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Comparison of different cool season cereal species and cultivars in terms of straw yield and quality

Farklı serin mevsim tahıl tür ve çeşitlerinin saman verimi ve kalitesi açısından karşılaştırılması

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ABSTRACT

This study was carried out in the year 2015-16 and 2016-17 growing season in order to determine and compare the yield, digestibility dry matter and relative feed value of straw obtained from cereals. In the study, which was carried out in three replications according to the randomized blocks experimental design; 3 bread wheat, 3 durum wheat, 3 triticale and 4 barley cultivars were used as plant material. The difference between cereal species in terms of plant height, biological yield, seed yield, straw yield and crude protein was statistically significant (P≤0.01). In terms of these features the highest results were obtained from triticale straw and the lowest values were obtained from barley and bread wheat straw. At the same time, the lowest crude protein ratio was obtained from triticale straw, where the best yield results were obtained. The difference between cereal species in terms of crude protein yield, ADF and NDF contens, digestibility dry matter and relative feed values were found to be statistically insignificant. As a result, it was determined that the species with the highest yield among the species was trikale. In terms of quality criteria, it was determined that only the crude protein content was statistically significant among the species and the lowest value was obtained from triticale and the highest value was obtained from bread wheat and barley in terms of this property.

Key Words: Cereals, Cultivars, Seed yield, Straw yield, Straw quality

ÖZ

Bu çalışma, tahıllardan elde edilen samanların verim, sindirilebilir kuru madde ve nispi yem değerini belirlemek ve karşılaştırmak amacıyla 2015-16 ve 2016-17 yetişme sezonlarında yürütülmüştür. Tesadüf blokları deneme desenine göre üç tekerrürlü olarak yürütülen çalışmada; 3 adet ekmeklik buğday, 3 adet makarnalık buğday, 3 adet tritikale ve 4 adet arpa çeşidi bitkisel materyal olarak kullanılmıştır. Bitki boyu, biyolojik verim, tohum verimi, saman verimi ve ham protein açısından tahıl türleri arasındaki fark istatistiksel olarak önemli bulunmuştur (P≤0.01). Bu özellikler açısından en yüksek sonuçlar tritikale samanından, en düşük değerler ise arpa ve ekmeklik buğday samanlarından elde edilmiştir. Aynı zamanda, en iyi verim sonuçlarının elde edildiği tritikale samanından en düşük ham protein oranı elde edilmiştir. Ham protein verimi, ADF ve NDF içerikleri, sindirilebilir kuru madde ve nispi yem değeri açısından tahıl türleri arasındaki fark istatistiksel olarak önemsiz bulunmuştur. Sonuç olarak, en yüksek verime sahip türün tritikale olduğu belirlenmiştir. Kalite kriterleri açısından, sadece ham protein içeriğinin türler arasında istatistiksel olarak önemli olduğu ve bu özellik açısından en düşük değerin tritikaleden, en yüksek değerin ise ekmeklik buğday ve arpadan elde edildiği belirlenmiştir.

Anahtar Kelimeler: Tahıllar, Çeşitler, Tohum verimi, Saman verimi, Saman kalitesi

Introduction

The roughage needed in Turkey's livestock is supplied from three main sources. The first of these sources is meadow and pasture areas, the second is forage crops cultivated in field crops and the third is the straw of cereals (Altin et al., 2009; Sayar et al., 2010).

Straws are the crumbled stems and leaves that remain after the plants whose grains will be used have matured and threshed. Due to the excess of nutrients that are difficult to digest in the straws, they have a lower feed value than dry forage. For this reason, the straw alone is not consumed by animals. Straws are used with dense feeds such as bran, pulp and ground grains. Daily straw consumption is 2 to 7 kg DM in cattle, 1 to 2 kg DM in sheep and 3 to 4 kg DM in horses (Ergul, 2008).

