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Full Length Article

Relationships between Chemical Composition and Seed Yield of some Lentil (*Lens culinaris*) Cultivars

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ABSTRACT

Lentil is one of the major legumes crops in all over the world including Turkey. Lentil may be helpful in meeting the protein need of diet. This study was carried out on Kışlık kırmızı 51, Yeşil pul 11, Yeşil pul 21, Fırat 89, Emre 20 and Malazgirt 89 lens cultivars were used as material to find relationships of these varieties with their chemical characteristics. Moisture, dry matter content, ash content, nitrogen content, crude protein, water soluble protein, total carbohydrates, crude fiber and crude fat contents were determined. Principle component analysis was applied on chemical components according to cultivars. Seed yield ranged from 167 kg to 180 kg. The highest seed yield was obtained from Yeşil Pull 11 cultivar. The factor 1 (dry matter), factor 2 (moisture), factor 3 (crude protein) affected cumulative variance between 82.7 and 90.5% according to cultivars. There were significant relationships between seed yield and dry matter at all cultivars. Dry matter, moisture and crude protein affected seed yield.

Key Words: Yozgat; Lens; Chemical composition; Principle component analysis

INTRODUCTION

Turkey is basically an agricultural country and its economy depends on agricultural sector. Legumes crops take place in agriculture of Turkey. Legumes are cultivated on large areas of Turkey. There are protein-calorie malnutrition problems in Turkey as all over the World. Legumes may be helpful in solving this problem. Legumes crops have richly essential amino acids, particularly lysine. It has been demonstrated that legume protein is the natural protein suitable to complement that present in cereals grains and legumes grains comprise an important part of human diet (Riberio & Melo, 1990). Amjad *et al.* (2006) explained that legumes are helpful in enhancing the protein content. Lentil (*Lens culinaris* Medik.) is one of the most important crops with 4.4% protein, 1.8 oil, 41-50.8% carbohydrates, 21.4 fibrous, high percentage of other mineral nutrients and unsaturated linloeic and oleic acid for human consumption (Özdemir, 2002).

Lentil is one of the major legumes crops in Turkey, grown in non-irrigation conditions. Different lens varieties showed some genetic variation for plant height, number of branch, number of pod per plant, number of seed per plant, harvest index and biological yield. These studies are helpful to develop high yielding varieties. Chemical composition of lens crops can vary with cultivars, soil and climatic conditions of the area. Karadavut and Palta (2010) explained that chemical composition varied in different locations. Stacey *et al.* (2006) explained that chemical composition varied with time. Accumulation of chemical matters of varieties in seeds has not been investigated (Palta *et al.*, 2010). Especially accumulation of moisture, ash, total nitrogen, total protein, water soluble protein, oil and fiber varied speedy with time (Palta *et al.*, 2010). However, accumulation patters of chemical matters needs to be examined carefully.

The chemical composition levels in the improved or registered lentil cultivars are not emphasized previously. This study presents variation of some chemical parameters i.e., moisture, ash, total nitrogen, total protein, oil and fiber with time.

MATERIALS AND METHODS

Kışlık kırmızı 51, Yeşil pul 11, Yeşil pul 21, Fırat 89, Emre 20 and Malazgirt 89 lentil cultivars were used as material. Those cultivars were improvement in Turkey for arid and semi-arid zones. The seeds were grown under non-irrigation conditions during 2005-2006 growing seasons at Yozgat ecological conditions (in Central Anatolia Region). The soil type was silty clay with low levels of organic matter (1.2%) and pH 7.6. This location has a typical continental climate. Long term average rainfall is 410 mm. Phosphorus fertilizer was applied at the rate of 50 kg P ha^{-1} at the time of sowing. The experimental design was a randomized complete block with four replications. Plots

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were 4 rows spaced 0.35 m apart and 10 cm between plants. Weeds were controlled by hand. At maturity, pods from plants in the two middle rows, of each plot were harvested manually; sun dried for two weeks, threshed manually.

