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Cultivar and Harvest Stage Effects on Nutritive Value of Whole Crop Oat (*Avena sativa* L.) Silages

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ABSTRACT

This study was carried out to investigate the effects of feed value and dry matter (DM) on rumen degradability properties of silages of oat (*Avena sativa L.*) cultivars (Kahraman and Kırklar) at different harvest stages (pre-flowering, flowering, milk, soft dough). Field and digestibility trials were carried out in randomized blocks, in a 2x4 factorial trial design during the 2016-2017 vegetation period. For the rumen digestibility of silages, three heads of Karayaka rams with rumen cannulated, average 50±3 kg body weight and 3 years old were used. As a result of the experiment, It was observed that the crude protein (CP) level of Kahraman cultivar was higher than that of Kırklar cultivar, and the CP content of cultivars decreased from the pre-flowering period to the soft dough period. In addition, with the progress of the growing period, the neutral detergent fiber (NDF) content of the varieties increased. Also, the net energy lactation (NEL) level of Kırklar cultivar was higher than Kahraman cultivar. However, the NEL levels of the cultivars decreased with the progression of the growing period. The water solubility of DM and CP of Kahraman cultivar was higher than that of Kırklar cultivar. In addition, effective dry matter degradability (EDMD) decreased with growth period in both cultivars. It was observed that the effective crude protein degradability (ECPD) rate of Kahraman cultivar was higher than that of Kırklar cultivar and ECPD rate of cultivars decreased with the progress of the growing period. As a result, Kahraman cultivar may be preferred more than Kırklar cultivar, since it has higher EDMD and ECPD in the rumen and also has higher RFV value.

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Çeşit ve Hasat Dönemlerinin Yulaf Silajlarının Besin Değeri Üzerine Etkileri

ÖZET

Bu çalışma, yulaf (Avena sativa L.) çeşitlerinin (Kahraman ve Kırklar) farklı hasat dönemleri (çiçeklenme öncesi, çiçeklenme, süt olum, hamur olum) silajlarının yem değeri ve kuru maddenin (DM) rumende parçalanabilirlik özelliklerine olan etkilerini araştırmak amacıyla yürütüldü. Tarla ve sindirilebilirlik denemeleri, 2016-2017 vejetasyon döneminde tesadüf bloklarında, 2x4 faktöryel deneme düzeninde yürütüldü. Silajların rumende sindirilebilirliği için üç baş, rumen kanüllü, ortalama 50±3 kg canlı ağırlığında ve 3 yaşında Karayaka koçlar kullanıldı. Deneme sonucunda Kahraman çeşidinin ham protein (CP) içeriğinin Kırklar çeşidine göre daha yüksek olduğu ve çeşitlerin CP içeriğinin çiçeklenme öncesi dönemden yumuşak hamur dönemine doğru azaldığı görüldü. Ayrıca yetiştirme döneminin ilerlemesi ile çeşitlerin nötral deterjan lif (NDF) içeriği arttı. Ayrıca Kırklar çeşidinin net enerji laktasyon (NEL) seviyesi Kahraman çeşidine göre daha yüksekti. Ancak, büyüme periyodunun ilerlemesi ile çeşitlerin NEL seviyeleri azaldı. Kahraman çeşidinin kuru madde ve ham proteinin suda çözünürlüğü, Kırklar çeşidinden daha yüksekti. Ayrıca, etkin kuru madde parçalanabilirliği (EKMP), her iki çeşitte de büyüme periyodu ile azaldı. Kahraman çeşidinin etkin ham protein parçalanabilirliği (EHPP) oranının Kırklar çeşidine göre daha yüksek olduğu ve yetiştirme döneminin ilerlemesiyle çeşitlerin EHPP oranının düştüğü görüldü.

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Sonuç olarak, Kahraman çeşidinin, rumende etkin KM ve HP sindirilebilirliklerinin daha yüksek olduğu, ayrıca, daha yüksek nispi yem değerine sahip olması nedeniyle Kırklar çeşidine göre daha fazla tercih edilebilir.

