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Some Micronutrient Values and Some Quality Traits in Husk and Groats of Oat Genotypes

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Abstract: Oat is one of the important cereal crops due to its high nutritional content and versatile usage in human diet and animal feed. Therefore, it was aimed to examine some nutritional values in grain (groat and husk) and, some quality traits of five commercial oat varieties and six advanced oat lines under Kahramanmaraş conditions in 2016-2017 cropping year. The experiments were arranged in a randomized complete block design with four replications. According to the results, thousand seeds (groat + husk) weight was found as 26.17 to 45.51 g, test weight (groat + husk) was 47.80 to 54.30 kg, crude protein ratio of grain was 13.97 to 16.55%, groat percentage was 66.31% to 73.33%, husk ratio was 26.67% to 33.68%, iron content of groat was 22.75 to 39.44 mg kg^{-1}, iron content of husk was 54.06 to 90.27 mg kg^{-1}, zinc content in groat was 28.09 to 66.21 mg kg^{-1}, zinc content of husk was 14.04 to 36.59 mg kg^{-1}, calcium content in groat was 83.30 to 191.50 mg kg^{-1}, the calcium content of husk was 313.7 to 442.30 mg kg^{-1}. When genotypes were evaluated according to the examined characteristics, it was noted that TL137 genotype was the best in terms of both thousand grain weight and test weight, but it was low in protein ratio was low. TL576, Fetih, Kirk-lar and Kahraman genotypes were determined to be the highest genotypes in terms of groat percent-age. It was observed that the iron content in groat of Sari, TL139 and TL452 genotypes was high, but the iron content of Kahraman and TL42 genotypes was low in both groat and husk. It was noted that TL452 genotype had low both zinc and calcium content in groat.

Yulaf Genotiplerinin Kabuk ve İç Tanelerindeki Bazı Mikro Besin Değerleri ve Bazı Kalite Özellikleri

Anahtar Kelimeler
Yulaf, Tohum, Kabuk, Tane karakterleri, Elementler

Öz: Yulaf, yüksek besin içeriği ve insan beslenmesinde ve hayvan yemlerinde çok yönlü kullanımı nedeniyle önemli tahıl bitkilerinden biridir. Bu nedenle, 2016-2017 üretim yılında Kahramanmaraş koşullarında beş ticari yulaf çeşidi ve altı ileri yulaf hattının tanelerinde (dane ve kavuz) bazı besin değerleri ile bazı kalite özelliklerinin incelenmesi amaçlanmıştır. Deneme tesadüf blokları deneme desenine göre dört tekerrürlü olarak düzenlenmiştir. Sonuçlara göre bin tane (dane+kavuz) ağırlığı 26.170 ile 45.510 g, hektolitre ağırlığı (dane+kavuz) 47.80 ile 54.30 kg, tanede ham protein oranı 13.97% ile 16.55%, kavuzsuz tane oranı 66.31% ile 73.33%, kavuz oranı 26.67 ila 33.68 mg kg^{-1}, danede demir içeriği 22.75 ila 39.44 mg kg^{-1}, kavuzda demir içeriği 54.06 ila 90.27 mg kg^{-1}, danede çinko içeriği 28.09 ila 66.21 mg kg^{-1}, kavuzda çinko içeriği 14.04 ila 36.59 mg kg^{-1}, danede kalsiyum içeriği 83.30 ila 192.50 mg kg^{-1}, kavuzda kalsiyum içeriği 313.7 ila 442.30 mg kg^{-1} olarak bulunmuştur. İncelenen özelliklere göre genotipler değerlendirildiğinde TL137 genotipinin hem bin tane ağırlığı hem de test ağırlığı bakımından en iyi olduğu ancak protein oranlarının düşük olduğu dikkat çekmiştir. TL576, Fetih, Kırklar ve Kahraman genotiplerinin dane oranı bakımından en yüksek genotipler olduğu belirlenmiştir. Sarı, TL139 ve TL452 genotiplerinin danede demir içeriğinin yüksek olduğu, Kahraman ve TL42 genotiplerinin ise hem dane hem de kavuzda demir içeriğinin düşük olduğu görülmüştür. TL452 genotipinin danede hem çinko hem de kalsiyum içeriğinin düşük olduğu kaydedilmiştir.

