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EVALUATION OF GRAIN QUALITY PROPERTIES AND MINERALCONTENTS (NUTRITIONAL VALUES) OF TRITICALE (X *TRITICOSECALE WITTMACK*) CULTIVARS UNDER RAINFED AGRICULTURAL CONDITIONS IN THE EASTERN BLACK SEA REGION OF TURKEY

ABDULVELİ SİRAT[1*], BİLGE BAHAR[2] AND NECMİYE BAHAR[1]

[1]*Siran Mustafa Beyaz Vocational School, Gumushane University, Siran-Gumushane, Turkey*
[2]*Department of Food Engineering, Faculty of Engineering and Natural Sciences, Gumushane University, Gumushane, Turkey*
[*]*Corresponding author's email: awsirat@hotmail.com*

Abstract

Triticale is an important alternative crop and is largely grown on marginal lands in Turkey to overcome the shortage of rising animal feed problem. Sometimes Triticale is also used as human food. This study was conducted for two years between 2013-2014 and 2014-2015 to determine some grain quality characteristics of nine different Triticale (Tatlicak-97, for cvs. Presto, Karma-2000, Melez-2001, Mihkam-2002, Ege Yildizi, Alperbey, Umranhanım, and Tacettinbey) cultivars under dry farming conditions at Siran-Gumushane (Eastern Black Sea Region, Turkey). The experiment was conducted with three replications based on the randomized complete block design. According to two-years average, thousand-grain weight of cultivars changed from 38.85-45.12 g, also, hectoliter weight 74.68-77.21 kg hl^{-1}, protein contents 10.56-12.09%, starch contents 64.74-68.19%, moisture contents 9.44-9.72%, ash contents 1.25-1.60%, oil contents 0.79-1.27%, ADF (acid detergent fiber) 3.22-4.39%, NDF (neutral detergent fiber) 15.14-16.88%, potassium (K) contents 0.432-0.527%, magnesium (Mg) contents 0.113-0.135%, and phosphorus (P) contents 0.360-0.387%. In terms of quality characteristics, the maximum thousand-grain weight was obtained from Tacettinbey and Ege Yildizi; the maximum grain yield weight from Tatlicak-97; the maximum hectoliter weight from Tatlicak-97, Ege Yildizi and Mihkam-2002 cultivars; Also, cv. Karma-2000 and Alperbey had the maximum protein contents, and Umranhanım and Mihkam-2002 cultivars had the maximum starch content. It is concluded that studies relating to Agronomic practices of these and other Triticale cultivars would help in improving the life style and the livestock sector of the region.

Key words: Triticale varieties, Quality characteristics, ADF, NDF, Mineral matter

Introduction

Animals based foods provide about 20% calories per day compared to more than 50% of the daily calories needed by people need throughout the world are covered by cereals and about ¾ of their daily nutritional needs are also provided by cereals. Therefore, it seems cereals, would also make main food source of human food in the future (Kun, 1996). It is possible to meet the increasing food need by increasing production due to population growth. Triticale (*x Triticosecale* Wittmack) is an amphidiploid grain cultivated in cool-climate. Today, hexaploid triticale is grown in larger areas world over (Ammar *et al.*, 2004) for animal feed.

Triticale, combines the high yield feature of wheat and the durability of rye in its structure, can adapt to many different climates and soil conditions. The triticale can provide higher yields compared to barley, wheat, and oats in arid, stony, inclined, acidic, barren lands with disease and pest problems. Triticale has the ability to benefit from soil better than wheat, barley, and oats, and is less affected by changing environmental conditions with higher efficiency (Gregory, 1975). Interest in increasing the production of triticale, in barren areas is increasing due to suitable agronomic applications and use of new cultivars with high productivity (Yanbeyi & Sezer, 2006).

Triticale has production of 12.80 million tons in an area of 3.81 million ha around the world (Anon., 2018). Turkey has 215.1 tons of triticale production on 64.1 thousand ha area and the average yield per decare of 336 kg (Anon., 2019). In 2018, approximately 28.2 ha of triticale was planted in Gumushane province with 83 tons of produce. The yield per ha was 24.3 kg (Anon., 2018).

Meadows and pastures are the most important sources of forage, it is necessary to give importance to forage crops agriculture to reduce the grazing pressure in these areas (Ozer *et al.*, 2010).

Triticale is a plant that can contribute significantly to the roughage preventing excessive grazing of pastures and controlling erosion (Atak & Ciftci, 2006). With the expansion of triticale agriculture in Turkey, unproductive barren, salty, acidic, and diseased farmland where precipitation is limited will be better utilized, thus, such areas will contribute to the economy of the country.

The protein contents in triticale is between 12-14%, and it is harvested early. It can help in easily meeting of micronutrients such as iron, zinc, molybdenum, and is more tolerant compared to other cereals (Geren *et al.*, 2002).

