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Research Article

INVESTIGATION OF MINERAL MATTER CONTENT OF HUSKS SEPARATED FROM OAT VARIETIES CULTIVATED IN TURKEY

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ABSTRACT. Husk is considered as the waste material separated from the grain during the conversion of oats into products. Husk can be considered as a material rich in organic and inorganic terms, as it is cheap and easy to obtain, does not cause environmental pollution, is transported from processing centers. In this study, 7 oat varieties registered in Turkey were used. The husks of the cultivars were separated from their husks in an air pressure husking machine. The husks were ground to pass through a 0.5 micron sieve and made ready for analysis. Mineral analysis was carried out in the separated husks. According to the results of the mineral substance analysis carried out in the husk samples, the amounts of Ca, Mg, K, Fe, Na, Si, Al, Mn, Ni, Cu, Zn, Ba minerals in the oat husks are 1093.51-2619.68 mg/kg, 467.47-1806.83 mg/kg, respectively. 1105.42-1456.27 mg/kg, 515.75-1872.56 mg/kg, 105.69-869.05 mg/kg, 574.35-1069.74 mg/kg, 18.25-221 mg/kg, 10.02-60.73 mg/kg, 0.52-4.78 mg/kg, It was found between 0.98-1.59 mg/kg, 1.85-5.32 mg/kg, 1.23-2.63 mg/kg. At the end of the study, it is thought that oat husks are rich in inorganic matter and can be used in various food applications.

Keywords: *Husk, Oat, Mineral, Macro element, Micro element*

INTRODUCTION

Production, consumption and trade balances in basic agricultural products are changing rapidly in the world. Grain products have been used as an important raw material for the renewable energy sector and commodity markets in the world in recent years and have become a valuable investment tool. The fact that agriculture has a globally commercial value with population growth and increasing incomes of people, the change in consumption habits over time, as well as the fact that it is a factor affecting the economies of countries in terms of added value and employment increases the importance of the agricultural sector. On the other hand, global problems such as hunger and poverty, climate change, food security and reliability issues give agriculture a special importance. As long as humanity exists, agriculture will continue to exist as a strategic sector, and food as a strategic product. Agriculture and food will continue to be the issue of our future, not today [1].

In our country, 23.4 million hectares of land is arable land. 66.4% (15.5 million hectares) of our agricultural lands, excluding fallow lands, are reserved for field agriculture. Grain is cultivated in approximately 71% (11.1 million hectares) of this area. Wheat ranks first with a share of 69% in the total grain cultivation areas. Wheat is followed by barley with a share of 22%, corn with a share of 6% and paddy with a 1%

share. Our oat and rye production is at a sufficient level and its share, which corresponds to 1% in terms of area, has been maintained at the same level for many years [2].

Oat (*Avena sativa* L.) is a grain whose importance is increasing day by day in human nutrition as well as animal nutrition. Among the cultivated plants produced, oat ranks 6th among cereal varieties in the world with a cultivation area of 9.6 million hectares and a production amount of 22.7 million tons [3].

The purpose of human nutrition is to provide normal healthy nutrition, growth and development. The term growth and development includes the process of mental change as well as physical development. Therefore, growth and development is a process that occurs under the influence of genetic, nutritional, social and cultural conditions [4]. (Baysal, 1996). When considered from this point of view, it is understood how important minerals are for human development.

Oat; It contains high amounts of valuable nutrients such as soluble fibers, proteins, unsaturated fatty acids, vitamins, minerals and phytochemicals [5]. (Flander et al., 2007). In recent years, oats have attracted attention in research and commercial areas, as they contain high levels of β-glucan content and compounds with antioxidant effects [6, 7].

Oat is an important grain that is used in the production of animal feed, human food and various industrial products and its importance is increasing day by day [8].

It is thought that the husk has a rich structure in terms of nutritional content and mineral substance content, as well as containing cell wall components in its structure. In this study, the mineral content of grain separated oat husks, which is widely grown in our country and has come to the fore in recent years, was determined and its possibilities for use as a functional food component were investigated.