The seeds were cleaned from dust and other foreign materials and stored at the room temperature for analysis. Moisture and dry matter content of samples were determined according to AOAC (Anonymous, 1990). Ash contents were determined by Pearson (1962). Nitrogen content of cultivar was estimated by using Kjeldal procedure (Anonymous, 1990). The percentage of crude protein was calculated as taken percent nitrogen by 6.25. The water soluble protein contents were determined by Biuret methods (Plummer, 1979). Total carbohydrates were calculated by Onyeike *et al.* (1995). Crude fiber contents were determined by AACC (Anonymous, 1983). The results were presented standard deviation of four replications. Data were statistically analyzed using Minitab Software V14.1. The significant difference between means was calculated by one way ANOVA. Correlation analysis was done for determining relations between dry matter and chemical compositions. Principle component analysis (PCA) was applied on chemical components.

RESULTS AND DISCUSSION

According to two years analysis results obtained from lentil cultivars, there are significant variation among cultivars. Descriptive statistics of lentil cultivars are shown Table I. The highest variance is shown in seed yield (4.709) and total carbohydrate (2.958), for all that dry matter and water soluble protein showed lower variation than other characters.

Chemical composition of the seeds of six lentil cultivars and results of multiple comparison test (Duncan) are shown in Table II. Dry matter contents in these varieties ranged from 78.10 g to 89.25 g; being the highest in Emre 20 followed by Malazgirt 89 (88.22 g) cultivar. The lowest dry matter was obtained by Yeşil Pul 21 lens cultivar. A significant difference was observed among cultivars. Moisture content ranged from 5.44 g to 6.42. The highest moisture was observed by Fırat 89 cultivar. Moisture content can vary according to climatically conditions. There are reports of negative correlations between dry matter and moisture content (Amir *et al*., 2007).

Total nitrogen, protein content and water soluble protein contents ranged from 2.92 to 3.25 g, 3.92 to 4.42 g and 1.96 to 2.21 g, respectively. There are significant different appeared among varieties. Total carbohydrates ranged from 42.63 to 49.55%. Carbohydrates were the highest in Malazgirt 89 followed by Emre 20. This variation may be attributed to climatic and varietal differences. Crude fat ranged from 2.53 to 3.06 g with significant differences among the cultivars. All of the six lens cultivars were noted to be poor in crude fat (Kaya & Yalçın, 1999). Germinated lentil proteins had improved solubility and water and fat adsorption properties. Foaming capacity of germinated lentil proteins was higher than that of non-germinated seeds, while the foam stability decreased progressively. These improved functional properties make germinated lentil proteins a useful product to be used in food formulations in order to enhance their quality (Bamdad *et al*., 2009).

Table I: Descriptive statistics of seed yield and chemical compositions

Variable	Mean	Standard Deviation	Variance	Minimum	Maximum
Dry matter	84.1	0.45	0.203	73.2	88.6
Seed yield	175.2	2.17	4.709	172.1	180.5
Moisture	5.8	0.12	0.014	5.4	6.3
Ash	2.8	0.16	0.026	2.6	2.9
Total nitrogen	3.2	0.10	0.010	2.9	3.4
Crude protein	4.2	0.15	0.023	3.9	4.5
Water soluble protein	2.1	0.16	0.026	1.9	2.3
Total carbohydrate	46.3	1.72	2.958	41.6	52.8
Crude fat	2.8	0.05	0.003	2.5	3.1
Crude fibre	14.8	0.19	0.036	14.3	15.2

There are significant differences among cultivars according to crude fiber and ash contents. Lentil comprises an important of human diet. Lentil can be especially used arrangement of insulin and digestibility systems. In this reason, crude fiber is very important components for digestibility. Seed yield ranged from 167 kg to 180 kg. There is significantly variation according to lentil cultivars. They were found to be high in Yeşil Pul 21 cultivar. This cultivar is followed by Malazgirt 89 cultivar. The lowest seed yield was obtained by Kışlık Kırmızı 51 lentil cultivar. The crude protein and water soluble protein content of cultivars were lower than that reported by Cone *et al*. (2002) and Wang and Daun (2004).