The study aimed to determine the quality characters of triticale cultivars that may be alternatives to wheat and barley for animal nutrition in disadvantaged and barren areas, especially in Gumushane province in the Eastern Black Sea Region.

Materials and Methods

Nine different (Tatlicak-97, Presto, Karma-2000, Melez-2001, Mihkam-2002, Ege Yildizi, Alperbey, Umranhanım, and Tacettinbey) types of triticale were used. The research was conducted in a farmer's field in Siran district of Gumushane (Turkey) province in the Eastern Black Sea Region in 2013-2014 and 2014-2015 seasons. The research site is located on 40^o 12 '- 40^o 11' north latitudes and 39^o 09 '- 39^o 07' east longitudes and is approximately 1445 m above sea level.

Soil samples were taken before planting from a depth of 0-40cm for physical and chemical analysis. Analyses were conducted at the Soil Science, and Plant Nutrition Department Laboratory, Faculty of Agriculture, Kahramanmaras Sutcu Imam University Turkey.

The meteorological data was obtained from The Directorate of Meteorologicy Gumushane, Turkey.

Some features of 9 triticale cultivars in the experiment are given in Table 1. The experiment was conducted with three replications according to the randomized blocks research design. The plot dimensions of the experiment were arranged as 1.2 m × 6 m = 7.2 m^2. The amount of seed used in the experiment was determined by using the weight, purity and germination percentages of the cultivars. Thus the cultivation density of the plots was 500 seeds per m^2; the seeds were sown approximately at a depth of 5 cm in 6 rows, Depending on the weather conditions sowing was done, 29.10.2013 in the first year and on 22.10.2014 in the second year. According to the soil analysis results, the fertilizers were applied as 8 kg pure N and 6 kg pure P_2O_5. Half of the nitrogen fertilizer and all phosphorus were applied at planting, while the remaining half of nitrogen was applied before the bolting stage.

Only central single row was harvested avoinding external rows to avoid the effects of neighbouring varieitis leaving a distance of 0.50 meters using sickle. The harvested plants were tied in sheaves and dried in the field (outdoors) for 3-4 days followed by their threshing with a threshing machine.

In the study, thousand-grain weight (g), hectoliter weight (kg hl^{-1}), protein contents (%), starch contents (%), moisture contents (%), ash contents (%), fat contents (%), acid detergent fiber (ADF) and neutral detergent fiber (NDF) values (%), and mineral contents such as K, Mg and P contents (%) were investigated. Thousand-grain weight, hectoliter weight and protein contents measurement and analysis was done according to Elgun *et al*., (2001), also the starch contents was estimated by the Ewers' Polarimetric method (Anon., 2005). ADF and NDF values were determined according to Van Soest *et al*., (1991).

The data obtained in the study were analyzed using the JMP 7.0.2 statistical package software according to the randomized complete block research desigs (Anon., 2007). P-probability values were determined by using F-test to see effective differences between genotypes; comparisons between average values were evaluated according to the LSD test and then grouped. Correlations between the studied parameters were determined using the same package software.

Results and Discussion

The soils were clayey-loam (62.0%), slightly alkaline (7.99%), calcareous (25.56%), salt-free (0.12%). They were medium in organic matter (2.41%) and phosphorus contents (0.613 kg ha^{-1}) and high in potassium level (14.13 kg ha^{-1}). The soil structure of the experimental area for the 2nd year was clayey-loam (57.0%), and had sufficient organic material (3.32%), less phosphorus (0.418 kg ha^{-1}), sufficient in potassium (13.23 kg ha^{-1}), moderately calcareous (12.43%), lightly salty and alkaline (Table 2).

The climate characteristics of Gumushane province reflect a transition between the terrestrial climate and the Eastern Black Sea climate. Considering the Triticale breeding period, a total of 426.9 mm of precipitation was recorded in Gumushane province according to the long-term average. Also, the maximum monthly total precipitation (66.4 mm) was noted in May, while the lowest precipitation average (12.4 mm) was seen in July according to the long-term average (Table 3). In 2013-2014 and 2014-2015, the lowest total precipitation was in July with 19.3 and 2.8 mm, respectively, while the maximum total precipitation was in May with 66.7 mm and March with 67.4 mm, respectively.

The lowest monthly temperature average in the triticale cultivation period as the long-term average is -1.7°C in January, and the maximum monthly temperature average is 20.2°C in July. These values were seen as 2.1°C in January and 26.0°C in July 2013-2014, respectively, 0.8°C in January and 24.5°C in July 2014-2015. As an average for many years, the annual moisture was 62.93%, also it was 56.73% in 2013-2014 and 59.14% in 2014-2015 (Table 3).

Table 1. Triticale cultivars used in the experiment.