MATERIALS AND METHODS

Material

The oat varieties used in the study were procured from the Geçit Kuşağı Agricultural Research Institute (GKTAE, Eskişehir), Aegean Agricultural Research Institute (ETAE, İzmir) and Thrace Agricultural Research Institute (TTAE, Edirne) under the General Directorate of Agricultural Research and Policy (TAGEM). The samples were harvested in 2018 and sent from the institutes.

Methods

Cleaning of samples

In the study, foreign materials of the oat samples were primarily separated with a cleaning device (Labofix' 90, Schmidt AG, Germany). In this device, broken and undersized grains are separated by the cylindrical sieve system, and dust and husk pieces are separated by the air flow.

Separation of husks of oats

After the oat samples were separated from foreign matter and broken grains, the husks were separated from the husk separator (Codema, LH 5095, Minnesota, USA) working with compressed air.

Grinding the separated husks

After the husking process was completed, the oat samples, which were passed through the sample cleaning device and cleaned, were ground in a hammer mill (Perten 3100, Huddinge, Sweden) with a 500 µ pore size sieve and made ready for analysis.

Determination of mineral substance amount

The amount of mineral substance was determined according to the method of NMKL [9]. Samples are weighed in incinerators. With the addition of HNO_3 and H_2O_2, samples are burned at 200°C for 45 minutes in the microwave combustion system (Milestone Easy, Italy). Before starting the analysis, the mix calibration standard provided by the company is used. Analysis was performed on the samples according to NMKL 186, 2007 and in ICP-MS (Inductively Coupled Plasma-Mass Spectrometer) device (Thermo Scientific, USA). Spectrophotometer results are given in mg/kg on wet/dry matter.

Statistical analysis

In this study, each analysis was repeated in triplicate and the averages with standard deviation values are given in the relevant tables. Statistical analyzes were performed in SPSS (18.0) statistical analysis package program. The status of the samples having a statistically significant difference on the basis of the relevant criteria was examined by one-way Anova analysis. The “P” statistical values have emerged as a result of the Anova test on the basis of each sample and the criteria it is evaluated. Related Post-Hoc tests were applied according to the Anova test values being less than 0.05. The technique used in Anova analysis was tested with the condition of homogeneity of variance of each sample and was subjected to the relevant Post-Hoc tests. Duncan Post-Hoc test was applied in case of homogeneous distribution of variances, and Games-Howell Post-Hoc test was applied in case of non-homogeneous distribution. The averages of the samples taken according to the relevant criteria are lettered as a result of clustering. Different letters indicate that the means are different from each other, and double letters are lettered to be close to the group averages before and after them.

RESULTS AND DISCUSSION

Microelement (Transition, Intermediate and Semi-Metal) Content in Huks

According to the results of the statistical anova analysis, it was seen that the difference between the averages on the basis of minerals was statistically significant, since there was a significance value ($P<0.05$) for each mineral among all varieties. Micro element analysis results of oat husks are given in Table 1. Mn and Fe have great importance in respiration, chlorophyll formation and enzymatic activities in plants. When the micro element analysis results of oat husks were examined, the lowest Mn element was found in Yellow (10.02 ppm), the highest in Checota (60.73 ppm), the lowest Fe mineral in Kahraman (515.75 ppm), and the highest in Checota (1872.56 ppm).

