5.1	1317±65	45±2.3	3.63±0.2	4.24±0.2	0.41±0.02	0.51±0.03	0.81±0.04
	14002 (M)	4.61±0.2	529±26.5	254±12.7	2256±112	55±2.8	4.56±0.2	6.23±0.3	0.67±0.03	0.97±0.05	1.7±0.09
	14002 (IM)	2.92±0.1	237±11.9	93±4.7	1213±60	44±2.2	3.99±0.2	4.19±0.2	0.35±0.02	0.53±0.03	0.73±0.04
	14003 (M)	3.71±0.2	448±22.4	111±5.6	1876±93	53±2.7	4.44±0.2	6.15±0.3	0.61±0.03	0.86±0.04	1.20±0.06
	14003 (IM)	2.42±0.1	183±9.2	56±2.8	932±46	41±2.1	3.34±0.2	4.11±0.2	0.28±0.01	0.46±0.02	0.70±0.04
	14004 (M)	4.10±0.2	502±25.1	195±9.8	2076±103	54±2.7	5.11±0.3	6.43±0.3	0.65±0.03	0.91±0.05	1.9±0.10
	14004 (IM)	3.32±0.2	248±12.4	75.2±3.8	1071±53	46±2.3	3.22±0.2	4.33±0.2	0.32±0.02	0.54±0.03	0.84±0.04
LSD 5%		1.100	53.471	121.570	75.061	3.776	1.105	0.151	0.022	0.250	0.606
Mung Bean Straw	08009 (M)	4.71±0.2	241±12.1	54±2.7	1728±86.4	171±8.6	3.71±0.2	4.61±0.2	0.43±0.02	0.32±0.02	1.10±0.06
	08009 (IM)	1.91±0.1	114±5.7	29±1.5	832±41.6	102±5.1	1.17±0.1	2.38±0.1	0.18±0.01	0.19±0.01	0.09±0.00
	14001 (M)	3.10±0.2	217±10.9	48±2.4	1654±82.7	155±7.8	3.62±0.2	4.52±0.2	0.38±0.02	0.27±0.01	0.96±0.05
	14001 (IM)	1.67±0.1	98±4.9	22±1.1	771±38.6	85±4.3	1.09±0.1	2.21±0.1	0.16±0.01	0.15±0.01	0.06±0.00
	14002 (M)	2.40±0.1	194±9.7	45±2.3	1422±71.1	141±7.1	3.55±0.2	4.11±0.2	0.37±0.02	0.29±0.01	0.94±0.05
	14002 (IM)	1.53±0.1	81±4.1	25±1.3	701±35.1	76±3.8	1.11±0.1	2.11±0.1	0.15±0.01	0.12±0.01	0.05±0.00
	14003 (M)	1.40±0.1	104±5.2	37±1.9	1076±53.8	84±4.2	2.39±0.1	4.04±0.2	0.31±0.02	0.21±0.01	0.82±0.04
	14003 (IM)	0.98±0.0	31±1.6	19±1.0	509±25.5	45±2.3	0.09±0.0	2.01±0.1	0.07±0.00	0.08±0.00	0.04±0.00
	14004 (M)	1.81±0.1	156±7.8	42±2.1	1286±64.3	102±5.1	3.59±0.2	4.41±0.2	0.34±0.02	0.25±0.01	0.91±0.05
	14004 (IM)	1.33±0.1	61±3.1	24±1.2	632±31.6	66±3.3	1.05±0.1	2.27±0.1	0.12±0.01	0.16±0.01	0.06±0.00
LSD 5%		1.10	53.47	121.57	75.06	3.78	1.10	0.15	0.02	0.25	0.61

Values are mean ± SD (n=3)