Straws are generally poor in protein, mineral substances and vitamins. Therefore, animal husbandry is used as a basal feed in small holder systems or supplementary feed in developed countries. However, their use is quite common in countries like Turkey, and there is no possibility to give up their use for a longer period of time (Kilic, 2006).

When the literature findings on the subject are examined, it is seen that different studies have been conducted on different cereal species. Cakmak et al. (1993) the effects of processing of straw with different chemicals on dry matter degradation and metabolizable energy in rumen, Sehu et al. (1996) *in vivo* digestibility and degradation properties in rumen of some cereal straws, Akdeniz et al. (2004) yield and quality characteristics of some barley cultivars, Degirmencioglu (2004) *in vitro* digestibility of some roughage in sheep and goats, Yavuz (2005) relative feed value and digestion of some ruminant feeds, Kalkan and Filya (2011) the effect of cellulose enzyme on nutritional value and digestion of wheat straw, Abdi and Kilic (2018) and Kilic et al. (2019) examined the effect of additives on roughage quality and digestibility in some straws.

According to the latest data, there are 17.220.903 cattle and 46.117.399 sheep and goats in Turkey. These correspond to 19.042.278 animal units (AU) in total. The amount of quality roughage that the existing animals should consume annually is 86 million tons. The amount of roughage obtained from forage crops cultivation areas and meadow pastures in our country is 31 million tons, and there is a 55 million tons of roughage deficit (Acar et al., 2020). According to 2022 data, the number of cattle was 17 million and the number of sheep and goats has increased to 56 million (TUIK, 2023). With the increase in the presence of animals, the amount of roughage that these animals need increases. Increasing roughage needs are largely met by cereal straws.

The aim of the research was to reveal the straw yield and quality values of different cool season cereal species and cultivars.

Material and Methods

This study was carried out for two years in the 2015 to 2016 and 2016 to 2017 growing season in the Bingol University of Research and Application Area in Turkey. In the study, three cultivars of bread wheat (Pehlivan, Syrena odes'ka and Krasunia odes'ka), three cultivars of durum wheat (Yelken-2000, Kunduru-1149 and Dumlupinar), three cultivars of triticale (Karma, Tacettinbey and Aysehanim), four barley cultivars (Erginel-90, Kiral-97, Sur-93 and Sahin-91) were used as plant material.

The climate data of the research area were obtained from the Bingöl Meteorology Directorate was given Table 1 (MGM, 2018).

Table 1. Climate data of Bingol province for the long years (2000-2015) and 2015-16 and 2016-17 years

Months	Average Temperature (°C)			Total Precipitation (mm)			Humidity (%)		
	2015-16	2016-17	LY	2015-16	2016-17	LY	2015-16	2016-17	LY
October	14.3	15.2	14.2	220.9	4.4	70.3	68.3	43.0	58.9
November	14.4	6.4	6.5	18.9	53.7	91.8	56.4	47.9	64.7
December	1.3	-2.2	0.2	46.2	152.6	121.8	58.6	73.4	70.7
January	-2.8	-3.7	-2.5	235.1	63.9	154.0	75.3	71.1	73.3
February	2.4	-2.3	-0.9	86.3	32.9	137.7	73.7	61.6	72.2
March	7.0	5.9	4.9	125.5	114.5	124.1	60.4	64.7	64.2
April	13.9	10.8	10.9	45.5	166.4	103.8	48.4	58.8	61.2
May	16.3	16.4	16.2	62.2	92.4	66.8	57.4	56.2	55.8
June	22.2	22.6	22.6	34.6	9.6	18.4	43.6	39.0	42.5
July	27.0	28.0	27.0	3.5	0	7.3	33.4	28.1	36.7
Total/Mean	**11.6**	**9.7**	**9.91**	**878.7**	**690.4**	**896.0**	**57.6**	**54.4**	**60.0**

LY: Long Years

In the 2015-16 growing season, the average temperature was recorded as 11.6 ^{0}C, the total precipitation as 878.7 mm and the relative humidity as 57.6%. In the 2016-17 growing season, the average temperature was recorded as 9.7 ^{0}C, the total precipitation as 690.4 mm and the relative humidity as 54.4%. It was observed that the temperature value obtained in the first year was above the average of long years and the temperature value obtained in the second year was close to the average of long years (9.91 ^{0}C). It was observed that the total amount of precipitation obtained in the first year was close to the average of long years and the amount of precipitation obtained in the second year was below the average of long years (896.0 mm). The relative humidity obtained in both years was below the average of long years (60%) (Table 1).

