Asian Journal of Chemistry Vol. 21, No. 2 (2009), 1535-1540

Relationships Between Protein Content and Chemical Compositions of Local Dry Bean (*Phaseolus vulgaris* L.) Genotypes Grown in Turkey

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In present study, bean local genotypes grown in the Central Anatolian Province of Turkey have been analyzed to determine and compare their protein and mineral contents. Statistically significant variations were found amongst the genotypes for all variables. The protein and minerals analyzed for all bean genotypes show that protein varies 18.33 to 23.67 %, potassium from 963.3 to 1140 mg/100 g, phosphorus from 310.9 to 423.9 mg/100 g, calcium from 125.1 to 322.0 mg/100 g, magnesium from 90.25 to 105.9 mg/100 g, sulfur from 136.6 to 181.3 mg/100 g, sodium from 25.47 to 45.17 mg/100 g, manganese from 1.70 to 3.27 mg/100 g, iron from 3.84 to 8.41 mg/100 g and zinc from 2.09 to 2.85 mg/100 g. Positive and significant relationships were found statistically between protein and potassium, protein and phosphorus, protein and magnesium, protein and sulfur and protein and iron. The results show that bean genotypes can serve as a significant source of protein and minerals to meet the demand of populations living in Turkey.

Key Words: Local bean genotype, Protein content, Mineral content.

INTRODUCTION

Legumes play an important role in human nutrition, since they are rich source of protein, calories, certain minerals and vitamins[1]. In Turkey, the dry bean is considered to be a healthy vegetarian food. It is cheap source of high quality protein in the diets of millions in Turkey, who cannot afford animal protein for balanced nutrition. In addition to protein, it is a good source of trace elements and carbohydrates[2].

The major elements calcium, phosphorus, potassium, magnesium, sulfur, sodium are structural components of tissues and function in cellular and basal metabolism and water and acid-base balance[3]. Trace elements iron, manganese and zinc elements are essential for human being. As each essential element has a specific role in the metabolism of human being as co-factors in several enzyme reactions or as necessary

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constituents of important structural proteins that cannot be partly or wholly replaced by any other element. Its deficiency leads to impairment of biological functions from optimal to sub optimal level and results in deficiency disorders of that specific trace element in human[4].

Plant breeders recognized the importance of considering the quality requirements of end users when developing new varieties of pulse crops. Proteins are major components of grain legumes and their nutritional and functional properties dramatically affect the overall quality of seed[5]. Breeding a variety rich in protein content will also require consideration of some minerals elements of the grain.

The aim of this study was to investigate the protein and chemical composition and define the relationship between the protein content and mineral properties of some local dry bean genotypes grown in Central Anatolian of Turkey. The results permit to select and identify the best rich nutrients of local genotypes. It would also give base genotype information to ongoing research work on mineral elements and protein content of local dry bean genotypes grown in Central Anatolian of Turkey.

EXPERIMENTAL

A total of 15 local bean genotypes (*Phaseolus vulgaris* L.) from Turkey used in this study were grown at Central Anatolian in Turkey. The total annual rainfall of this area is about 250 mm. These local genotypes were a part of the germplasm collection at the Central Anatolian in Turkey. These genotypes were grown the Research Farm of the Selcuk University in the Central Anatolia (Turkey) in 2006 under similar field conditions and normal agronomic practices required for bean crops were followed. Genotypes were sown in May 2006 and harvested in August and September of same year. Samples were collected after harvesting mature whole raw beans.

Sample preparation: After harvest, bean genotypes samples were prepared for each plot. The seeds were cleaned manually to remove all foreign matter such as dust, stones and chaff as well as immature, broken seeds. Before analysis, initial moisture content of bean genotypes were determined by using a dry air heated oven at 70 ± 1 ºC for 48 h on a 50 g bean sample[6].

Determination of the protein content and mineral content

Protein content: Protein content was determined using the LECO TruSpec CN (LECO Corporation, St. Joseph, MI). 0.2 g sample was placed in the sample holder and analyzed. Per cent protein was calculated with the nitrogen conversion factor 6.25 for whey protein.

Mineral content: About 0.5 g dried and ground sample was put into a burning cup and 2 mL of 35 % H_2O_2 and 5 mL of 65 % HNO_3 were added. The sample was incinerated in a MARS 5 Microwave Oven at 180 ºC temperature and a solution diluted to certain volume with distilled water. Mineral concentrations were determined by ICP-OES (Perkin-Elmer DV 2000). These values were expressed as mg/100 g dry matter.

Statistical analysis: All data were subjected to a randomized complete blocks model of ANOVA and F-test applied to examine the statistical significance of differences amongst the varieties. Analysis variance LSD range test and coefficient of correlation analysis were performed using TARIST obtained from the Agriculture Faculty, Aegean University, Turkey.