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INTRODUCTION

Oat is an important animal feed world wide as a nutritious grain and forage source (Güngör et al. 2017). The most preferred plant as forage among cereals is oat. It is relatively late and has abundant leaves. Oats have new shoots growing in every period. Early regrowth after grazing or plucking is relatively good. In addition, cluster formation can be evaluated as an advantage compared to spike-forming grains (Çeri & Acar 2019). However, Khan et al. (2014), in their study where they compared the yield and quality characteristics of oat genotypes, stated that the genotypes were significantly different in terms of yield and quality characteristics. Çeri & Acar (2019) reported that 1 755 323 tons of green roughage was obtained from 1 063 555 hectares of cultivation area in Turkey in 2017. However, the plant's production location, climate and growth periods are highly effective on feed quality (David et al., 2010). In addition, the chemical composition of forage crops differs among regions according to climatic conditions, soil structures, varieties and application practices (Shoaib et al., 2014). This plant is a good source of protein, fiber and minerals for livestock (Strychar, 2011). Also, Mobashar et al. (2018), in the maturity process of the oat plant, the fiber and lignin content increases as the forage plant matures. He stated that as the plant growth period progresses, the intake potential of oats decreases, reduces the digestion rate of feed and therefore reduces animal production. However, Rosser (2014) stated that the effect of harvest time on NDF, ADF and lignin concentration in annual and perennial grasses is variable. Wallsten & Martinsoon (2009) in their study; It was stated that the NDF concentration and digestibility of oats decreased from the milk stage to the yellow stage. In addition, they stated that during the maturation process of cereal plants, the rate of passage of DM from the rumen did not change, but the water-soluble part of the silages increased with the advancing maturation process, although the water-soluble part of the silages was initially low. Also, in the maturation process of the oat plant; The water-soluble crude protein level decreases from 55% to 33%, and the effective dry matter degradability decreases quadratically with the progression of the millet, oat and wheat growing periods, but does not change in barley (Rosser et al., 2013). The aim of this study is to investigate the effects of plant harvesting period and oat varieties on the nutritional value of whole plant oat silages.

MATERIAL and METHOD

Forage agronomy

The research was carried out on the trial fields of Gaziosmanpaşa University Agricultural Application and Research Center during the vegetation period of 2016-2017. In the study, Kahraman and Kırklar oat varieties, which were registered in 2014 by the Edirne Thrace Agricultural Research Institute, were used. This study was conducted during the 2016 and 2017 growing season. Kırklar is an oat variety that developed earlier than the Kahraman variety. The trial area had soil clay, fertile and soil salt (2 S cm-1), pH, lime (%), P_2O5 (kg ha-1), K_20 (kg ha-1), Organic matter (%) 0.032, 7.47, 2.42, 2.04, 1523.2, 19.8, respectively. Data on the climate characteristics of the trial area were given in Table 1. In the 2016 and 2017 growing seasons, the annual precipitation was lower than the average for many years. The research was carried out in 3 replications according to the 2x4 factorial experiment in random blocks. The planting area was arranged for each variety with 500 plants per m^2. The plots had an area of 0.2 meters between the lines and an area of 5 m x 20 m (100 m^2).

While sowing seeds, 4 kg of composite fertilizer (15-15-0) and 1.3 kg of ammonium nitrate fertilizers (33%) were used during the cultivation period. Two oat varieties were harvested in 4 different harvest periods (Pre flowering, flowering, milk and soft dough) and silage was done.

Silage preparation and chemical analysis

After harvesting the fresh material, it was cut into approximately (therotically) 2 cm long and 1.5 kg plant material placed in jars with a capacity of 2 kg which tightly closed and subjected to fermentation for 60 days (Filya, 2002). After opening the silage covers, for the chemical analysis of the silages samples dried, milled and passed through a 1 mm sieve. The ash content of the silage samples were found in the muffle furnace at 525 °C for 8 hours. Crude protein content of silage was determined by multiplying the total nitrogen amount determined by Kjeldahl method with 6.25 coefficient. Also, Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents of the silage samples were determined by ANKOM (ANKOM 200 Fiber Analyzer. Ankom tech.) (Van Soest et al., 1991; Anonymus, 2007b). Net energy lactation (NEL) values of dried silage samples were calculated by the formulas given below.