No	Cultivars	Release year	Origin
1.	Tatlicak-97	21.04.1997	Bahri Dagdas International Agricultural Research Institute (Konya)
2.	Presto	28.04.2000	Transitional Zone Agricultural Research Institute (Eskisehir)
3.	Karma-2000	28.04.2000	Transitional Zone Agricultural Research Institute (Eskisehir)
4.	Melez-2001	24.04.2001	Bahri Dagdas International Agricultural Research Institute (Konya)
5.	Mihkam-2002	02.05.2002	Bahri Dagdas International Agricultural Research Institute (Konya)
6.	Ege Yildizi	30.03.2005	Ege Agricultural Research Institute (İzmir)
7.	Alperbey	30.03.2010	Bahri Dagdas International Agricultural Research Institute (Konya)
8.	Umranhanım	30.03.2010	Eastern Anatolia Agricultural Research Institute (Erzurum)
9.	Tacettinbey	26.04.1999	Cukurova University Faculty of Agriculture (Adana)

Table 2. Some physical and chemical properties of the soils of the research area*.

Years	Saturation (%)	Total salt (%)	PH	CaCO3 (%)	P2O5 (kg ha-1)	K2O (kg ha-1)	Organic matter (%)
2013-14	62.0 Clayey loam	0.12 Saltless	7.99 Slightly alkaline	25.56 Limy	0.613 Middle	14.13 Much	2.41 Middle
2014-15	57.0 Clayey loam	0.18 Slightly salty	7.77 Slightly alkaline	12.43 Middle Limy	0.418 Little	13.23 Sufficient	3.32 Sufficient

*Analyses were conducted at the Soil Science, and Plant Nutrition Department Laboratory, Faculty of Agriculture, Kahramanmaras Sutcu Imam University

Table 3. Some meteorological data from the experimental site (temperature, precipitation, and relative humidity percentage)*.

Months	October	November	December	January	February	March	April	May	June	July	Total/ Mean
Total precipitation (mm)											
2013-2014	28.2	19.6	31.3	28.5	22.1	45.3	38.1	66.7	31.0	19.3	330.1
2014-2015	61.4	51.6	14.2	55.5	34.4	67.4	46.8	45.3	40.4	2.8	419.8
Long years	45.7	42.9	40.4	36.2	32.9	43.5	60.7	66.4	45.8	12.4	426.9
Average temperature (°C)											
2013-2014	12.3	8.7	-2.2	2.1	3.3	8.9	13.5	17.1	20.8	26.0	11.05
2014-2015	14.4	7.2	6.2	0.8	3.3	7.3	9.6	15.9	20.5	24.5	10.97
Long years	11.4	5.1	0.5	-1.7	-0.4	3.7	9.4	13.7	17.2	20.2	7.91
Relative humidity (%)											
2013-2014	53.5	63.4	65.0	62.9	54.3	55.7	53.8	58.5	51.5	48.7	56.73
2014-2015	64.6	64.5	63.0	62.0	59.5	55.9	57.4	55.1	60.6	48.8	59.14
Long years	62.0	66.7	68.2	66.9	64.2	62.0	60.2	60.8	59.8	58.5	62.93

*Meteorological data was obtained from The Directorate of Meteorologicy Gumushane, Turkey

Table 4. The thousand-grain weights, hectoliter weight and the average value of the protein contents of the triticale cultivars used in the research.

Cultivars	Thousand grains weight (g)			Test weight (kg hl^{-1})			Protein content (%)		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tatlicak-97	40.00	43.33	41.67bc	75.00fg	79.42 a	77.21a**	13.26	10.54	11.90
Presto	39.63	44.00	41.82bc	73.87hı	78.13bcd	76.00cd	12.85	9.63	11.24
Karma-2000	37.27	40.43	38.85d	74.00h	79.00ab	76.50bc	13.38	10.80	12.09
Melez-2001	37.63	43.13	40.38cd	73.13hı	76.22e	74.68e	12.20	10.37	11.29
Mihkam-2002	40.80	43.27	42.04bc	75.00fg	78.56abc	76.78ab	13.06	10.18	11.62
Ege Yildizi	40.63	45.13	42.88ab	74.07gh	79.49a**	76.78ab	12.08	10.66	11.37
Alperbey	37.30	40.40	38.85d	73.00 ı	78.56abc	75.78d	13.53	10.62	12.08
Umranhanım	41.50	42.97	42.24bc	75.07f	77.71cd	76.39bcd	11.50	9.61	10.56
Tacettinbey	41.97	48.27	45.12a**	69.60j	77.14de	73.37f	12.37	10.79	11.58
Mean	**39.64b**	**43.44a****	**41.54**	**73.64b**	**78.25a****	**75.94**	**12.69**	**10.36**	**11.52**
LSD	Cultivar: 2.37			Cultivar:0.70	Y × C: 1.00				

There is no difference at the * p<0.05 and ** p<0.01 level between the means indicated by the same letter.