Table 1. *Micro element analysis results in husks separated from oat varieties*

Varieties	Mn¹	Fe¹	Ni¹	Cu¹	Zn¹	Al¹	Si¹
Checota	$60,73^{f}$	$1872,56^{g}$	$4,78^{g}$	$1,59^{f}$	$3,15^{e}$	$30,00^{c}$	$1069,74^{f}$
Haskara	$29,03^{d}$	$919,89^{f}$	$0,91^{f}$	$1,03^{b}$	$5,32^{f}$	$24,11^{b}$	$723,76^{d}$
Sarı	$10,02^{a}$	$786,63^{e}$	$0,56^{b}$	$0,98^{a}$	$2,23^{b}$	$163,47^{f}$	$574,35^{a}$
Avar	$16,79^{b}$	$547,54^{b}$	$0,83^{e}$	$1,09^{c}$	$2,38^{c}$	$18,25^{a}$	$646,70^{b}$
Kırklar	$31,15^{e}$	$619,68^{c}$	$0,60^{c}$	$1,09^{c}$	$1,85^{a}$	$58,71^{e}$	$797,93^{e}$
Küçükyayla	$28,57^{d}$	$739,29^{d}$	$0,74^{d}$	$1,20^{e}$	$2,23^{b}$	$221,00^{g}$	$781,62^{e}$
Kahraman	$24,19^{c}$	$515,75^{a}$	$0,52^{a}$	$1,18^{d}$	$2,67^{d}$	$53,02^{d}$	$675,48^{c}$

[1] It is given in mg/kg (ppm).
Mean±standard deviation,(n=3)
The difference between the means shown with different letters in the same column is statistically significant (P<0.05).

Ni, Cu and Zn are important for carbohydrate transport, use of sugar, uptake of water to the plant, protein production, formation of the cell wall and the activity of enzymes. The lowest Ni mineral was detected in Kahraman (0.52 ppm) and the highest in Checota (4.78 ppm) cultivars. Cu mineral was found the lowest in Yellow (0.98 ppm) and the highest in Checota (1.59 ppm). The lowest amount of Zn mineral was detected in Kırklar (1.85 ppm) and the highest in Haskara (5.32 ppm) cultivars. The lowest Al mineral is in Avar (18.25 ppm) and the highest in Küçükyayla (221 ppm); Si mineral was determined the lowest in Yellow (574.35 ppm) and the highest in Checota (1069.74 ppm) cultivars. Silicon plays a very important role in the plant's protective mechanism and drought tolerance.

As previously reported by Peterson et al. (1975) [10], studied the concentration of ten mineral substances in the husk, bran and endosperm of oats. According to this study, the amount of phosphorus in the husk, bran and endosperm of oats is 0.54%, 0.94, 0.27, the amount of potassium is 0.44%, 0.98, 0.18, the amount of magnesium is 0.18%, 0.35%, respectively. , 0.07, calcium content 0.18%, 0.35, 0.07, iron content 47.20, 96.00, 20.40 ppm, zinc 35.80, 54.40, 36.10 ppm, manganese The amount of copper is 46.00, 81.70, 31.60 ppm, the amount of copper is 4.30, 5.67, 2.99 ppm, the amount of boron is 1.10, 2.72, 0.00 ppm and the amount of barium is 0.63 , 2.40, 0.34 ppm was found. Bran was determined as the fraction containing the most of all elements.

Chemical changes in the husks of four different oats grown under different weather conditions were examined and the mineral composition was examined. As a result of the mineral analysis, Al 1.4-13 μg/g, Ba 1.3-4 μg/g, Ca 820-1400 μg/g, Cu 1.3-4.7 μg/g, Fe 11-130 μg/g, K 2700-6400 μg/g, Mg 480-1500 μg/g, Mn 27-52 μg/g, Na 14-89 μg/g, P 310-4400 μg/g [11].

Macro element (Alkaline and Soil Alkaline) Content in Husks

According to the results of the statistical anova analysis, it was seen that the difference between the averages on the basis of minerals was statistically significant, since there was significance (P<0.05) on each mineral basis among all varieties. The macro element analysis results of oat husks are given in Table 2. K, Mg, Na and K are macro elements necessary for increasing the resistance of plants against drought, diseases and stress, increasing product quality and normal flowering and root development. When considered from a chemical point of view, they can exhibit a similar structure by assuming sodium duties in periods when potassium is deficient. When the macro element analysis results of husks separated from oat varieties are evaluated, the lowest Na mineral is Kahraman (105.69 ppm), the highest Yellow (869.05 ppm), K mineral is the lowest (1105.42 ppm), the highest is Küçükyayla (1456.27 ppm), Mg is the lowest. Hero (467.47 ppm) was highest in Checota (1806.83 ppm) cultivars. The lowest amount of Ca mineral was detected in Yellow (1093.51 ppm), the highest in Küçükyayla (2619.68 ppm), the lowest in Ba mineral in Avar (1.23 ppm) and the highest in Küçükyayla (2.63 ppm).