RESULTS AND DISCUSSION

Protein content: The protein content was significantly differences amongst the genotypes (Table-1). The protein content of 15 bean genotypes ranged from protein content 18.33 to 23.67 %, with a mean of 20.98 % (Table-1). Most of the bean genotypes had protein content in the range of 20 to 24 % and only a few genotypes had protein content below 19 %. The results shown that differences were found in protein content of local bean genotypes and protein content range was quite large. The protein contents of bean seeds is usually more than 20 % and varies considerably[2]. Önder and Babaoglu[7] indicated that protein content varied from 20.44 to 25.44 % in different bean genotypes. Ceyhan[8] reported that protein content of bean genotypes between 21.46 and 28.78 %. Ceyhan *et al.*[9] indicated that protein content ranged from 21.40 to 27.29 %. Previous results of protein content show minor differences when compared with literature[8,9]. These differences might be due to genetic constitutions and environmental factors[9,10].

Mineral contents: Macro element contents such as potassium, phosphorus, calcium, magnesium, sulfur and sodium content of 8 genotypes of dry beans are presented in Table-1. For all genotypes, significant differences were observed in the mineral contents (Table-1).

Macro element concentrations of bean genotypes ranged from 963.34 (PV12) to 1139.66 mg/100 g (PV5) for potassium, from 310.92 (PV12) to 423.94 mg/100 g (PV4) for phosphorus, from 125.1 (PV15) to 299.49 mg/100 g (PV3) for calcium, from 90.25 (PV12) to 105.9 mg/100 g (PV8) for magnesium, from 136.65 (PV12) to 181.35 mg/100 g (PV4) for sulfur, from 25.47 (PV14) to 45.17 mg/100 g (PV7) for sodium (Table-1). Concentrations observed were lower than those observed for the dry bean varieties grown in Turkey[9] for potassium (1856.40 to 2159.24 mg/100 g), phosphor (570.00 to 796.59 mg/100 g), calcium (120.06 to 182.65 mg/100 g), magnesium (174.56 t0 197.95 mg/100 g) and sodium (45.57 to 51.89 mg/100 g). Macro element concentrations varied from genotype to genotype, but were higher than observed genotypes in study[8]. Phosphorus and calcium values obtained are similar to or lower than concentrations reported by Shimelis and Rakshit[11]. These differences might be due to genetic factors and grown conditions[9,10].

The contents of manganese, iron and zinc present in dry beans are given in Table-1. The manganese, iron and zinc were significantly differences amongst the genotypes (Table-1). Micro element content of all genotypes varied from 1.70 (PV4) to 3.27 mg/100 g (PV8), 3.84 (PV12) to 8.41 mg/100 g (PV15), 2.09 (PV15) to 2.85 mg/100 g (PV8) (Table-1), respectively, for manganese, iron and zinc. Iron values

TABLE-1
MEAN DATA AND STATISTICAL GROUPS BEAN GENOTYPES WITH RESPECT TO ANALYZED VARIABLES

Genotype	Protein content (%)	(mg/100 g)			
		Potassium	Phosphorus	Calcium	Magnesium
PV1	18.66 ef[1]	998.02 de	329.31 def	261.20 b	92.69 ef
PV2	23.09 ab	1084.46 abc	336.26 c-f	222.00 bc	97.02 cd
PV3	18.33 f	999.51 de	310.92 ef	322.00 a	97.41 cd
PV4	22.71 ab	1099.82 ab	423.94 a	196.39 c	103.65 ab
PV5	22.01 bc	1139.66 a	403.71 ab	193.16 c	100.75 bc
PV6	19.23 def	1005.22 de	314.97 ef	258.77 b	92.03 ef
PV7	19.54 de	996.27 de	365.00 b-e	206.98 bc	99.10 c
PV8	23.67 a	1088.26 abc	376.34 a-d	199.97 c	105.89 a
PV9	19.69 de	978.59 e	341.49 c-f	218.71 bc	93.82 def
PV10	21.22 c	1023.85 cde	391.50 abc	179.15 cd	100.04 bc
PV11	19.87 d	974.00 e	362.23 b-e	205.73 bc	92.57 ef
PV12	19.60 de	963.34 e	299.46 f	197.69 c	90.25 f
PV13	22.73 ab	1117.76 ab	352.03 b-f	201.14 c	97.58 cd
PV14	21.09 c	1057.09 bcd	368.71 a-e	185.10 c	94.80 de
PV15	23.30 a	992.73 de	410.71 ab	125.15 d	91.46 ef
Mean	20.98	1034.57	359.10	211.54	96.60
	$LSD_{0.01}$: 1.161	$LSD_{0.01}$: 68.65	$LSD_{0.01}$: 58.84	$LSD_{0.01}$: 55.69	$LSD_{0.01}$: 3.858