Two-year combined variance analysis results of the reviewed properties and their averages are given in Table 4, 5, 6, and 7 showing significant differences among cultivars in different parameters (a thousand weights, hectoliter weight, starch contents, ash contents, NDF, and magnesium contents) which were statistically significant. It was observed that the differences over the years significantly affected the thousand-grain weights, hectoliter weight, oil contents, and ADF characteristics. Also, a significant year × variety interaction was observed for hectoliter weight.

Thousand-grain weight, hectoliter weight, starch contents, and oil contents, had higher values in the second year compared to the first year. These quantitative characters were well correlated with meteorological data, it as the average values of total precipitation and relative humidity were higher in the second year compared to long-term average and the values in the first year.

Thousand-grain Weights (g): According to statistical analysis results, year and variety factors were found significant (p<0.01) (Table 4). When the averages of the cultivars were compared, the maximum value in terms of thousand-grain weights was obtained from the Tacettinbey cultivar with 45.12 g, while the lowest thousand-grain weight was recorded from cvs. Karma-2000 and Alperbey (38.85 g). The average thousand-grain weights for the first year of the research (39.64g) was found lower than the second year (43.54 g) (Table 4). The poor climatic conditions in the first year of the research seemed to be responsible for lesser weight of thousand-grains. In the second year, the total amount of precipitation (159.5 mm) in March, April, and May, during development period of the plants, was higher than the precipitation of the same period of the first year (150.1 mm); It was estimated that there might be an increase in grain size of the cultivars, resulting in the increase of thousand-grain weight also. Many researchers (Yanbeyi & Sezer, 2006; Mut *et al.*, 2006) have reported that there were significant differences among Triticale genotypes in terms of thousand-grain weights. The results from the study were largely in harmony with the results reported by Albayrak *et al.*, (2006), Atak & Ciftci (2006), Yanbeyi & Sezer (2006), Akgun *et al.*, (2007), Geren *et al.*, (2012), Kizilgeci & Yildirim (2017) and Mut & Kose (2018).

Hectoliter weight (kg hl^{-1}): Hectoliter weight was statistically different (p<0.01) during years, and among cultivars. Similarly a significant (p<0.01) interaction was noted for year × cultivar (Table 4). According to the average of the two years, the hectoliter weight varied between 73.37-77.21 kg hl^{-1}. The minimum and the highest hectoliter weight was obtained from cv. Tacettinbey (73.37 kg hl^{-1}) and cv. Tatlicak-97 with 77.21 kg hl^{-1} in the same order, followed by cv. Mihkam-2002 and cv. Ege Yildizi (76.78 kg hl^{-1}) which were statistically similar. The first and second-year hectoliter weight was 73.64 and 78.25 kg hl^{-1}, respectively (Table 4). The hectoliter weight, is considered one of the easiest and most important features used in determining quality, of the product on commercial scale. The significance of year × cultivar interaction is thought to be due to the different responses of the genotypes used environment during two years in the experiment to the changing climatic conditions. The results are in agreement to the findings of Albayrak *et al*., 2006 (65.95-73.32 kg hl^{-1}) Mut *et al*., 2006 (65.9-71.1 kg hl^{-1}), Yanbeyi & Sezer, 2006 (57.8-76.3 kg hl^{-1}), Geren *et al*., 2012 (59.5-76.7 kg hl^{-1}), Kizilgeci & Yildirim, 2017 (73.13-79.50 kg hl^{-1}) and Mut & Kose, 2018 (66.7-71.3 kg hl^{-1}). It has been reported that hectoliter weight varies according to the cultivar and growing conditions depending on the protein contents of the grain, the homogeneity of the grains, and the weight of endosperms of the respective cultivars used in the study (Kun, 1996; Mut *et al*., 2014).

Protein contents (%): Statistically different (p<0.01) protein contents were noted among cultivars based on the the years, and cultivars. An significant (p<0.01) interaction was noted between years × cultivars in terms of protein quantity (Table 4). The protein contents of triticale cultivars significantly affectedcontents that varied in the range of 10.56-12.09% (Table 4). Current studies showed that the protein contents of cereals was affected by the environmental conditions and the genotypes. The results are in agreement with Kun (1996) and Ciftci *et al*., (2003) reported that the protein contents in triticale may be higher compared to other cool-climate cereal strains. Erekul & Köhn (2006) examined four triticale cultivars in two locations and reported that the protein contents varied in the range of 10.9-17.0%. In other study examining twelve triticale genotypes (Tohver *et al*., 2005), it was noted that the protein contents ranged 9.7-14.5%. Brand *et al*., 2003 (13.9-15.4%), Atak & Ciftci, 2006 (11.3-14.3%), Akgun *et al.*, 2007 (10.3-12.7%), Alp, 2009 (10.63-11.43%), Rakha *et al.*, 2013 (13.0-14.9%), Kizilgeci *et al.*, 2017 (13.5-16.3%), and Kizilgeci & Yildirim, 2017 (14.0-16.2%) have also reported similar observations.