According to the results of the soil analysis, it was determined that the research area has sandy, clayey and loamy, slightly alkaline (pH: 7.54), slightly salty (180.9 µS cm^{-1}), low organic matter content (1.68%), high potassium (75.88 kg da^{-1}) and low phosphorus content (3.59 kg da^{-1}).

The field trial was established on 13 October 2015 in the first year and 17 October 2016 in the second year. The trial was designed in a randomized block design with three replications. In the trial the parcel lengths were 5 m, the distance between the rows was 20 cm and each parcel had 6 rows. 500 seeds were given per square meter. Fertilizer was given to the trial area with 4 kg of nitrogen and 8 kg of phosphorus on pure material per decare. During the stalking period of the plants, fertilization was carried out with 4 kg nitrogen over pure substance and the total amount of nitrogen given was completed to 8 kg.da^{-1}. The trial was carried out under rainfed conditions. Harvest was done on 11 July 2016 in the first year and on 06 July 2017 in the second year, during the full ripening period of the seeds.

Plant height was calculated by measuring the average of the 10 plants randomly selected from each parcel from the soil surface to the highest point. Three rows harvested for seed purposes were weighed and converted into decares to obtain biological yield. Straw and seed yields were calculated by separating the seed and stem from each other. Crude protein (CP), NDF (neutral detergent fiber) and ADF (acid detergent fiber) analyzes of straw samples which were milled by hand mill were performed with NIRS (Near Infrared Spectroscopy - Foss Model 6500) device. Analyzes were determined at Dicle University Technology Application and Research Center and using the IC-0904FE calibration set of the NIRS device. The crude protein yield was calculated with the help of the obtained crude protein. Digetible dry matter (DDM=88.9–(0,779 x %ADF) and relative feed value (RFV=(DDM x DMI) / 1.29) were calculated with the help of ADF and NDF (Morrison, 2003).

The variance analysis was applied to the

obtained data with the help of JMP statistical package program in accordance with randomized block trial design. Cultivars and species were compared separately within themselves. Significant results were compared with the LSD test (JMP, 2002).

Results and Discussion

Plant height and biological yield

Plant height and biological yield values of different cereal species and cultivars were given in Table 2. As seen in Table 2, in terms of plant height the difference between the species, the difference between the cultivars of all species and difference between the years of barley were found to be statistically significant.

Plant height of cereal species varied between 78.5 and 109.0 cm. The highest plant height was obtained from triticale with 109 cm followed by durum wheat with 90.9 cm. The lowest plant height was obtained from bread wheat with 81.2 cm and barley with 78.5 cm. In terms of cultivars; Pehlivan and Syrena odeska cultivars in bread wheat, Kunduru-1149 cultivar in durum wheat, Karma and Tacettinbey cultivars in triticale and Sur-93 and Sahin-91 cultivars in barley gave higher values than other cultivars. The plant height obtained in the second year of barley was found to be statistically higher than the plant heighy obtained in the first year (Table 2).