NEL, Mcal kg^{-1} = 2.296- (0.0257*ADF) (grass) (1)

equations were used (Anonymus, 2007a). Digestible dry matter of herbage were calculated by using this equation

Table 1. Climate characteristics of the trial site (2016-2017)
Çizelge 1. Deneme sahasının iklim özellikleri

Months/Items	Precipitation (mm)	Long year av. (1929-2016)(mm)	Average (°C)	Long years av. (1929-2016) (°C)
March	59.0	57.1	8.1	9.7
April	34.5	23.6	10.0	13.5
May	34.8	31.9	16.9	18.0
June	35.4	48.5	20.0	21.0
July	0.2	3.8	23.5	24.8
August	7.6	4.4	24.3	25.6
September	0.2	19.6	23.2	22.5
October	55.6	51.8	16.1	15.7
Total	227.3	240.7	17.8	18.9

Digestible dry matter (DDM)=88.9-(0.779*ADF%), (2)

potential dry matter intake (as percent of body weight) was determined by using this equation,

Potential dry matter intake ($PDMI$)= 120/ (NDF%) (3)

Specified by Jaranyama & Garcia (2004). RFV was calculated according to ADF and NDF values during the full bloom period of Alfalfa. That depends on the Feed intake potential and dry matter digestibility of the feeds and helps to classify (Prime: >151, premium: 151-125, good: 124-103, fair:102-87, poor:86-75, reject:<75) the feeds according to their quality.

Relative feed value (RFV) = $PDMI \times DDM$/1.29 (4)

İn-situ incubations

This study was carried out with the approval of Gaziosmanpaşa University Animal Experiments Local Ethics Committee, dated 9.3.2017 and numbered 51879863-25 (2017 HADYEK -47). Nylon bag technique was used to determine the degradability of silage samples in the rumen. For this purpose, a rumen fistula (3.5 cm inner diameter) was placed, approximately 50±0.4 kg live weight, 3 years old, 3 head Karayaka rams were used (Ørskov & McDonald,1979). Before starting digestion trial, the animals were weighed and placed in individual compartments. The animals were adapted to the trial conditions for 3 weeks. The animals were fed at 125% of their maintenance level (Anonymus, 2007a). The feeds, roughage: concentrate ratio was prepared at 60: 40 and the animals were fed twice a day (at 8.30 in the morning and at 16.30 in the evening). A mixture of alfalfa hay and triticale hay (60: 40) as roughage and barley as concentrate was used. In addition, the animals were given a vitamin and mineral mixture. Clean water was always kept in front of the animals. Silage samples were dried at 65 °C for 48 hours and then samples were prepared by grinding through laboratory hammer mill with a 2.5 mm screen. Samples (5 g) were placed in a bags (bags, made of polyester fabric of 5x10 cm size and 40-50 micron pore diameter). Bags were put into the rumen for incubations of 0, 16, 24, 48, 72 and 96 hours to determine DM and CP degradablities. The degradability of nutrients in the rumen were calculated by the method specified by Ørskov & McDonald, (1979). The nylon bags removed from the rumen at the end of the incubation were washed until clean water flowed in tap water. Then, after drying at 80 °C for 24 hours in the drying cabinet and cooling in the excavator, the degradability of the feeds in the rumen was calculated with the equation given below. Digestible dry matter (DDM) and digestible crude protein (DCP) were calculated by the formula given below.

DDM and CPD (%)=(*İnitial weight-final weight*) / (*İnitial weight*)×100 (5)

Degradation characteristics of nutrients (DM and CP) were calculated (Ørskov & Mc Donald, 1979; Van Soest *et al.* 1991) using the equation,

Degradation (D) $= a + b\,(1\text{-}e^{-ct})$ (6)

Where: D: disappearance rate of nutrients at time *t*. a: the portion of nutrients (DM, CP) solubilized at the beginning of incubation (time 0). b = slowly degraded nutrients (DM and CP) in the rumen c: rate constant of disappearance of 'b', t = time of incubation. Degradation characteristics; a, b, c and effective ruminal degradability of DM, and CP were calculated by Ørskov & Mc Donald (1979). The effective DM and CP degradability were calculated by using equation,

The effective DM and CP degradability (EDMD) and (ECPD)=$a+(bc\,/\,c+k)$ (7)

Where: k = ruminial out flow rate, k_1 = 0.02 h^{-1} and k_2=0.05 h^{-1}) for DM and CP. Also, silage samples were weighed and placed in nylon bag to determine washing losses by using washing machine for 30 minutes. The loss of washing was found by weighing the dried feed samples in the drying cabinet (Lai & Thu Huong, 1999).