Starch contents (%): Signifcant (p≤0.01) differences were noted among cultivars for their starch contents. Non significant difference was was noted for years in terms of starch contents. Similarly there was a non-significant interaction between years × cultivar (Table 5). The maximum starch content was obtained from cv. Umranhanim (68.19%) and cv. Mihkam-2002 (66.87%). The lowest starch contents was found in cv. Melez-2001 (64.74%) (Table 5). Average starch contents of 2013-2014 and 2014-2015 cultivation seasons, was 64.37 and 67.45%, respectively. In general, the high amount of starch in the endosperm of the grain constitutes about 60% of the seed weight. Due to climatic conditions and genetic differences. Current fluctuations in starch contents are in agreement with Alaru *et al.*, (2003). The results alsp confirm the findings of Brand *et al*., 2003 (59.8-63.6%), Rakha *et al*., 2013 (63.5-70.4%), and Kizilgeci & Yildirim, 2017 (62.46-64.65%), and Mut & Kose, 2018 (62.4-66.4%).

Table 5. The average value for starch contents, moisture and ash contents of triticale cultivars used in the experiment.

Cultivars	Starch contents (%)			Moisture contents (%)			Ash contents (%)		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tatlicak-97	63.84	68.36	66.10 bcd	9.50	9.56	9.53	1.59	1.21	1.40 bc
Presto	64.36	68.60	66.48 bc	9.50	9.57	9.54	1.60	1.24	1.42 abc
Karma-2000	63.69	66.74	65.21 cd	9.63	9.43	9.53	1.72	1.46	1.59 a
Melez-2001	63.63	65.85	64.74 d	9.44	9.45	9.44	1.75	1.45	1.60 a**
Mihkam-2002	65.45	68.30	66.87 ab	9.51	9.44	9.48	1.42	1.15	1.29 c
Ege Yildizi	63.71	66.44	65.07 cd	9.84	9.61	9.72	1.60	1.42	1.51 ab
Alperbey	63.50	66.63	65.06 cd	9.61	9.57	9.59	1.63	1.32	1.48 ab
Umranhanım	66.89	69.49	68.19 a**	9.66	9.62	9.64	1.37	1.12	1.25 c
Tacettinbey	64.22	66.62	65.42 bcd	9.74	9.66	9.70	1.44	1.35	1.39 bc
Mean	**64.37**	**67.45**	**65.91**	**9.60**	**9.54**	**9.57**	**1.57**	**1.30**	**1.44**
LSD		Cultivar: 1.64						Cultivar: 0.19	

There is no difference at the * p<0.05 and ** p<0.01 level between the means indicated by the same letter

Table 6. The average value for oil, ADF and NDF contents of triticale cultivars used in the research.

Cultivars	Fat contents (%)			ADF contents (%)			NDF contents (%)		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tatlicak-97	0.86	0.93	0.90	4.65	3.80	4.23	16.12	15.38	15.75 cd
Presto	0.82	1.08	0.95	4.16	3.64	3.90	16.39	16.46	16.43 ab
Karma-2000	0.89	1.21	1.05	4.49	3.44	3.97	16.57	16.44	16.50 ab
Melez-2001	1.10	1.23	1.17	4.60	3.60	4.10	16.52	16.45	16.48 ab
Mihkam-2002	0.70	0.87	0.79	4.26	3.40	3.83	15.58	15.35	15.46 d
Ege Yildizi	1.10	1.13	1.12	4.24	4.54	4.39	17.30	16.47	16.88 a**
Alperbey	1.06	1.33	1.19	3.48	2.96	3.22	16.13	16.17	16.15 bc
Umranhanım	0.87	0.90	0.89	3.87	3.48	3.68	14.86	15.42	15.14 d
Tacettinbey	1.23	1.32	1.27	3.03	3.24	3.14	16.00	16.49	16.25 abc
Mean	**0.96b**	**1.11a***	**1.04**	**4.09a***	**3.57b**	**3.83**	**16.16**	**16.07**	**16.12**
LSD								Cultivar: 0.65	

There is no difference at the * p<0.05 and ** p<0.01 level between the means indicated by the same letter

Moisture contents (%): Non significant differences were noted in terms of moisture during years and among cultivars, Similarly non significant interaction was noted between years × cultivars in terms of moisture (Table 5). The moisture contents of the cultivars ranged 9.44 to 9.72%. The maximum moisture content of 9.72% was obtained from the cv. Ege Yildizi. The moisture contents of the cultivars was 9.53% for cv. Tatlicak-97, 9.54% for cv. Presto, 9.53% for cv. Karma-2000, 9.44% forcv. Melez-2001, 9.48% for cv. Mihkam-2002, 9.59% for cv. Alperbey, 9.64% for cv. Umranhanım) and 9.70% forcv. Tacettinbey, that varied numerically (Table 5). The moisture contents of cereals is one of the most important parameters to determine their harvesting, storage, processing, trade, marketing, and quality (Zia-Ur, 2006; Hong *et al*., 2007). The amount of moisture in triticale grains varied depending on the climatic conditions in the region at the time of cultivation, the amount of precipitation during the harvest season, the seed storage method, the relative moisture, and the temperature of the storage place (Kun, 1996).