Table 2. Plant height and biological yields of cereal species and cultivars

Species	Cultivars	Plant height (cm)			Biological yield (kg da^{-1})		
		2015-16	2016-17	Mean	2015-16	2016-17	Mean
Bread Wheat	Pehlivan	81.9	86.8	84.4 a**	485	572	529
	Syrena odes'ka	83.3	79.2	81.3 a	466	457	462
	Krasunia odes'ka	79.0	76.8	77.9 b	491	435	463
	Mean	81.4	80.9	81.2 C**	481	488	485 C**
Durum Wheat	Yelken-2000	79.8	79.4	79.6 c**	667	571	619
	Kunduru-1149	105.0	97.7	101.4 a	681	670	676
	Dumlupinar	93.3	89.8	91.6 b	554	527	541
	Mean	92.7	89.0	90.9 B	633	589	611 B
Triticale	Karma	112.2	111.7	112.0 a*	897	988	943
	Tacettinbey	113.3	108.9	111.1 a	1023	968	996
	Aysehanim	103.4	104.4	103.9 b	1008	874	942
	Mean	109.7	108.3	109.0 A	976	943	960 A
Barley	Erginel-90	68.9	76.1	72.5 b**	463	686	575
	Kral-97	65.7	71.1	68.4 c	430	589	510
	Sur-93	85.4	90.6	88.0 a	352	400	377
	Sahin-91	85.6	84.7	85.1 a	426	658	542
	Mean	76.4 B**	80.6 A	78.5 C	418 B**	584 A	501 C

The averages shown with the same letter are not different from each other within the error limits of *)P≤0.05 **)P≤0.01 according to the LSD.

The difference between the biological yields of cereal species was found to be statistically significant between species and only between years of barley. The biological yields of the species varied between 485 and 960 kg da^{-1} on average. The statistically highest biological yield was obtained from triticale with 960 kg da^{-1}. This was followed by 611 kg da^{-1} of durum wheat. The lowest biological yield was obtained from barley with 501 kg da^{-1} and bread wheat with 485 kg da^{-1}. The biological yield obtained in the second year of barley was found to be statistically higher than the yield obtained in the first year (Table 2). It is predicted that this difference is due to the genetic structure of barley.

Similar to these results, Akdeniz et al. (2004) stated that plant height was 59.9 to 72.1 cm and biological yield was 452.3 to 773.7 kg da^{-1} in barley. In addition, the average plant height obtained from the study was lower than Yilmaz et al. (1994)'s results and higher than Yilmaz et al. (2001)'s results. The reason for this difference; varies depending on many factors such as cultivars used, ecological factors, fertilization and harvest time.

Seed and straw yield

Seed and straw yield values of different cereal species and cultivars were given in Table 3. The difference between the species and the difference between cultivars of bread wheat in seed yield were found to be statistically significant.

Table 3. Seed and straw yields of cereal species and cultivars

Species	Cultivars	Seed yield (kg da^{-1})			Straw yield (kg da^{-1})		
		2015-16	2016-17	Mean	2015-16	2016-17	Mean
Bread Wheat	Pehlivan	194	181	188 a*	291	391	341
	Syrena odes'ka	115	196	156 ab	351	261	306
	Krasunia odes'ka	137	143	140 b	354	292	323
	Mean	149	173	161 C**	332	315	324 C**
Durum Wheat	Yelken-2000	242	194	218	425	377	401
	Kunduru-1149	219	214	217	462	456	459
	Dumlupinar	182	163	173	372	364	368
	Mean	214	190	202 B	419	399	409 B
Triticale	Karma	343	367	355	554	620	587
	Tacettinbey	384	344	364	639	624	632
	Aysehanim	388	333	361	620	541	581
	Mean	372	348	360 A	604	595	600 A
Barley	Erginel-90	140	167	154	323	519	421 a*
	Kral-97	100	135	118	330	454	392 a
	Sur-93	118	135	127	234	265	250 b
	Sahin-91	145	185	165	281	473	377 a
	Mean	126	156	141 C	292 B**	428 A	360 BC

The averages shown with the same letter are not different from each other within the error limits of *)P≤0.05 **)P≤0.01 according to the LSD.