1. INTRODUCTION

Oat (*Avena sativa* L.) is an important cereal crop. It is used as grain and forage crop. The characters of covering and protecting on soil of oat create diversification for sustainable agriculture. Oat is known as a rich plant in terms of protein, fat, starch, vitamins (especially vitamin E) and nutrients. Also, it has the soluble fibers that has hypocholesterolemic properties. The high nutritional value of the oat plant is due to the high amount of mineral substances (2.90-3.40%) [1]. Oat contains high protein (12.40- 24.40%), fat (2-12%), vitamins and mineral (54 mg Ca, 4.7 mg Fe, 117 mg Mg, 523 mg P, 429 mg K, 2 mg Na, 4 mg Zn in 100 grams,) substances [2; 3]. Although oat grains used for animal feed, it is recently uses as a multipurpose crop in human nutrition and industry has made it possible for oat to be among the prominent plants in the grain group [4]. Decker et al. [5] stated that husks of cereals as significant quantity of agricultural by-products represent with low digestibility and a high lignocellulose content. And also husks that finely milled could be used as a human food source. Additionally, it could be used in animal bedding and feeding purposes [6]. Barbieri et al. [7] stated that wheat husks were produced 10 million tons in Europe. When the husk currently re-searched potential utilization options, it is hoped that it will take place in many different composite material in the future [6]. Thereby oat husks will be improving the circular economy of agricultural as by-products so a lignocellulose material that have the potential for assessment. Although oat is consumed as whole grain cereal, it is used as breakfast products, oat-cookies, beverages and granola bars across the world, due to the health benefits. It is also a very good source of energy due to high rate of fat than other grains [8]. However, it has a well-balanced amino-acid composition, compared to other cereal grains [9]. In general, the unsaturation oil ratio of cereal lipids are range between 70-86% [10].

Oat has high protein content and the avenin seed storage protein in their seeds formed an important raw material source for alternative feed production in animal nutrition due to their high composition of lipids, unsaturated fatty acids, soluble fiber, essential amino acids, minerals, vitamins [11]. Oat grains are considered beneficial for health in terms of human nutrition [12]. It is an important plant due to its properties such as lowering cholesterol, decreasing heart disease, high fiber and iron con-tent, and lowering blood sugar levels in terms of human health [4].

Since oat products are used in the industry, it has an important cultivation area in the world. Oat crops might be grown in cool and rainy climates [12]. According to the data of 2021, oats yielded 23.6 million tons of which 9.6 million hectares were cultivated in the world. It was recorded that 208 thousand tons of product was obtained by planting 132.9 thousand ha in Turkey [13]. Over time, the richness of seed properties (protein, oil, vitamins and minerals) has increased the interest in oats [14]. In this study, it was aimed to determine some groat and husk characteristics of 11 oat genotypes and to determine the oat genotypes showing superiority in terms of the examined charac-teristics.

2. MATERIAL AND METHOD

In the study, 5 oat varieties (Kirklar, Fetih, Sari and Kahraman were belong to Avena sativa L. species and Arslanbey was belongs to Avena byzantina C. Koch species) and six local oat genotypes (TL38, TL137, TL139, TL576, TL42 and TL452 belongs to Avena sativa L.) were used as the material in the experiment. The trial was carried out in the 2016-2017 growing season under the conditions of Kahramanmaras province. Kahramanmaras region, where the experiment was conducted is located in the Eastern Mediterranean Region between the coordinates of 37°35'4.92" North latitude and 36°55'35.08" East longitude of Turkey. The sowing date was on 19.01.2017. It was planted late, due to the climatic conditions. The reason for this was the lack of sufficient rainfall in November and the excess of precipitation in December. Genotypes were planted with a drill between 20 cm row space, 5 m row length, 400 seed m^2, as 6 rows in per plot. The experiment was arranged in a randomized complete block design with four replications. The fertilizer was applied 7 kg da^{-1} nitrogen and phosphorus with planting (20-20-0: N; P; K). In addition, 7 kg da^{-1} nitrogen was applied as top dressing at the beginning of the jointing stage. Herbicide (2,4-D amin) was applied for weed control. The relative humidity value varied between 65.9% and 42.9%, the average temperature values were the lowest 3.8 °C and the highest 26.4 °C, and the total precipitation was 408.7 mm.