Ash contents (%): The ash contents varied significantly among cultivars (p<0.01). The ash contents changed between 1.25% and 1.60% (Table 5). The maximum ash content of 1.60% was obtained from cv. Melez-2001, followed by cv. Karma-2000 with ash contents of 1.59%. This was ensued with e ash contents of 1.51% with ash contents of of cv. Ege Yildizi, 1.48% sh content of cv. Alperbey and 1.42% ash content of cv.cv. Presto which were statistically similar. The lowest ash content was 1.25% and 1.29% respectively in cv. Umranhanim and cv. Mihkam-2002 (Table 5). The amount of ash, shows the genetic variations in the genetic structures of the genotypes as affected by growing techniques and affected by the climate and environmental conditions. The ash contents had reported range of 1.5-2.3% by Brand *et al*., (2003), 1.68-2.17% by Mut & Kose, (2018) in their studies conducted on triticale. Different researchers have reported that the ash contents differ depending one thgenotypes (Ereifej *et al.*, 2001; Anjum *et al.*, 2014; Mahla *et al*., 2015).

Oil contents (%): Oil contents showed statistically different (p<0.05) results depending on the years. A non-significant interaction was noted between years × cultivars (Table 6). Average value of 2013-2014 and 2014-2015 experimental seasons, showed oil contents range of 0.96% and 1.11%, respectively.

The average values of the cultivars in the current study showed a range of 0.79% in cv. Mihkam-2002 to 1.27% in cv. Tacettinbey. The oil contents of the cultivars was 0.90% for cv. Tatlicak-97, 0.95& for cv. Presto, 1.05% for cv. Karma-2000, 1.17% for cv. Melez-2001, 0.79% for cv.Mihkam-2002, 1.12% for cv. Ege Yildizi, 1.19% for cv. Alperbey and 0.89% for cv. Umranhanım, respectively (Table 6). The researchers report that the oil contents differed depending on the cultivar, climatic conditions, and cultivation techniques (Grausgruber *et al*., 2000; Ereifej *et al.*, 2001; Barteczko *et al*., 2009). The results are similar to the oil contents ranges of 2.1-2.3%, 1.13-1.17% and 1.11-1.76%) found by Brand *et al.*, (2003),, Rakha *et al.*, (2013), and Mut & Kose, (2018) in the same order.

ADF contents (%): The average values for the acid detergent fiber (ADF) value of the cultivars in the experiment are given in Table 6. THE ADF value changed between 3.14-4.39% in the 2015 and 2016 respectively. The maximum ADF value was noted on cv. Ege Yildizi with value of 4.39% and the lowest value was noted in cv. Tacettinbey with value of 3.14%. The ADF values of Triticale cultivars used in the study were 4.23% (cv. Tatlicak-97), 3.90 (cv. Presto), 3.97 (cv. Karma-2000), 4.10 (cv. Melez-2001), 3.83 (cv. Mihkam-2002), 3.22 (cv. Alperbey) and 3.68 (cv. Umranhanım), respectively. The ADF referred to cellulose, lignin, and the amount of insoluble protein in the plant cell wall structure. It was also a good indicator that gives information about the digestibility of the feed and the energy intake of the animal. Feeds with high ADF have low digestibility and energy value (Kutlu, 2008). The reults of the current study are in agreement with the observations and findings of Brand *et al*., 2003 (3.6% to 4.1%), Rakha *et al*., 2013 (2.5% to 3.1%), Alijosius *et al*., 2016 (2.5% to 2.9%) and Mut & Kose, 2018 (2.43% to 3.59%).

NDF contents (%): NDF refers to cellulose, hemicellulose, lignin, cutin, and insoluble protein in the plant cell wall structure. The neutral detergent fiber (NDF) value of triticale cultivars differed significantly (p<0.01) (Table 6). According to the average of the cultivars, the lowest NDF contents were obtained from cv. Umranhanım with 15.14% NDF, followed by cv. Mihkam-2002 with 15.46% NDFand were statistically similar. The maximum NDF value of 16.88% was determined in the cv. Ege Yildizi, followed by cv. Presto, cv. Melez-2001, cv. Karma-2000, and cv.Tacettinbey (Table 6). Since NDF value is directly effective in feeding animals, the consumption of feed of the animal increases as this value decreases in the feed (Van Soest *et al.*, 1991). The results confirm the findings of Brand *et al*., 2003 (17.6% to 21.1%), Rakha *et al.*, 2013 (8.0% to 14.8%), Alijosius *et al.*, 2016 (10.3% to 13.1%), Mut & Kose, 2018 (17.5% to 19.1%).