Seed yields of cereal species varied between 141 and 360 kg da^{-1}. The highest seed yield was obtained from triticale with 360 kg da^{-1}. Triticale was followed by durum wheat. The lowest value was obtained from bread wheat and barley. While no difference was found between durum wheat, triticale, and barley cultivars, it was observed that Pehlivan and Syrena odeska cultivars gave higher values than Krasunia odeska cultivar in bread wheat. The difference between the years of species was not statistically significant (Table 3).

In terms of the straw yield, the difference between species and the difference between years and cultivars of barley were found to be statistically significant. Straw yield between species ranged between 324 and 600 kg da^{-1}. The highest straw yield was obtained from triticale with 600 kg da^{-1}, followed by durum wheat with 409 kg da^{-1}. The lowest straw yield was obtained from barley with 360 kg da^{-1} and bread wheat with 324 kg da^{-1}. The straw yield of barley was 292 kg da^{-1} in the first year and 428 kg da^{-1} in the second year, and the yield obtained in the second year was found to be statistically higher than the first year. It was observed that Sur-93 cultivar gave lower value than other cultivars (Table 3). It is thought that this lowness is due to the genetic structure of the cultivar. Since the highest biological yield was obtained from triticale in the study, the highest seed and straw yield was obtained from triticale.

Feeding values of the straw of cereal species vary considerably from each other. Moreover, there are significant differences between the chemical contents and digestibility of even the same species of straw (Devendra, 1982). Straws containing low levels of nutrients provide the animals to be physically satiated due to their high content of non-digestible organic matter and help to better digest other nutrients (Ergun et al., 2002). Similar to the results obtained in this study, Akdeniz et al. (2004) reported that they obtained a seed yield of 201 to 301 kg da^{-1} and straw yield of 251 to 473 kg da^{-1}. Genetic and environmental factors are effective on seed and straw yields. Therefore, it is possible to obtain different seed and straw yields in different ecological conditions.

Crude protein content and yield

As can be seen in Table 4, in terms of crude protein content, the difference between the species and the difference between years and cultivars of barley were found to be statistically significant.

Table 4. Crude protein (CP) content and yield of cereal species and cultivars

Species	Cultivars	CP (%)			Protein yield (kg da^{-1})		
		2015-16	2016-17	Mean	2015-16	2016-17	Mean
Bread Wheat	Pehlivan	6.14	4.08	5.11	29.0	23.9	26.5
	Syrena odes'ka	4.00	6.25	5.13	18.7	28.4	23.5
	Krasunia odes'ka	5.43	5.19	5.31	26.2	22.6	24.4
	Mean	5.19	5.17	5.18 AB**	24.6	25.0	24.8
Durum Wheat	Yelken-2000	4.45	4.95	4.70	30.0	25.1	27.5
	Kunduru-1149	3.79	4.56	4.17	26.6	31.0	28.8
	Dumlupinar	3.28	3.94	3.61	17.6	20.8	19.2
	Mean	3.84	4.48	4.16 B	24.7	25.6	25.2
Triticale	Karma	2.08	2.92	2.50	18.6	28.1	23.3
	Tacettinbey	3.25	3.20	3.23	33.3	31.4	32.3
	Aysehanim	3.51	2.60	3.05	33.8	22.5	28.2
	Mean	2.95	2.91	2.93 C	28.6	27.4	28.0
Barley	Erginel-90	6.11	6.78	6.44 a**	27.5	47.5	37.5 a*
	Kral-97	5.25	7.45	6.35 a	22.6	44.3	33.5 ab
	Sur-93	4.25	7.33	5.79 a	14.9	29.5	22.2 bc
	Sahin-91	3.68	3.77	3.73 b	15.3	23.7	19.5 c
	Mean	4.82 B**	6.33 A	5.58 A	20.1 B**	36.3 A	28.2

The averages shown with the same letter are not different from each other within the error limits of *)P≤0.05 **)P≤0.01 according to the LSD.