Some climatic values of the months in which the research was carried out are given in the Table 1 [14]. Soil of the test area was clay-loam. It was determined that the soil was slightly alkaline (7.76), excessively lime (24.48%), slightly salty (0.32%), less in terms of phosphorus (3.2 kg da^{-1}), sufficient in potassium (98.64 kg da^{-1}), medium level in organic matter (2.28%) [15]. In the study, the thousand seeds (groat+husk) weight, crude protein ratios, test weight (groat+husk), groat percentage, husk ratio, iron content in groat, zinc content in groat, calcium content in groat, iron content of husk, zinc content of husk and calcium content of husk characters of oat genotypes were investigated. The weight of one thousand seeds was calculated by counting 100 grains four times and then dividing by four and multiplying by ten. The test weight was determined by measuring with the test pot and then weighing. After milling oat groats into flour, the crude protein ratios from samples taken as flour was made using the WINISI package program on the FOSS 6500 NIR system device. Groat percentage was measured with weighing the de-hulled grains. The husk ratio was calculated using the husk to groat+husk ratio. Determinations of the iron, zinc, calcium were realized by atomic absorption spectrometry (AAS) after microwave digestion.

Table 1. Some important climatic data of trial site in 2016-2017

Months	Average Relative Humidity (%)	Average Temperature (°C)	Precipitation (mm)	Maximum Temperature (°C)	Minimum Temperature (°C)
October	40.1	20.5	10.7	32.5	9.2
November	49.5	11.1	36.8	23.7	0.3
December	67.9	4.5	105.0	15.2	-4.5
January	65.9	3.8	126.7	7.9	1.9
February	44.0	7.4	3.7	13.0	2.2
March	55.4	12.2	74.5	17.7	7.4
April	49.0	15.8	67.8	21.8	10.0
May	55.0	19.6	105.0	26.0	14.5
June	42.9	26.4	3.1	33.3	19.9

The variance analysis and the average of the data obtained in the experiment were analysed in the SAS statistical package program. Mean data belong to the cultivars were grouped by Duncan's multiple comparison test [17].

3. RESULTS AND DISCUSSION

The thousand seeds weight, test weight, crude protein ratio were showed in the Table 2. The groat percentage, ratio of husk, iron content in groat, iron content of husk were given in the Table 3. The zinc and calcium content of groat, zinc and calcium content of husk were given in the Table 4.

In the study, the differences among oat genotypes were found statistically insignificant in terms of thousand seeds weight. The average thousand seeds weight was found to be 34.92 g. The highest thousand seeds weight was obtained on TL137 genotype with 45.51 g, and the lowest thousand seeds weight was obtained on TL139 genotype with 26.17 g (Table 2).

As a result of the study, the weight of thousand seeds of oat genotypes varied among 26.17 to 45.51 g. It was noted that TL 137 line had a higher thousand seeds weight than the registered cultivars. Other lines had a lower thousand seeds weight than registered cultivars (Figure 1). Previously, many researchers reported that thousand seeds weight in oat genotypes ranged from 16.32 g to 42.62 g (Sahin et al. [18, 19, 20, 21]. The cited thousand seeds weights were found to be largely consistent with our research findings.