Genotype	(mg/100 g)				
	Sulfur	Sodium	Manganese	Iron	Zinc
PV1	137.53 e	29.17 de	2.28 d	4.89 cde	2.21 cde
PV2	157.53 cd	28.50 de	2.71 bc	4.28 ef	2.41 bcd
PV3	138.64 e	29.60 b-e	2.61 cd	4.95 cde	2.32 b-e
PV4	181.35 a	30.77 b-e	1.70 e	5.66 bc	2.24 cde
PV5	169.20 b	43.40 ab	2.27 d	5.33 bcd	2.21 cde
PV6	142.40 e	29.37 cde	2.60 cd	4.73 de	2.28 cde
PV7	169.58 b	45.17 a	1.82 e	5.72 bc	2.62 ab
PV8	168.16 bc	41.27 a-d	3.27 a	5.94 b	2.85 a
PV9	136.86 e	36.70 a-e	2.51 cd	4.76 de	2.33 b-e
PV10	147.44 de	29.80 b-e	3.03 ab	5.12 b-e	2.42 bcd
PV11	137.48 e	43.00 abc	2.27 d	5.11 b-e	2.51 bc
PV12	136.65 e	41.57 a-d	2.36 cd	3.84 f	2.17 de
PV13	162.51 bc	38.20 a-e	2.50 cd	4.54 def	2.49 bc
PV14	164.41 bc	25.47 e	2.55 cd	7.66 a	2.36 b-e
PV15	169.64 b	26.90 e	2.48 cd	8.41 a	2.09 e
Mean	154.62	34.59	2.46	5.39	2.37
	$LSD_{0.01}$: 11.19	$LSD_{0.05}$: 13.82	$LSD_{0.01}$: 0.404	$LSD_{0.01}$: 0.891	$LSD_{0.01}$: 0.311

[1]Mean in the same row different letters are not significantly different

obtained are similar to or lower than concentrations reported by many workers[8,9,11,12]. The zinc values are similar to or slightly greater than concentrations given by several researchers[8,9,11,12]. The differences observed may be due to variety, cultivar and agronomic practice differences.

Correlations: The correlation coefficients among the examined characters are presented in Table-2. Positive and significant relationships were found statistically between protein content and potassium content, protein content and phosphorus content, protein content and magnesium content, protein content and sulfur content and protein content and iron content (Table-2). The same type of relationship was found statistically between potassium content and phosphorus content, potassium content and magnesium content, potassium content and sulfur content, phosphorus content and magnesium content, phosphorus content and sulfur content, phosphorus content and iron content, magnesium content and sulfur content, magnesium content and zinc content, sulfur content and iron content, sodium content and zinc content, manganese content and zinc content. Negative and significant relationships were determined statistically between protein content and calcium content, calcium content and sulfur content and calcium content and iron content. Other variables were insignificantly positively and negatively correlated (Table-2). The results are consistent with the finding of Ceyhan[8], who found similar interrelations in bean.

TABLE-2
CORRELATIONS COEFFICIENTS BETWEEN PROTEIN CONTENT AND MINERALS IN BEAN GENOTYPES

Variable	Protein	K	P	Ca	Mg	S	Na	Mn	Fe	Zn
Protein	–									
K	0.632‡	–								
P	0.592‡	0.443‡	–							
Ca	-0.545‡	-0.066	-0.505‡	–						
Mg	0.462‡	0.694‡	0.509‡	-0.007	–					
S	0.699‡	0.666‡	0.702‡	-0.458‡	0.623‡	–				
Na	-0.082	0.032	0.100	-0.062	0.210	0.050	–			
Mn	0.244	0.099	-0.063	0.120	0.156	-0.193	-0.049	–		
Fe	0.358†	0.021	0.609‡	-0.509‡	0.045	0.523‡	-0.226	-0.006	–	
Zn	0.204	0.245	0.153	0.077	0.507‡	0.132	0.301†	0.336†	-0.043	–

† and ‡ statistically significant at 0.05 and 0.01 probability levels, respectively.

Conclusion

This study about dry beans demonstrated protein and mineral content differences among the local bean genotypes. All genotypes contained good amounts of protein and mineral content. The lower cost of the legumes the reduced incomes of the majority of people of Turkey, together with the high prices of animal products, may justify these efforts. This may be of potential importance for breeding studies in selecting for improved legumes with high protein and mineral content. These results revealed that bean may provide a sufficient amount of minerals to meet the human mineral requirement.

ACKNOWLEDGEMENT

This study was supported by Selcuk University Scientific Research Project (BAP) Konya, Turkey.

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(*Received*: 26 March 2008; *Accepted*: 15 October 2008) AJC-6942