The highest crude protein content was observed in barley (5.58%) followed by bread wheat (5.18%) and durum wheat (4.16%). The lowest crude protein content was obtained from triticale with an average of 2.93%. Among the cultivars of barley; Erginel-90, Kral-97 and Sur-93 were statistically in the same group and gave higher values than Şahin-91 and 6.33% obtained in the second year of barley was statistically higher than 4.82% obtained in the first year (Table 4).

Crude protein yields vary between 24.8 and 28.2 kg da^{-1} as the average of two years and there is no statistical difference between species. It was determined that there was a statistical difference between cultivars and years of barley. Erginel-90 cultivar gave the highest value compared to other cultivars and Kral-97 cultivar was in the same group with this cultivar. In addition, 36.3 kg da^{-1} yield obtained in the second year was higher than 20.1 kg da^{-1} yield obtained in the first year in barley and this difference was found to be statistically significant (Table 4).

Previous studies have reported that the ratio of crude protein content in wheat straw varies between 2.10 and 4.06% (Cakmak et al., 1993; Sehu et al., 1996; Degirmencioglu, 2004; Yavuz, 2005; Ergul, 2008; Kalkan and Filya, 2011; Abdi and Kilic, 2018; Kilic et al., 2019). It has been reported that the crude protein ratio in barley straw varies between 3.44% (Ergül, 2008) and 2.05-4.13% (Akdeniz et al., 2004). In the research; although the values obtained from durum wheat were similar to those obtained by the researchers, it was observed that the values obtained from bread wheat and barley were higher than the values determined by the researchers. This is because; the different cultivars of plants used in the studies, soil structure of the trial areas, applied fertilization, plant harvesting time, seed rates in the straw are factors such as.

Crude protein content is one of the most important criteria for determining feed quality. The level of crude protein should be at least 6% in feed rations (Senel, 1986). From this point of view, we can conclude that cereal straws should not be a preferred feed in animal rations.

Acid detergent fiber and neutral detergent fiber ratios

The ADF and NDF content of different cereal species and cultivars were given in Table 5. The difference between the species in terms of the ADF content is insignificant, the difference between cultivars in bread and durum wheat and between years in durum wheat and barley were statistically significant (Table 5).

The ADF content among the species varied between 45.0 and 51.9%. It was seen that Pehlivan cultivar among bread wheat cultivars have higher values than other cultivars and Kunduru-1149 and Dumlupinar cultivars in durum wheat compared to other cultivars. It was found that the ADF value obtained in durum wheat in the first year (49.6%) was higher than the ratio obtained in the second year (45.5%). Also, the rate of ADF obtained in barley in the first year (49.7%) was higher than the ratio obtained in the second year (41.6%) (Table 5).

Table 5. Acid detergent (ADF) and neutral detergent (NDF) fiber content of cereal species and cultivars

Species	Cultivars	ADF (%)			NDF (%)		
		2015-16	2016-17	Mean	2015-16	2016-17	Mean
Bread Wheat	Pehlivan	45.0	49.5	47.3 a**	67.9	75.8	71.9
	Syrena odes'ka	44.6	42.5	43.6 b	70.0	68.6	69.3
	Krasunia odes'ka	43.3	44.9	44.1 b	68.6	71.9	70.3
	Mean	44.3	45.6	45.0	68.9 B*	72.1 A	70.5
Durum Wheat	Yelken-2000	45.5	42.9	44.2 b*	72.1	70.3	71.2
	Kunduru-1149	52.3	45.6	48.9 a	80.4	72.1	76.3
	Dumlupinar	51.0	47.9	49.4 a	79.9	74.1	77.0
	Mean	49.6 A*	45.5 B	47.5	77.5 A*	72.2 B	74.8
Triticale	Karma	54.8	50.6	52.7	83.6	79.0	81.3
	Tacettinbey	52.0	50.0	51.0	80.2	77.4	78.8
	Aysehanim	51.7	52.1	51.9	80.2	79.7	80.0
	Mean	52.9	50.9	51.9	81.3	78.7	80.0
Barley	Erginel-90	46.5	42.3	44.4	74.6	70.1	72.3
	Kral-97	48.9	41.6	45.3	78.0	67.1	72.6
	Sur-93	49.7	45.6	47.7	80.0	72.2	76.1
	Sahin-91	53.7	36.9	45.3	82.9	61.4	72.2
	Mean	49.7 A**	41.6 B	45.7	78.9 A**	67.7 B	73.3