As seen in the Table 2, the variation among the genotypes was for significantly different for test weight ($p<0.01$). The average test weight was determined as 50.30 kg. The highest test weight was recorded in Kirklar genotype with 54.30 kg and the lowest test weight was recorded in TL576 genotype with 47.80 kg.
In the study, the test weight of oat genotypes was observed between 47.80 - 54.30 kg. Test weight is an important factor determining the quality of oat grain [22]. It was noted that TL 42, TL 137 and TL139 lines showed close values to Kahraman, Sari, Aslanbey cultivars and did not differ statistically (Figure 1). This shows that oat lines performed as successful as registered varieties. Test weights in previous studies were found by Sari et al. [4] 50.3- 57.7 kg in lines and 45.4 - 51.4 kg in standard varieties, Erbas [23] 34.5 - 51.0 kg, Sahin [24] 36.6 - 49.7 kg. As stated by many researchers, growing conditions, genetic factors, grain fullness, climate, environment, soil and relationships between these factors are the properties that affect the test weight [19; 24; 22; 14].

It is determined that oat genotypes are statistically significant in terms of crude protein ratio ($p<0.01$). The average crude protein ratio among genotypes was found 15.34%. It was noted that the highest protein rate was on TL38 genotype with 16.55%, and the lowest protein rate was on Arslanbey genotype with 13.97% (Table 2).

The grain crude protein ratio among oat genotypes ranged from 13.97% to 16.55%. In terms of protein in grain, TL38 and TL42 lines were not significantly different from Kahraman cultivar with the highest crude protein ratio among registered cultivars, and they were in the same group. Crude protein ratio in previous studies were determined 12.60% [18], and by Topkara [26] the average of genotypes as 14.98% and the average of varieties as 14.60%, 11.9-15.8% for landrace and improved oats varieties [27]. In earlier works, the crude protein ratio was determined in Triticale 10.80% to 19.20% [28; 29], 19.40% in barley, 8.8% in millet and 13.3% in rye [30]. It has been reported that the crude protein ratio depends on the environment and genotype [14; 29]. Exclusively, there was negative relationship between grain yield and crude protein ratio of cereals [29]. Generally, higher protein content in grain of oat is desired. It is determined that the protein content of oat grain is high and therefore it is an important plant in terms of human nutrition [18].

Table 2. Mean data of the oat genotypes for thousand seeds weight, test weight, crude protein ratio

Genotypes	Thousand Seeds Weight (g)	Test Weight (kg)	Crude Protein Ratios (%)
TL38	31.18	48.80 cd	16.55 a
TL42	29.10	50.20 b-d	16.43 a
TL137	45.51	51.60 a-c	14.15 cd
TL139	26.17	50.20 b-d	14.67 b-d
TL452	33.98	48.30 cd	15.00 bc
TL576	27.26	47.80 d	15.45 b
Fetih	35.74	48.70 cd	15.52b
Sari	38.71	50.80 b-d	15.47 b
Arslanbey	39.84	49.60 b-d	13.97 d
Kirklar	38.39	54.30 a	14.95 cb
Kahraman	38.24	53.00 ab	16.52 a
General Means	34.92	50,30	15.34
C.V. (%)	7.06	4.24	4.01
P<0.001	ns	**	**

** significant at 0.01 level, ns: not significant, C.V. : Coefficient of Variation.

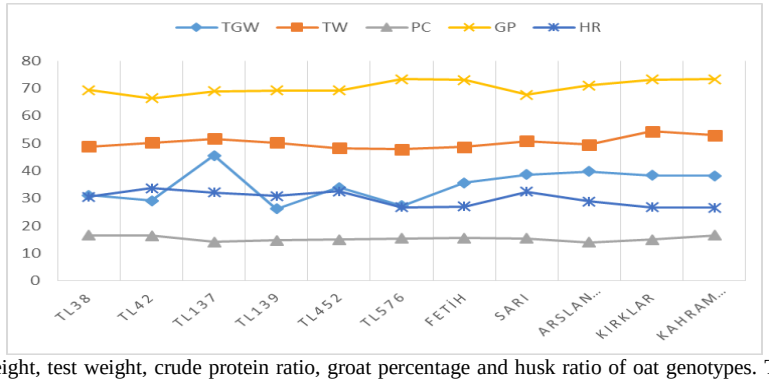

Figure 1. Thousand seeds weight, test weight, crude protein ratio, groat percentage and husk ratio of oat genotypes. TWG; thousand seeds weight, TW; test weight, PR; crude protein ratio, GP; groat percentage, HR; husk ratio

It was observed that oat genotypes had a statistically significant ($p<0.01$) variation for the groat percentage. The means of groat percentage of oat genotypes was found as 70.39%. The highest was recorded on the Kahraman genotype with 73.33%, and the lowest groat percentage was recorded on the TL42 genotype with 66.31% (Table 3).