Statistical analysis

Statistical analysis was performed using the GLM procedure of SPSS Software-16 for Windows (Anonymus, 2007c). Field trial were sown 2x4 factorial experimental design in randomized blocks. As a mathematical model;

$$Yijk = \mu + ai + bj + cij + e_{ijk}. \quad (8)$$

Yijk = Observation value of this equation, μ = Population average, ai = Effect of cultivars (i = 1,2), bj = Effects of harvest periods (j =1, 2, 3 and 4), cij: period variety interaction (j = 1, 2, 3 and 4; i = 1,2) eijk = used as the error value. The differences between harvest periods and "Tukey" were determined by multiple comparison test (Anonymus, 2007c).

RESULTS and DISCUSSION

Chemical composition

It was found that there was no significant difference between cultivars in terms of DM (Table 2). However, it has been observed that the DM increased from the pre-flowering period of plant to the soft dough stage and this increase was found to be statistically significant (P<0.001). The DM increased by 60% in Kahraman variety, while the Kırklar variety increased by 53% from the pre-flowering period to the dough formation period. Likewise, Ayhan et al. (2004) and Aydoğan et al. (2014) stated that there were a significant increase in DM yields with the progress of the vegetation period in their work. Oat varieties and harvest periods had no effect on the pH values of silage. Although, the pH level of the silage did not change according to the harvest periods. The silages pH, in the pre-flowering period were the lowest, slightly increased during the flowering and milk period, but small in size decreased during the dough period. The crude protein ratio of the Kahraman variety; except the dough period, was higher than Kırklar. This difference between cultivars was found to be statistically significant (P<0.001). Crude protein content (Figure 1) of forage is one of the most important criteria for hay quality evaluation (Assefa & Ledin, 2001; Başbağ et al 2018). Kim et al. (2006) stated that among the oat varieties, the CP content of late-maturing varieties was higher than that of the early-maturing varieties. The findings of this study were similar to reflected by David et al. (2010) and Aydoğan et al. (2014). In addition, a low CP level during the dough period causes reduced silage buffering capacity, promoting a faster pH drop and may contribute to less degradablity of other nutrient components of silage (Cherney & Cherney, 2003). Also, In terms of crude protein content, the interaction between cultivars and seasons was statistically significant (P<0.001). It was observed that the crude protein level of Kahraman cultivar was higher than that of the Kırklar cultivar, except for the soft dough period.

Table 2. Effects of different harvest stages on chemical composition of silages
Çizelge 2. Farklı hasat dönemlerinin silajların kimyasal bileşimine etkileri

Item		Chemical Composition (%)					
Variety	Harvest stage	DM	pH	CP	NDF	ADF	Ash
Kahraman	Pre flowering	12.42±0.09	4.59±0.21	23.01±0.06	38.94±0.24	27.45±0.08	13.14±0.03
	Flowering	20.81±1.46	5.17±0.47	13.24±0.23	63.52±0.14	37.04±0.22	9.94±0.02
	Milk	23.46±0.17	5.16±0.47	14.24±0.11	58.30±0.35	38.46±0.11	9.50±0.05
	Soft dough	30.95±0.50	5.07±0.30	11.20±0.13	62.09±0.12	37.23±0.14	8.34±0.02
	Mean	21.91±2.02	5.0±0.15	15.42±1.36	55.71±2.97	35.05±2.67	10.23±0.053
Kırklar	Pre flowering	15.53±2.60	4.59±0.21	20.48±0.29	43.48±0.61	28.38±0.39	12.64±0.02
	Flowering	16.75±1.22	5.17±0.47	11.20±0.16	61.0±0.49	38.34±0.34	12.30±0.01
	Milk	23.97±1.77	5.16±0.46	11.39±0.41	61.34±0.13	35.94±0.10	10.17±0.02
	Soft dough	32.73±0.38	5.07±0.30	12.14±0.42	57.47±0.03	35.10±0.72	8.86±0.02
	Mean	22.25±2.19	5.0±0.15	13.8±1.18	55.82±2.20	34.44±1.13	10.99±0.47
Harvest stage	Pre flowering	13.98±1.37[d]	4.59±0.13	21.75±0.58 [a]	41.21±1.06 [c]	27.92±0.28 [c]	12.89±0.11 [a]
	Flowering	18.78±1.24[c]	5.17±0.29	12.22±0.47[bc]	62.26±0.61[a]	37.69±0.34 [a]	11.12±0.52 [b]
	Milk	23.71±0.8 [b]	5.16±0.03	12.82±0.66 [b]	59.82±0.70 [b]	37.20±0.56 [a]	9.84±0.15 [c]
	Soft dough	31.84±0.49[a]	5.07±0.19	11.67±0.29 [c]	59.78±1.03 [b]	36.17±0.58 [b]	8.60±0.12 [d]
	Mean	22.08±1.46	4.99±0.10	14.61±0.85	55.77±1.81	34.74±0.86	10.61±0.36
SEM		1.46	0.102	0.896	1.812	0.858	0.357
P value	Variety	0.726	1.0	***	0.650	*	***
	HS	***	0.21	***	***	***	***
	V*HS int.	0.077	1.0	***	***	***	***