Mty= Maturity level, Cv.= Cultivars, M= Mature, IM: Immature

Estimation of different Sugars

Sugars in the extracts were identified by comparing their retention times with standard sugars. Each sugar component was recognized by its distinctive standard retention time. Internal references were used for the verification under the chromatographic conditions described above, sugars eluted form mungbean at different maturity level were found as maltoheptose, maltohexaose, maltopentaose, maltotriose, mannitole, melezitose, sorbitol, raffinose, maltose, gulucose, lactose and dulcitol, Sucrose, Robitol, Arabitol, Stachyose and Lectitol. Sugars extracted from absolute ethanolic extract were expressed asmg/100mg of extract. It is apparent from recorded (Table 3) data that mungbean seeds have multiple types of sugars and all types of sugar contents were found non-significant in concentration except Sorbitol contents were significant ($p \leq 0.05$) variation with respect to maturity level. All types of sugar content increased at maturity in all studied *V. radiata* lines, while low concentration was found at younger growth stage. Data represented in table shows that Maltoheptose, Maltohexaose, Maltopentaose and maltotriose were predominant components in all seeds of mungbean lines and but their amounts were found very low in immature seeds as compared to mature seeds except maltoheptaose in line 14004 MB. Among all sugars the foremost component was the maltoheptaose and its highest amount was ranged (3.881- 47.708mg/100mg) was found in line 08009 (MB) and the lowest amount was found of Sorbitol, ranged in 0.258-7.87mg/100mg in 14003MB.

This sugar profile is most suitable for human and animal feed. Gulucose, sucrose and raffinose were found in low concentration in mature mungbean seeds in all mung bean lines while not found in immature seeds of the cultivar 14002. The values are comparable as reported by (Bhardwaj and Hamama, 2016). Among studied sugar sucrose, robitol, lectitol, arabitol and stachyose were found least abundant and were not detectable limits in most of the mungbean cultivars.

Table 3a. Sugar content profile (mg/100mg of extract) of mung bean seeds at two different maturity stages (mature and immature).

Cultivars	Maltoheptaose Mty = ns Cv.= ns	Maltohexaose Mty = ns Cv.= ns	Maltotriose Mty = ns Cv.= ns	Maltopentaose Mty = ns Cv.= ns	Mannitole Mty = ns Cv.= ns	Melezitose Mty = ns Cv.= ns	Sorbitol Mty = * Cv.= ns	Raffinose Mty = ns Cv.= ns
08009 (M)	47.71±2.39	26.89±1.34	19.09±0.95	--------------	--------------	0.75±0.04	0.66±0.03	--------------
14001 (M)	46.08±2.30	35.27±1.76	15.29±0.76	--------------	--------------	--------------	--------------	--------------
14002 (M)	34.36±1.72	20.65±1.03	9.83±0.49	30.28±1.51	0.40±0.02	--------------	--------------	17.47±0.87
14003 (M)	38.20±1.91	17.72±0.89	15.15±0.76	25.16±1.26	0.50±0.02	2.03±0.10	0.26±0.01	--------------
14004 (M)	24.77±1.24	16.57±0.83	--------------	40.09±2.00	0.63±0.03	0.36±0.02	--------------	15.21±0.76
08009 (IM)	37.93±1.90	8.62±0.43	18.53±0.93	5.46±0.27	6.24±0.31	12.83±0.64	7.87±0.39	--------------
14001 (IM)	3.88±0.19	2.27±0.11	12.17±0.61	--------------	3.93±0.20	--------------	4.35±0.22	--------------
14002 (IM)	5.46±0.27	7.12±0.36	16.97±0.85	--------------	--------------	4.82±0.24	--------------	--------------
14003 (IM)	7.31±0.37	19.64±0.98	4.61±0.23	3.68±0.18	17.36±0.87	--------------	6.25±0.31	16.29±0.81
14004 (IM)	41.82±2.09	5.49±0.27	14.93±0.75	5.82±0.29	4.30±0.21	--------------	6.42±0.32	6.14±0.31
LSD=5%	45.64	24.79	19.20	35.18	12.75	11.25	5.64	24.70

Values are mean ± SD (*n*=3)

Mty= Maturity level, Cv.= Cultivars, M= Mature, IM: Immature

Table 3b. Sugar content profile (mg/100mg of extract) of mung bean seeds at two different maturity stages (mature and immature).