The groat percentage of oat genotypes were determined to be among 66.31% to 73.33%. It was seen that TL 576 line, Kahraman and Kirklar varieties had the highest grain/groat+ husk ratio and were statistically in the same group. In previous studies, it found that the mean of the groat percentage of genotypes varied between 67.4% and 81.1% [23].

It has been determined that the husk ratios of oat genotypes are statistically significant ($p<0.01$). As can be seen in the Table 3, among the genotypes, the average of husk ratio was recorded to be 29.85%. It was determined that the highest of husk ratio was on TL42 genotype with 33.68%, while the lowest of husk ratio was on Kahraman genotype with 26.67%.
In this study, the husk ratio of oat genotypes varies between 26.67% and 33.68%. Average husk ratio of oat genotypes, Sahin et al. [18] found it to be 27.1%. Kahraman et al. [21] found 20.6–39.2% in Kirklareli location and 17.0-39.5% in Edirne location. Bedoic et al. [31] were determined that after the grain harvested was obtained 25-32% husks of oat seed. Our findings were showed that the ratio of groat and husk varied as depending on the variety and growing conditions. The similar findings in previous studies were also recorded.

It was observed that the differences among genotypes for the iron content of groat and iron content of husk were statistically significant ($p<0.01$). It was determined that the average iron content in groat was 34.05 mg kg^{-1} and the average iron content of husk was 71.82 mg kg^{-1}. It was observed that the highest groat iron content was on the Sari genotype with 39.44 mg kg^{-1}, while the lowest iron content was on the TL38 genotype with 22.75 mg kg^{-1}. The highest iron content of husk was determined on the Arslanbey genotype with 90.25 mg kg^{-1}, while the lowest iron content of husk was determined on the TL42 genotype with 54.06 mg kg^{-1} (Table 3).

Iron content in groat of oat genotypes was found between 22.75 - 39.44 mg kg^{-1} and iron ratio of husk between 54.06 and 90.25 mg kg^{-1}. It has been determined that the iron content in the oat grain is significantly lower than that in the husk. It was seen that TL 139 and TL 452 lines used in the research had higher values than other varieties in terms of iron content in groat, except for the Sari variety. TL 38, TL 137 and TL 139 lines used in the research were found to have higher values than other varieties, except for Arslanbey variety, in terms of iron content in husk (Figure 2). Li et al. [32] found that the rate of Fe in grain content of oat plants in 3 different locations of China was between 27.6-66.52 mg kg^{-1}. In another study, the Fe content in oat seeds was found to be 58.00 mg kg^{-1} [33], and 26.7 mg kg^{-1} [34]. The finding of Yilmaz and Koyuncu [35] was stated that Fe content of oat husk was as 26 µg g^{-1}. Yalcin [1] cited iron ratio to be variety according to year and location, it reported that it had a value between 32.6 - 123.3 mg kg^{-1} at the Kirklareli location and 30.4 - 52.4

mg kg^{-1} at the Karacabey location. Alemayehu et al. [26] noted that iron ratio of oat groat was 2.5-3 mg 100 g^{-1}. The Fe content in dry matter related to cereals in previous studies was found 35 mg kg^{-1} for wheat, 27 mg kg^{-1} for corn, 54 mg kg^{-1} for sorghum, 128.40 mg kg^{-1} for barley, 199.80 mg kg^{-1} for millet, 44.00 mg kg^{-1} for rye, 10.6 mg kg^{-1} for broom millet [36; 35; 30]. These results show that the iron content among cereals may vary depending on species. It is understood from the studies that the Fe content in the groat and the husk of the oat plant is higher than that of some grain plants. The human body needs Fe element too much. A person's daily need for Fe is 12 mg [38]. The daily Fe requirement of farm animals was recorded between in cattle 150-250 mg, in pig 10- 30 mg, in sheep 7-15 mg, in horse 90-100 mg [39]. Considering the daily Fe levels of humans and some farm animals, in this respect, the iron content in the oat groat and husk is of important.