Potassium content (%): Non significant differences were noted in the means of potassium contenets of the seeds during two years of the two years. Similarly, no interaction was noted between years × cultivars (Table 7). The potassium contents ranged 0.432-0.527% during two years. Potasium contents among the cultivars showed a statistically significant differences among cultivars. The minimum and maximum potassium contents ranged 0.432%-0.527% from cv. Umranhanimand cv. Karma-2000 respectively. The potassium percentages of other cultivars was 0.487% for cv. Tatlicak-9, 0.488% for cv. Presto, 0.490% for cv. Melez-2001, 0.463% for cv. Mihkam-2002, 0.488% for cv. Ege Yildizi, 0.465% for cv. Alperbey and 0.443% for cv. Tacettinbey, (Table 7). Plants need large amounts of potassium. Potassium is the most common cation in the cytoplasm. It has important roles in the realization of photosynthesis, enzyme activities, and the regulation of the water contents of the plants. Therefore, potassium is not only important for cultivation and yield but also for raising the sugar and protein contents in cereals (Kacar & Katkat, 2010; Alkan & Kandemir, 2015). These studies are confirmed by the findings of Myer & Lozano, (2004); Poutanen, (2012); Jakobsone *et al.,* (2015); Mut & Kose, (2018).

Magnesium contents (%): The magnesium (Mg) contents of the cultivars in terms of cultivars differed significantly (p<0.01). The non significant interaction was noted for year × cultivar for magnesium contents (Table 7). When two-year magnesium averages were examined, Mg contents ranged 0.113-0.135%. The minimum and maximum magnesium percentages (0.135%) were obtained in cv. Karma-2000 followed by cv. Ege Yildizi and cv. Tacettinbey cv. Alperbey, cv. Tatlicak-97 and cv. Melez-2001 that showed Mg contents of 0.135%, 0.132% and and 0.127% respectively. The lowest magnesium value was noted for cv. Umranhanım with the contents of 0.113% (Table 7). These results are in agreement with the findings of Myer & Lozano, (2004); Poutanen, (2012); Jakobsone *et al*., (2015); Mut & Kose, (2018).

Phosphorus contents (%): Phosphorus (P) values among cultivars showed non-significant differences among the cultivars and between the years. Non significant interaction was noted between year × cultivars (Table 7). Two-year phosphorus contents ranged 0.360-0.387%. The maximum phosphorus contents of 0.387% were noted from cv. Karma-2000 and the lowest phosphorus contents of 0.360%was noted in cv. Umranhanim (Table 7). The results of the current study was approved by the previous studies with similar differences among the cultivars (Myer & Lozano, 2004; Poutanen, 2012; Jakobsone *et al*., 2015; Mut & Kose, 2018).

Table 7. The average value of potassium, magnesium and phosphorus contentss of triticale cultivars used in the research.

Cultivars	Potassium Contents (%)			Magnesium Contents (%)			Phosphorus Contents (%)		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tatlicak-97	0.550	0.423	0.487	0.137	0.117	0.127 ab	0.390	0.360	0.375
Presto	0.543	0.433	0.488	0.130	0.113	0.122 bc	0.383	0.360	0.372
Karma-2000	0.580	0.473	0.527	0.143	0.127	0.135 a**	0.400	0.373	0.387
Melez-2001	0.540	0.440	0.490	0.130	0.123	0.127 ab	0.387	0.367	0.377
Mihkam-2002	0.510	0.417	0.463	0.130	0.113	0.122 bc	0.380	0.350	0.365
Ege Yildizi	0.520	0.457	0.488	0.143	0.127	0.135 a	0.387	0.373	0.380
Alperbey	0.520	0.410	0.465	0.140	0.123	0.132 a	0.393	0.370	0.382
Umranhanım	0.463	0.400	0.432	0.117	0.110	0.113 c	0.370	0.350	0.360
Tacettinbey	0.453	0.433	0.443	0.140	0.130	0.135 a	0.383	0.370	0.377
Mean	**0.520**	**0.432**	**0.476**	**0.134**	**0.121**	**0.127**	**0.386**	**0.364**	**0.375**
LSD					Cultivar: 0.01				

There is no difference at the * p<0.05 and ** p<0.01 level between the means indicated by the same letter.

Table 8. Correlation coefficients and significance levels between traits examined in triticale cultivars.