Cultivars	Maltose Mty = ns Cv.= ns	Gulucose Mty = ns Cv.= ns	Lactose Mty = ns Cv. = ns	Dulcitol Mty = ns Cv.= ns	Sucrose Mty = ns Cv.= ns	Robitol Mty = ns Cv.=ns	Lectitol Mty = ns Cv.= ns	Arabitol Mty = ns Cv.= ns	Stachyose Mty = ns Cv.= ns
08009 (M)	--------------	0.59±0.03	2.37±0.12	-------------	1.42±0.07	--------------	-------------	-------------	0.53± 0.03
14001 (M)	--------------	0.51±0.03	2.50±0.13	-------------	-------------	--------------	-------------	0.36±0.02	-------------
14002 (M)	--------------	--------------	2.47±0.12	-------------	1.67±0.08	0.35± 0.02	-------------	-------------	-------------
14003 (M)	--------------	--------------	0.40±0.02	0.59±0.03	-------------	--------------	-------------	-------------	-------------
14004 (M)	1.44±0.07	0.85±0.04	-------------	-------------	-------------	--------------	-------------	-------------	-------------
08009 (IM)	--------------	--------------	-------------	2.51±0.13	-------------	--------------	-------------	-------------	-------------
14001 (IM)	--------------	--------------	-------------	2.22±0.11	-------------	--------------	-------------	-------------	-------------
14002 (IM)	3.072±0.15	3.46± 0.17	-------------	-------------	-------------	--------------	10.93± 0.55	-------------	-------------
14003 (IM)	15.93±0.80	--------------	5.13±0.26	3.81±0.19	-------------	--------------	-------------	-------------	-------------
14004 (IM)	15.11±0.76	--------------	-------------	-------------	-------------	--------------	-------------	-------------	-------------
LSD=5%	15.097	3.513	6.130	2.940	1.671	0.305	9.600	0.316	0.461

Values are mean ± SD (*n*=3)

Mty= Maturity level, Cv.= Cultivars, M= Mature, IM: Immature

No earlier studies were found regarding different types of sugar and their contents from different aerial parts except mung bean seeds regarding different growth stages of maturity with which to compare the results of the present analysis. These results suggest that the *V. radiata* should be a part of diet and its aerial parts also can be used as a source of sugar components for a healthy growth of body (Taira *et al.*, 2013).

Conclusion

Significant increase was observed almost in all proximate composition including sugar and mineral contents at maturity level in all aerial parts and selected lines of mung bean as compared to early growth stage, it is due to the reason that during ripening of seeds the movement of metabolites takes place towards the reproductive path till maturity, except moisture contents that significantly decreased due to maturity or horridness of seed as well as the other aerial parts as compared to early stage growth. From these results, it can be suggested that aerial parts such as leaves and straw can also be used as a constituent of human and animal's diet in parallal with seeds, due to their high nitrogen and lower fiber contents, as well as source of minerals, protein and energy.

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References

Abbas M, Shah HU. 2007. Proximate and mineral composition of mung bean. Sarhad Journal of Agriculture Pakistan **23(2),** 463-466. www.researchgate.net/publication/313443210

Abdolrasoul HE, Ebrahim HE, Zahra D, Fereshteh JK, Asma M, Hossein B. 2010. Composition and antioxidant and antimicrobial activity of the essential oil and extracts of *Stachys inflata Benth* from Iran. Food Chemistry **119(2),** 452-458. DOI: 10.1016/j.foodchem.2009.06.037

Ahmad N, Sarfraz M, Farooq U, Mushtaq MZ, Ali MA, Khan A. 2016. Quality evaluation of some mungbean [*Vigna radiata* (L.) Wilczek] varieties/promising lines from punjab. Pakistan. Journal of Agricultural Research **54(1),** 85-95. ISSN: Online: 2076-7897: Print: 0368-1157

AOAC. 1990. Official Methods of Analysis, 14th ed. Washington DC: Association of official Agricultural Chemists. https://law.resource.org/pub/us/cfr/ibr/002/aoac.methods.1.1990.pdf

AOAC. 2012. Association of Official Analytical Chemists, Washington D.C, 19 Ed. https:// doi.org

Arif M, Bangash JA, Khan F, Abid H. 2011. Effect of soaking and malting on the selected nutrient profile of barley. Pakistan Journal of Biochemistry and Molecular Biology **44(1),** 18-21. https://pdfs.semanticscholar.org/e083/1d9934ce7bf4a2ebbf6c90

Bains TS, Brar JS, Singh G, Sekhon HS, Kumar BS. 2006. Improving income and nutrition by incorporating mung bean in cereal fallows in indo gangetic plains of South Asia. AVDRC Publication, Shanhua, Taiwan.