Table 3. Mean data of oat genotypes for groat percentage, husk ratio, iron content in groat and iron content in husk

Genotypes	Groat percentage (%)	Husk ratio (%)	Iron (Fe) content in groat (mg kg^{-1})	Iron (Fe) content of husk (mg kg^{-1})
TL38	69.40 bc	30.60 bc	22.75 e	87.38 b
TL42	66.31 c	33.68 a	31.65 d	54.06 j
TL137	68.88 bc	32.10 ab	34.59 c	88.31 b
TL139	69.15 bc	30.85 bc	38.58 ab	82.68 c
TL452	69.17 bc	32.52 ab	38.79 ab	72.67 b
TL576	73.30 a	26.70 d	36.26 bc	55.59 i
Fetih	72.97 a	27.03 d	34.44 c	59.42 g
Sari	67.58 c	32.42 ab	39.44 a	77.13 d
Arslanbey	71.05 ab	28.95 cd	31.00 d	90.25 a
Kirklar	73.19 a	26.80 d	36.69 bc	65.13 f
Kahraman	73.33 a	26.67 d	30.35 d	57.44 h
General Means	70.39	29.85	34.05	71.82
C.V. (%)	2.74	4.94	4.84	1.34
P<0.01	**	**	**	**

** significant at 0.01 level, C.V. : Coefficient of Variation

In the study, it was determined that the zinc content in groat and the zinc content o of husk of the genotypes are statistically significant (p<0.01). The average zinc content in groat was 40.66 mg kg^{-1}, while the average content of zinc of husk was 25.70 mg kg^{-1}. It was noted that the highest groat zinc content was found on the TL576 genotype with 66.21 mg kg^{-1}, while the lowest one was on the TL137 genotype with 28.09 mg kg^{-1}. The highest content of zinc of husk was recorded on the TL137 genotype with 36.59 mg kg^{-1}, while the lowest content of zinc of husk was recorded in the TL576 genotype with 14.04 mg kg^{-1} (Table 4). It was observed that the zinc content in groat was between 28.09 and 66.21 mg kg^{-1}, and the content of zinc of husk was between 14.04 and 36.59 mg kg^{-1}. It was determined that the zinc content of the oat groat was higher than the husk, and the zinc content of the TL 38 and TL 576 lines was significantly higher than the registered varieties. Except for the TL 576 line, it was noted that the lines were superior than registered varieties in terms of zinc content in husk the exception of Arslanbey (Figure 2).

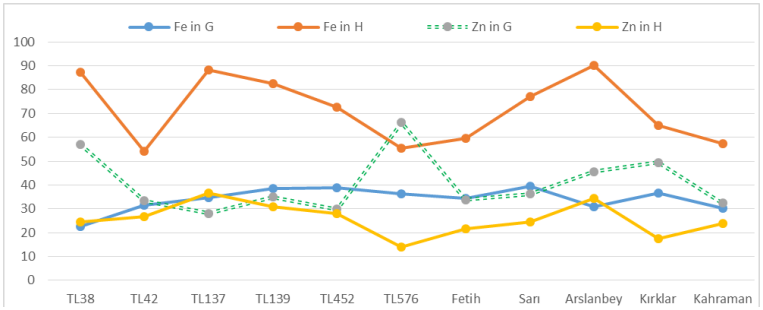

Figure 2. Iron content in groat, iron content of husk, zinc content in groat, zinc content of husk of oat genotypes. Fe in G; iron ratio in groat, F in H; iron ratio of husk, Zn in G; zinc ratio in groat, Zn in H; zinc ratio of husk