Traits	TW	PC	SC	MC	ASH	FAT	ADF	NDF	PC	MC	PC
TGW	0.436**	-0.311*	0.379**	0.109	-0.374**	0.171	-0.205	-0.008	-0.295*	-0.228	-0.258
TW	1	-0.472**	0.589**	-0.145	-0.445**	0.069	-0.101	-0.132	-0.346*	-0.486**	-0,393**
PC		1	-0.875**	-0.228	0.862**	-0.430**	0.167	0.374**	0.913**	0.844**	0.929**
SC			1	0.142	-0.908**	0.085	-0.223	-0.608**	-0.826**	-0.929**	-0.895**
MC				1	-0.370**	0.123	-0.095	-0.129	-0.430**	-0.782	-0.345*
ASH					1	-0.135	0.239	0.640**	0.943**	0.837**	0.957**
FAT						1	-0.275*	0.326*	-0.383**	-0.021	-0.16
ADF							1	0.070	0.236	0.136	0.138
NDF								1	0.550**	0.674**	0.578**
PC									1	0.787**	0.946**
MC										1	0.880**
PC											1

* p<0.05 and ** p<0.01 likely significant

TGW: thousand grain weight (g), TW: test weight ((kg hl^{-1}), PC: protein contents (%), SC: starch contents (%), MC: moisture contents (%), ASH: ash contents (%), FAT: oil contents (%), ADF: acid detergent fiber (%), NDF: neutral detergent fiber (%), PC: potassium contents (%), MC: magnesium contents (%), PC: phosphorus contents (%)

Correlations between the studied properties: Two types of correlations were noted between the studied parameters. Since a laerge number of parameters were studied, therefore each parameter will not be explained and defined individually. A positive correlation is a correlation between two parameters showed a tandem increase or decrease between the two characters in the same direction. Whereas, a negative correltion shows a non tandem increase or decrease in the opposite directions between the variables or parameters. The correlation coefficients calculated from the two-year results of the growth parameters in the study are given and explaned in Table 8.

A significant positive correlation existed between thousand-grain weight and kernel weight (r=0.436**), and starch contents (r=0.379**).

There was a significant negative correlation of r= -0.311*, r= -0.374** and r=0.295* between thousand-grain weight and protein contents ash (and potassium respectively.

Likewise, a significant positive correlation of r=0.589**, existed between starch contents and hectoliter weight.

There was a significant negative correlation of r= -0.472**, r= -0.445**, r= -0.346*, r= -0.486**, r= -0,393** between hectoliter weight and protein contents, ash, potassium, and magnesium and phosphorus in the same order.

There were positive correlations between protein contents and ash contents (r = 0.862 **), NDF (r = 0.374 **), potassium (r = 0.913 **), magnesium (r = 0.844 **) and phosphorus (r = 0.929 **).

Negative correlations were noted between protein contents and thousand-grain weight (r = -0.311 *), hectoliter weight (r = -0.472 **), starch contents (r = -0.875 **), and oil contents (r = -0.430 **).

Significant positive correlations were determined between NDF and ash contents (r = 0.640 **), oil contents (r = 0.362 *) potassium (r = 0.550 **), magnesium (r = 0.674 **) and phosphorus (r = 0.578 **) (Table 8).

These studies have determined a positive and significant correlations between thousand-grain weight and oil contents, starch contents, ADF value and hectoliter weight.and a negative and significant correlation between ash contents, protein contents, NDF and wet gluten contents. The results are in agreement with Mut *et al.*, (2017).

Campbell *et al.*, (1995) reported a significant and positive correlation between the hectoliter weight and the starch contents, oil contents & protein, and a significant and negative correlation of the hectoliter weight with ADF and NDF values. The results of the present study are in agreement with the studies by Goyal *et al*., (2011); Oral & Ulker, (2016); Mut & Kose, (2018) on the subject. No perfect positive or negative correlation of +1 or -1 was noted in the study. This meant that some other parameters also affected these correlations. The results of the study also reported a significant and negative correlation between protein contents and starch contents in the same order. The results of the study emphaise that most of the charcters are directly controlled by single genes in positive or negative direction and they could be used for selection and breeding of new cultivars.

Conclusion

Triticale is a new crop in the Eastern Black Sea Region and is not produced economically. There is need to select and breed cultivars specific to the local conditions. The study used 9 cultivars of variable genetic structure to check their suitability for the Eastern Balck se region that could be suitable for the producers and consumers equally. Significant differences were determined in terms of the investigated characters in trticale cultivars. Cvs. Tacettinbey, Ege Yildizi, and Alperbey cultivars that had the best performance in terms of thousand-grain weight, hectoliter weight, and crude protein contents. When evaluated in terms of animal feeding, cv. Umranhanım (starch contents), Melez-2001 (ash contents), cv. Tacettinbey (oil contents), cv. Karma-2000 yielded the best results in terms of potassium, magnesium, and phosphorus. The results of the present study suggests that triticale could be successfully and economically cultivated in the cold climate of Eastern Black sea region of Turkey and could aid in feeding of cattles and boost economic growth of the area. The triticale varieties selected for local use meet the current forage and fodder demands and the selected tritcale cultivars could be economically used in animal husbandry.

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