Table 2. *Macro element analysis results of husks separated from oat varieties*

Varieties	Na[1]	K[1]	Mg[1]	Ca[1]	Ba[1]
Checota	236,51^{d}	1358,53^{c}	1806,83^{e}	2383,87^{f}	2,62^{f}
Haskara	450,97^{e}	1409,58^{d}	1114,97^{d}	1629,15^{c}	2,42^{e}
Sarı	869,05^{g}	1426,75^{e}	1081,23^{c}	1093,51^{a}	1,75^{c}
Avar	726,57^{f}	1341,49^{b}	602,56^{b}	1356,43^{b}	1,23^{a}
Kırklar	163,69^{c}	1412,61^{de}	596,58^{b}	1847,27^{d}	2,14^{d}
Küçükyayla	123,03^{b}	1456,27^{f}	596,91^{b}	2619,68^{g}	2,63^{f}
Kahraman	105,69^{a}	1105,42^{a}	467,47^{a}	2111,11^{e}	1,63^{b}

[1] It is given in mg/kg (ppm).
Mean±standard deviation,(n=3)
The difference between the means shown with different letters in the same column is statistically significant (P<0.05).

In the study on investigating the amount of minerals, phytate and dietary fiber in different fractions of oat grain, elemental analyzes of Ca, Cu, Fe, K, Mg, Mn, Na, P and Zn were carried out in oat husks. Elemental analysis results were found as 960 µg/g, 1.8 µg/g, 26 µg/g, 7700 µg/g, 490 µg/g, 37 µg/g, 90 µg/g, 390 µg/g, 12 µg/g, respectively. have expressed [12].

In a study on the phytic acid, mineral substance content and digestibility of proteins of milling, the mineral substance contents of barley and oats as grains and in flour after milling were determined. As a result of the analysis, the amount of Na in barley grain and barley flour is 157.80 ppm and 84.90 ppm, Ca amount is 325.70 ppm and 279 ppm, K amount is 4393 ppm and 4347.70 ppm, Mg amount is 786.50 ppm and 834.30 ppm, Zn amount is 12.7 ppm and 14ppm, Fe content is 7.10. They stated that it is found as ppm and 14 ppm. Analysis results in oat grain and oat flour, respectively, Na content 21.4 ppm and 46.90 ppm, Ca content 532.70 ppm and 497.90 ppm, K content 4664.60 ppm and 4534 ppm, Mg content 734.80 ppm and 754.50 ppm, Zn content 7.9 ppm and 10 ppm, Fe. The amount is specified as 24.5 ppm and 26 ppm [13].

CONCLUSION

With oats gaining importance in recent years, cultivation areas and production volume have started to increase. With the use of oats in human nutrition in recent years, it has started to be consumed in baby foods, oatmeal and breakfast nutrition. It is a grain rich in protein, nutritious in terms of vitamins and minerals, and high in energy value. In our study, it has been observed that oat husks are rich in mineral content. It has also been determined that these rates are at a level that will be important for a waste product.

Thanks to Ca, Mg, K, Fe, Na, Si and other elements, it can be turned into plant food and used. It is thought that it can also be used in the food industry due to its rich mineral content. It can be preferred to use husk as organic fertilizer in agriculture. In recent years, pesticides and chemical fertilizers, which have been used extensively, have caused the soils to become unproductive. The husk can be used in agricultural lands by using it in the production of organic fertilizers and can prevent the destruction of fertile agricultural lands.

This part of the husk contained in the oat husk is seen as vegetable waste and its use in many sectors is thought to be important. As a result of the analyzes made within the scope of this study, there is a need for detailed research on the use of husk, which has high nutritional value, as an alternative material in different sectors and as an enriching component in functional foods.

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