The averages shown with the same letter are not different from each other within the error limits of *)P≤0.05 **)P≤0.01 according to the LSD.

The NDF content of the species vary between 70.5 and 80.0% and the difference between the species was not statistically significant (Table 5). The difference between the years of bread wheat, durum wheat and barley were found to be statistically significant. Further, it was seen that the values obtained in durum wheat and barley in the first year were higher than in the second year and the value obtained in the second year in bread wheat was higher than the first year.

Acid detergent fiber (ADF) and neutral detergent fiber (NDF) are the most important quality traits to animal feed. And, they have been widely used in recent years to determine the quality status of the feeds of livestock (Basbag et al; 2018; Basbag et al., 2021, Sayar et al 2022). ADF consists of the sum of cellulose and lignin contents of feeds, and it is generally used to determine the digestibility status of feeds, whereas NDF consists of the sum of ADF and hemicellulose in the animal feeds, and it is generally used to determine consumption status of feeds by animal (Schroeder, 1994; Jeranyama & Garcia, 2004; Sayar et al., 2022). Ruminant animals make it useful by fermenting pectin, hemicellulose and cellulose in the cell wall structure of the plants they cannot digest, thanks to the bacteria found in Rumen. Fermentation of plants varies depending on ADF and NDF values. The high NDF value in plants slows digestion and gives the animals a feeling of physical satiety and reduces the amount of feed they receive. In addition, since the digestion rate of ADF in plants is very slow, it is desirable to have a low amount of animal feed rations (Van Soest, 1994).

In previous studies, it was reported that ADF

value in wheat straw ranged between 35.9 and 53.3% and NDF ratio between 58.4 and 81.7% (Cakmak et al., 1993; Degirmencioglu, 2004; Fluharty, 2009; Kalkan and Filya, 2011; Abdi and Kilic, 2018; Kilic et al., 2019). The findings obtained from the study were found to be consistent with the literature findings. However, Sehu et al. (1996) reported that they obtained 45.2% ADF content and 85.9% NDF content in barley straw. The ADF content reported by the researchers was similar to the ADF content obtained from this study, but the NDF content was higher than the content reported in this study. It is estimated that this difference between NDF content are caused by cultivars. Early or late maturation of a cultivar may have an effect on the ratio of NDF to be obtained from that cultivar.

The highest ADF and NDF content were found in triticale. This means that triticale straw is more difficult to digest than other straw. Indeed, Twidwell et al. (1987) reported that triticale is a plant that is difficult to digest and the reason for this is due to the high plant height and ratio of the stalk.

Digestible dry matter and relative feed value

The digestible dry matter and relative feed values of different cereal species and cultivars were given in Table 6. There was no statistical difference between the species in terms of digestible dry matter content, but it was seen that the difference between the cultivars in bread and durum wheat, between years in durum wheat and barley was statistically significant.

The value of digestible dry matter varies between 48.5 and 53.9%. Syrena odeska and Krasunia odeska cultivars were found to be higher than Pehlivan and Yelken 2000 cultivar was higher in the digestible dry matter content than other cultivars in durum wheat. Also, the values obtained in the second year in durum wheat and barley were higher than those obtained in the first year (Table 6).