Bothwell TH, Baynes RD, MacFarlane BJ, MacPhail AP. 1989. Nutritional iron requirements and food iron absorption. Journal of Internal Medicine **226(5),** 357-365. https://doi.org/10.1111/ j.1365-2796.1989.tb01409.x

Caliskan O, Polat AA. 2011. Phytochemical and antioxidant properties of selected fig (*Ficus carica* L.) accessions from the eastern Mediterranean region of Turkey. Scientia Horticulturae **128(4),** 473-478. https://doi.org/10.1016/j.scienta.2011.02.023

Chandrasiri SD, Liyanage R, Vidanarachchi JK, Weththasinghe P, Jayawardana BC. 2016. Does processing have a considerable effect on the nutritional and functional properties of Mung bean (*Vigna radiata*)?. Procedia Food Science **6,** 352-355. DOI: 10.1016/j.profoo.2016.02.071

Chatha SAS, Anwar F, Manzoor M. 2006. Evaluation of the antioxidant activity of rice bran extracts using different antioxidant assays. Grasasy Aceites **57(3),** 328-335.

Dini A, Migliuolo G, Rastrelli L, Saturnino P, Schettino O. 1994. Chemical composition of Lepidium meyenii. Food Chemistry **49(4),** 347-349. https://doi.org/10.1016/0308-8146(94)90003-5

El-Adawy TA, Rahma EH, El-Bedawey AA, El-Beltagy AE. 2003. Nutritional potential and functional properties of germinated mung bean, pea and lentil seeds. Plant Foods for Human Nutrition **58(3),** 1-13. DOI: 10.1023/B:QUAL.0000040339.48521.75

Guo X, Li T, Tang K, Liu RH. 2012. Effect of germination on phytochemical profiles and antioxidant activity of mung bean sprouts (*Vigna radiata* L). Journal of Agricultural and Food Chemistry **60(44),** 11050-11055. DOI: 10.1021/ jf304443u.

Habib N, Anwar MZ, Saeed I. 2014. Comparative profitability analysis of recommended mungbean varieties at NARC experimental station, Islamabad, Pakistan. Pakistan Journal of Agricultural Research **27,** 1.

Ishida H, Suzuno H, Sugiyama N, Innami S, Tadokoro T, Maekawa A. 2000. Nutritive evaluation on chemical components of leaves, stalks and stems of sweet potatoes (Ipomoea batatas poir). Food Chemistry **68(3)**, 359-367. https://doi.org/10.1016/S0308-8146(99)00206-X

Jay JM. 2012. Modern food microbiology Springer Science & Business Media.

Johansen HN, Glitso V, Bach Knudsen KE. 1996. Influence of extraction solvent and temperature on the quantitative determination of oligosaccharides from plant materials by high-performance liquid chromatography. Journal of Agricultural and Food Chemistry **44(6),** 1470-1474.DOI: 10.1021/jf950 482b

Khang DT, Dung TN, Elzaawely AA, Xuan TD. 2016. Phenolic profiles and antioxidant activity of germinated legumes. Foods **5(27),** 1-10. https: //doi.org/ 10.3390/foods5020027

Khatik KL, Vaishnava CS, Lokesh G. 2007. Nutritional evaluation of green gram (*Vigna radiata* L.) straw in sheep and goats. Indian Journal of Small Ruminants **13(2),** 196-198.

Lambrides CJ, Godwin ID. 2007. Mungbean. In *Pulses, sugar and tuber crops*. Springer, Berlin, Heidelberg **3,** 69- 90.