Wide variation in the chemical composition of lentil cultivars was probably due to different varieties. Ecological variation may be responsible for the differences of chemical compositions. The marketing value of lentil cultivars is greatest when used for animal feed than as human food (Maheri-Sis *et al*., 2007). Environmental conditions exert significant influences on chemical composition of legumes (Al-Karaki & Ereifej, 1997). Significant genetic variations in chemical composition (e.g., protein) of legume seeds have been reported (Al-Karaki & Ereifej, 1997; Ereifej *et al*., 2001). The breeding programs are carried out in search for high yielding lens cultivars to meet the increasing demand for lentil seeds.

According to cultivars, correlation coefficients (only significant) between seeds yield and chemical compositions are shown Table III. In Table, seed yield revealed correlation dry matter, crude protein, total nitrogen, ash, crude fat and crude fiber according to cultivars. Anjam *et al.* (2005) explained that there was a high variation among the genotypes for the traits used for study to evaluate the genotypes. The plant height and pods per plant were significantly ($P < 0.05$) and biomass highly significantly ($P < 0.01$) correlated with the seed yield. The pod dehiscence and viral disease infection were highly negatively correlated

Table II: Chemical composition of seeds of lentil cultivars and seed yield

Components (g/100 g)	Kışlık Kırmızı 51	Yeşil Pul 11	Yeşil Pul 21	Fırat 89	Emre 20	Malazgirt 89
Dry Matter	80.11 b	82.24 b	78.10 c	81.65 b	89.25 a	88.22 a
Moisture	5.68 c	5.76 bc	5.51 c	6.44 a	6.02 c	6.16 b
Total nitrogen	3.14 b	2.92 c	2.96 c	3.21 a	3.25 a	3.18 ab
Crude protein	3.92 d	4.06 c	4.42 a	3.97 cd	4.34 a	4.26 b
Water soluble protein	2.07 bc	2.00 cd	2.02 c	1.96 d	2.12 b	2.21 a
Total carbohydrates	44.30 bc	48.61 a	45.55 b	42.63 c	47.61 ab	49.55 a
Crude fat	2.71 d	2.53 e	2.82 c	3.01 a	3.06 a	2.90 b
Crude fiber	14.88 b	14.74 c	14.91 b	15.13 a	15.12 a	14.53 d
Ash	2.71 b	2.78 b	2.81 ab	2.74 ab	2.87 a	2.64 c
Seed yield (kg/ha)	167 b	175 a	180 a	168 b	171 ab	175 a

with the seed yield. This association of the traits may be used in the breeding Programme to exploit the yield potential for enhancing the productivity of the lentil crop and to develop high yielding varieties with ease and target oriented research work.

The founded variation in seed chemical composition among cultivars in the present study could be due to genetic differences (Ereifej *et al*., 2001; Farshadfar & Farshadfar, 2008). Interestingly, crude protein was highly correlated with seed yield. There were significantly relation between seed yield and dry matter at all cultivars, except Malazgirt 89 cultivar. But crude protein was significantly relations with seed yield. In Yesil Pul 11 cultivar, seed yield and crude fat showed negative relations. Also crude fat showed negatively relation with seed yield. Studies on chemical diversity in lentil (*Lens culinaris Medik*.) indicated the existence of considerable amount of variation for grain yield and its components in the material.

Six different lentil varieties were tested for 8 chemical parameters. Principal components analysis (PCA) was used for statistical analysis of chemical data separately and combined (Table IV).