Table 6. Digestible dry matter and relative feed value of cereal species and cultivars

Species	Cultivars	Digestible dry matter (%)			Relative feed value (RFV)		
		2015-16	2016-17	Mean	2015-16	2016-17	Mean
Bread Wheat	Pehlivan	53.8	50.3	52.1 b**	73.7	62.1	67.9
	Syrena odes'ka	54.1	55.8	55.0 a	71.9	75.7	73.8
	Krasunia odes'ka	55.2	54.0	54.6 a	74.9	69.8	72.4
	Mean	54.4	53.4	53.9	73.5 A*	69.2 B	71.4
Durum Wheat	Yelken-2000	53.4	55.5	54.5 a*	69.1	74.6	71.8
	Kunduru-1149	48.2	53.3	50.8 b	55.8	68.9	62.3
	Dumlupinar	49.2	51.6	50.4 b	57.3	64.9	61.1
	Mean	50.3 B*	53.5 A	51.9	60.7 B*	69.5 A	65.1
Triticale	Karma	46.2	49.5	47.8	51.5	58.4	55.0
	Tacettinbey	48.4	49.9	49.2	56.1	60.9	58.5
	Aysehanim	48.6	48.3	48.5	58.0	56.4	57.2
	Mean	47.7	49.3	48.5	55.2	58.6	56.9
Barley	Erginel-90	52.7	55.9	54.3	66.6	74.5	70.6
	Kral-97	50.8	56.5	53.6	60.8	78.3	69.5
	Sur-93	50.2	53.4	51.8	58.5	68.9	63.7
	Sahin-91	47.0	60.1	53.6	52.9	91.3	72.1
	Mean	50.2 B**	56.5 A	53.3	59.7 B**	78.3 A	69.0

The averages shown with the same letter are not different from each other within the error limits of *)P≤0.05 **)P≤0.01 according to the LSD.

It was determined that the difference between the species in terms of relative feed value was not statistically significant and the difference between the years of bread wheat, durum wheat and barley were statistically significant. The relative feed value varied between 56.9 and 71.4. The highest values in bread wheat were obtained in the first year and the highest values in durum wheat and barley were obtained in the second year (Table 6).

The relative feed value method, which was

originally developed for alfalfa quality control in the United States, is now used for all forage plants (Ball et al., 1996). ADF and NDF values were used to calculate the relative feed value. The RFV value for alfalfa harvested during full flowering is considered to be 100. It was reported that feed quality decreases as RFV value falls below this value (Richardson, 2001). In terms of quality criteria of feeds, DDM values below 53 and RFV values below 75 are accepted as the lowest quality (Rivera and Parish, 2010). From this point of view, it was seen that durum wheat and trikale were in the lowest quality group in terms of DDM, and all cereal species in terms of RFV.

Abdi and Kilic (2018) reported the digestibility dry matter as 51.9% and the relative feed value as 61.2 in wheat straw. These values were found to be consistent with the findings obtained from the study. Yavuz (2005) reported that the digestible dry matter as 44.4% and relative feed value as 48.6 in wheat straw. These findings were found to be lower than those obtained from this study. These two parameters are directly related to ADF and NDF content of the straws. The low or high of these ratios causes the digestibility dry matter and relative feed values to directly high or low.

Conclusion

It was found that triticale which is one of the cereal species, gives higher values in terms of plant height, biological yield, seed yield and straw yield than other species. However, in terms of crude protein content, which is an important quality criterion, triticale has lower values than other cereal species. The highest crude protein content was obtained from barley and bread wheat. No differences were found between the species in terms of crude protein yield, ADF, NDF, digestible dry matter and relative feed value. It was concluded from the present study that cereal species had low values in terms of crude protein ratio, crude protein yield, digestible dry matter, relative feed value and high values in terms of ADF and NDF.

Conflict of interest: The authors declare that they have no conflict of interest.

Author contributions: E.C. was responsible for the selection of the study topic, performing the chemical analyzes, writing and submitting the manuscript. K.K. was responsible for the cultivation, morphological measurements of cereals and writing. All authors read and approved the final manuscript.

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