In previous study by Singh et al. [31] determined the content of Zn in oat seeds as 45 mg kg^{-1}. The content of Zn in oat husk was found as 12 µg g^{-1} in researches of Yilmaz and Koyuncu [35]. Li et al. [32] were reported that different oat varieties in 3 different locations of China the amount of Zn were 18.70 - 30.50 mg kg^{-1}. Yalcin [1] cited that the zinc content of oat lines and varieties were between 17.6 - 82.7 mg kg^{-1} for first year and 21.4 - 65.4 mg kg^{-1} for the second year in the Karacabey location. The same researcher observed the zinc content of oat lines and varieties were between 17.4 - 45.9 mg kg^{-1} for first year and 18.6 - 107.1 mg kg^{-1} for second year in the Kirklareli Location [21]. It was emphasized by Alemayehu et al. [27] that the zinc content in oats ranged from 1.6 to 2.1 mg 100 g^{-1}. Ragaee et al. [30] found that the content of Zn was 74.20 mg kg^{-1} in barley, 65.90 mg kg^{-1} in millet and 30.60 mg kg^{-1} in rye. In the other study conducted on barley plants, the Zn content in the seed was found to be 24.16 mg kg^{-1} [40]. Ozcan et al. [41] stated that zinc contents

of oats were 1.5 - 3.8 mg 100 g^{-1}, which is in close agreement with our result. It has been noted that the amount of Zn in the human body is 2 - 4 g and the daily Zn need of a person varies between 3 and 5 mg [38].

Zinc was a vital component of a number of enzymes participating in the synthesis and degradation of proteins, carbohydrates, lipids and nucleic acids, so it was required for the accurate growth and maintenance of the human body [42]. It is seen that the content of Zn in the seed and husk of oats is enough to meet the daily Zn need of an adult.

The differences amoung the oat genotypes were found to be statistically significant ($p<0.01$) in terms of calcium content in the groat and calcium content of husk. As can be seen in the Table 4, it was noted that the average calcium content in the groat was 140.97 mg kg^{-1} and the average calcium content of husk was 390.14 mg kg^{-1}. The highest calcium content in the groat was found on the TL139 genotype with 193.10 mg kg^{-1} and the lowest calcium content in groat was found on the TL576 genotype with 83.30 mg kg^{-1}. The highest calcium content of husk was found on the Arslanbey genotype with 442.30 mg kg^{-1}, and the lowest calcium content of husk was found in the TL576 genotype with 313.70 mg kg^{-1}.

In the research, it is determined that oat genotypes had calcium content in the seed between 83.30 and 193.10 mg kg and calcium content of husk between 313.70 and 442.30 mg kg^{-1}. It was observed that the calcium content in the husk of the oat grain is much higher than the grain, and the difference is still 2-3 times higher in some genotypes (Figure 3). TL139 line had a higher value than Fetih variety in terms of calcium content of groat. TL42 line showed higher value than other varieties except Fetih variety in calcium content of groat. In terms of calcium content in oat husk, TL42 line showed a higher value than other varieties, except for Arslanbey.

Table 4. Mean data of oat genotypes for Zinc content in groat, zinc content of husk, calcium content in groat and the calcium content of husk

Genotypes	Zinc (Zn) content in groat (mg kg^{-1})	Zinc (Zn) content of husk (mg kg^{-1})	Calcium (Ca) content in groat (mg kg^{-1})	Calcium (Ca) content of husk (mg kg^{-1})
TL38	57.11 b	24.50 cde	128.50 f	420.70 c
TL42	33.41 fg	26.83 cd	162.80 b	430.10 b
TL137	28.09 h	36.59 a	131.70 e	403.10 d
TL139	34.98 ef	30.85 b	193.10 a	345.30 g
TL452	29.85 h	27.96 bc	116.50 h	379.60 f
TL576	66.21 a	14.04 f	83.30 i	313.70 h
Fetih	33.88 fg	21.76 e	191.50 a	348.70 g
Sari	36.20 e	24.42 cd	144.70 d	405.70 d
Arslanbey	45.56 d	34.53 a	117.40 h	442.30 a
Kirklar	49.50 c	17.51 f	124.10 g	417.40 c
Kahraman	32.46 g	23.79 de	150.80 c	385.00 e
General Means	40.66	25.70	140.97	390.14
C.V. (%)	3.17	9.67	0.99	0.69
P<0.01	**	**	**	**