The most descriptive chemical component includes dry matter as representative of a major fraction of the seed yield formation. With three PCs, all cultivars were well accounted for, with 80% of the variation in chemical parameters explained. For all cultivars, we seen factor 1 (dry matter), factor 2 (total nitrogen) and factor 3 (crude protein) also account. Cumulative variance is 88.9%. Eigenvalues can be thought of as quantitative assessment of how much a component represents the data. The higher the eigenvalue of a component, the more representative it is of the data. Eigenvalues can also be representative of the level of explained variance as a percentage of total variance. The percent of variance explained is dependent on how well all the components summarize the data. In this study variability were explained between 84.4 and 92.0% according to cultivars.

Rad *et al.* (2009) explained that Principal component analysis (PCA) revealed that the first PCA explained 55.27% variation. Selection of genotypes that have high PCA1 and PCA2 are suitable for both stress and non-stress environments. Toklu *et al.* (2009) explained that principal component analysis (PCA) demonstrated that the first 3 principal components could explain the total variance that was observed to a large degree. PC1 is defined by the biological yield, the weight of the pods/plant, the number of pods/plant and the weight of seeds/plant. This is an

Table III: Correlation seed yield and chemical components (only significant)

Cultivars	Correlation (r)	
Kışlık Kırmızı 51	Seed yield * Dry matter	0.544**
	Seed yield * Crude protein	0.511**
	Seed yield * Total nitrogen	0.412*
Yeşil Pul 11	Seed yield * Dry matter	0.662**
	Seed yield * Crude protein	0.548**
	Seed yield * Total nitrogen	0.436*
	Seed yield * Ash	0.422*
Yeşil Pul 21	Seed yield * Dry matter	0.621**
	Seed yield * Crude protein	0.534**
	Seed yield * Total nitrogen	0.423*
	Seed yield * Crude fat	-0.450*
Fırat 89	Seed yield * Dry matter	0.521**
	Seed yield * Total nitrogen	0.432*
	Seed yield * Crude protein	0.496**
Emre 20	Seed yield * Crude protein	0.597**
	Seed yield * Ash	0.502*
	Seed yield * Water soluble protein	0.455*
	Seed yield * Dry matter	0.624**
Malazgirt 89	Seed yield * Crude protein	0.486**
	Seed yield * Crude fat	0.418*
	Seed yield * Total nitrogen	0.506**
	Seed yield * Crude fiber	0.471*

*, P<0.05 and **, P<0.01

Table IV: According to cultivars, eigen value, total variance (%) and cumulative variance (%)

Cultivars	Eigen values	Total variance	Cumulative Variance
Kışlık Kırmızı 51	3.8612	0.480	0.480
	1.9662	0.286	0.766
	1.3244	0.153	0.920
Yeşil Pul 11	3.1250	0.422	0.422
	1.8441	0.261	0.683
	1.2148	0.173	0.856
Yeşil Pul 21	2.8132	0.441	0.441
	1.3212	0.272	0.713
	1.0054	0.154	0.867
Fırat 89	4.2163	0.416	0.416
	2.2104	0.320	0.736
	1.1758	0.163	0.899
Emre 20	3.2451	0.461	0.461
	1.9087	0.285	0.746
	1.1010	0.172	0.918
Malazgirt 89	2.9651	0.423	0.423
	2.1045	0.259	0.682
	1.0631	0.162	0.844

indication of the importance of the Yield components. Principal component analysis (PCA) was performed for 12 quantitative traits. The first three principal components accounted for 73.13% of the total variation. Bicer and Sakar (2004) have also concluded that there is a significant variation for the agronomic characteristics between some of the lentil landraces of the south eastern Anatolian region of Turkey. These studies were supported our study.

CONCLUSION

The highest variance has occurred in seed yield and total carbohydrate of lentil, which resulted from physiologic responses of the cultivars to the environment that they were grown. Because dry matters content, moisture content and crude protein were effective on seed yield these parameters should be pay importance. The findings of this study showed that the breeders should choose the indices on the chemical composition. Dry matter accumulation, moisture and crude protein are suggested as useful indicators for lentil breeding.

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