Lopez S, Davies DR, Giraldez FJ, Dhanoa MS, Dijkstra J, France J. 2005. Assessment of nutritive value of cereal and legume straws based on chemical composition and in vitro digestibility. Journal of the Science of Food and Agriculture **85(9),** 1550-1557. https://doi.org/10.1002/jsfa.2136

Mahmood, T. 2011. Investigations of valuable phytochemicals in native berries and cherries fruits (Doctoral dissertation, University of Agriculture, Faisalabad). DOI: 10.3390/ijms13021380 ·

Nonogaki H, Bassel GW, Bewley JD. 2010. Germination still a mystery. Plant Science **179(6),** 574-581. https://doi.org/10.1016/j.plantsci.2010.02.0

Ouchi Y, Tabata RE, Stergiopoulos K, Sato F, Hattori A, Orimo, H. 1990. Effect of dietary magnesium on development of atherosclerosis in cholesterol-fed rabbits. Arteriosclerosis, Thrombosis, and Vascular Biology **10(5),** 732-737. https://pdfs.semanticscholar.org/cda8/8b40eca3178 62efae4eeda36

Padmashree A, Semwal AD, Khan MA, Govindaraj T, Sharma GK. 2016. Effect of infrared processing on functional, nutritional, antinutritional and rheological properties of mung bean (*Phaseolus aereus*) seeds. International Journal of Advanced Research **4(1),** 606-613.

Punna R, Rao Paruchuri U. 2004. Effect of maturity and processing on total, insoluble and soluble dietary fiber contents of Indian green leafy vegetables. International journal of food sciences and nutrition **55(7),** 561-567. DOI: 10.1080/096374805001264

Sathe SK. 2002. Dry bean protein functionality. Critical Reviews in Biotechnology **22(2),** 175-223. https://doi.org/10.1080

Shaheen S, Harun N, Khan F, Hussain RA, Ramzan S, Rani S, Khalid Z, Ahmad M, Zafar M. 2012. Comparative nutritional analysis between *Vigna radiata* and *Vigna mungo* of Pakistan. African Journal of Biotechnology **11(25),** 6694-6702. http://dx.doi.org/10.5897/AJB11.3496

Shi Z, Yao Y, Zhu Y, Ren G. 2016. Nutritional composition and antioxidant activity of twenty mung bean cultivars in China. The Crop Journal **4(5),** 398-406. https://doi.org/10.1016/j.cj.2016.06.011

Siddhuraju P, Becker K. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro climatic origins of drumstick tree (*Moringa oleifera Lam.*) leaves. Journal of agricultural and food chemistry **51(8),** 2144-2155. https://pubs.acs.org/doi/abs/ 10.1021/jf020444%2B

Steel RGD, Torrie JH. 1980. Principles and procedures of statistics: a biometrical approach MC Graw-Hill Book Company. *New York*.

Sun H, Mu T, Xi L, Zhang M, Chen J. 2014. Sweet potato (*Ipomoea batatas* L.) leaves as nutritional and functional foods. Food chemistry **156,** 380-389.
DOI: 10.1016/j.foodchem.2014.01.079

Taira J, Taira K, Ohmine W, Nagata J. 2013. Mineral determination and anti-LDL oxidation activity of sweet potato (*Ipomoea batatas* L.) leaves. Journal of food composition and analysis **29(2),** 117-125.

Van Soest PV, Robertson JB, Lewis BA. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. Journal of dairy science **74(10),** 3583-3597.

Wolf B. 1982. 'A comprehensive system of leaf analysis and its use for diagnosing crop nutrient status', Communication in Soil Science and Plant Analysis **13(12),** 1035-1059.

Yasmeen A, Yaseen T, Faisal M, Nazir S, Usman S, Nasreen Z, Ali S. 2017. Comparison of nutritional and dietary fiber composition of commonly consumed cereals and legumes. Pakistan Journal of Scientific and Industrial Research, Series B: Biological Sciences **60(2),** 119-121.

Youssef GM. 2014. Influence of blanched mung bean seeds on controlling blood glucose of diabetic male rats. Nature and Science **12(12),** 95-99. http://www.sciencepub.net/nature. 14

Zhang X, Shang P, Qin F, Zhou Q, Gao B, Huang H, Shi YH, Yu LL. 2013. Chemical composition and antioxidative and anti-inflammatory properties of ten commercial mung bean samples. LWT-Food Science and Technology **54(1),** 171-178.
DOI: 10.17221/434/2015-CJFS