** significant at 0.01 level, C.V. Coefficient of Variation.

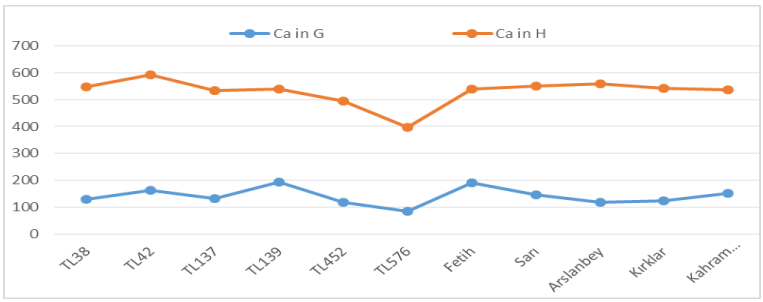

Figure 3. Graph of oat genotypes relative to calcium content in groat, calcium content of husk. Ca in G; calcium content in groat, Ca in H; calcium content of husk

The Ca Content in oat seeds by Singh et al. [31] was found as 796.00 mg kg^{-1}. Li et al. [30] were noted that the content of Ca in oats was between 480 - 600 mg kg^{-1} for 3 different regions of China. Mut et al. [22] found that the calcium content for oat were between 300 and 520 mg kg^{-1}. Sahin [24] observed that the ratio of calcium in oats were 0.418 - 0.466% in autumn application and 0.386-0.444% in spring application. It was stated by Alemayehu et al. [27] that the calcium content in oats varies between 44 - 102.7 mg 100 g^{-1}. Yilmaz and Koyuncu [33] indicated that the crude protein content of oat husk was 960 µg g^{-1}. The Ca ratio in previous studies was reported as 300 mg kg^{-1} in wheat, 260 mg kg^{-1} in corn, 250 mg kg- in sorghum, 736.20 mg kg^{-1} in barley, 508.60 mg kg^{-1} in millet, 348.70 mg kg^{-1} in rye, and 27.30 mg kg^{-1} in broomsorghum [36; 30]. These findings showed that the content of Ca of the oat plant was higher than that of some cereals. The daily Ca requirement of farm animals was found 20-30 g in cattle, 3-10 g in pigs, 2-3 g in sheep, horse 20 g [39]. The daily need of Ca element in the human body varied between 0.8 and 0.9 g [38]. Considering the amount of Ca in the nutritional values, the oat seed shell is quite good when mixed with other

cereal crops, therefore, the low oat production cost and high nutritional value will cause it to be among the plants sought today [1].

4. CONCLUSION

Compared to other plants cultivated in the same period as the oat plant itself, such as wheat, barley, lentils and broad beans, it is a plant to be cultivated in adverse field conditions. Knowing the nutritional values will contribute to the industrial field due to its use in human nutrion and animal feed. The highest values for agronomic traits and micronutrient contents in the study conducted out with 11 oat genotypes in Kahramanmaras province was obtained from TL137 genotype for thousand seeds weight (45.51 g) and Zn ratio (36.59 mg kg^{-1}) of husk, Kirklar for test weight (54.30 kg) value, TL38 genotype for crude protein ratio (16.55%), Kahraman variety for seed ratio (73.33%), TL42 genotype for husk ratio (33.68%), Sarı variety for iron ratio in seed (39.44 mg kg^{-1}), Arslanbey variety for iron ratio of husk (90.25 mg kg^{-1}) , TL576 genotype for zinc ratio in seed (66.21 mg kg^{-1}), TL139 genotype for Ca ratio in seed (193.10 mg kg^{-1}) and Arslanbey variety for calcium ratio of husk (442.30 mg kg^{-1}). It has been concluded that the oat lines used in the research can compete with the registered varieties and the researchers should be continued in the breeding programs to develop superior oat genotypes with better traits.

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