V:variety, HS: harvest stage, Int: interaction, DM:dry matter, CP:crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, SEM: standart error of mean, Differences between mean values shown with different letters in the same column are statistically significant. (*):p<0.05; (**):p<0.01; (***):p<0.001

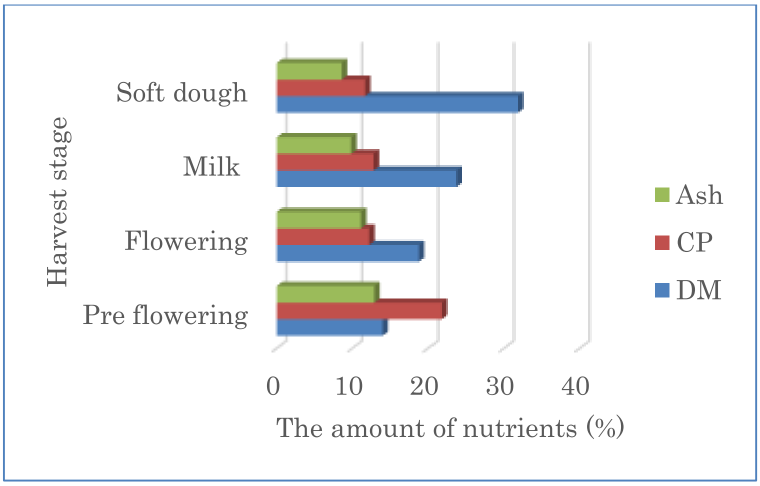

Figure 1. Change of chemical composition according to harvest time in silage
Şekil 1. Silajda hasat zamanına göre kimyasal bileşimin değişimi

Although there was no statistical difference between cultivars in terms of NDF, the difference between harvest periods was found to be significant (P<0.001). The Kahraman variety had a lower NDF rate in the pre-flowering period, but, during the dough period had a higher NDF value than the Kırklar variety (Table 2). Also, The interaction of NDF content of silages between cultivars and seasons was statistically significant (P<0.001). NDF content of Kahraman cultivar was found to be higher than that of Kırklar cultivar during flowering and soft dough periods.

Kırklar cultivar was observed to have higher ADF rate than Kahraman cultivar. This difference was also statistically significant (P<0.05). There was significant interaction between stages of maturity and cultivars in terms of NDF (P<0.001). Similar results were reported by Coblentz et al. (2018).

Acid detergent fiber (ADF) rates of the varieties were lowest in the pre-flowering period, although concantration of ADF increased during the flowering and milk periods, Acid detergent fiber (ADF) was in a reduction trend in the dough period (Table 2). Parallel results were declared by Uzun (2010) and Coblentz et al. (2018). and Acid detergent fiber (ADF) levels of oat varieties change according to early or late maturation. Cell walls of oat varieties that matured early was higher than that of late matures (Kim et al 1999; Kim et al.,2006). The ash content (Figure 1) of Kırklar cultivar was determined to be higher than the Kahraman cultivar considering all harvest periods (P<0.001). The amount of ash in plants decreased significantly with the progression of the vegetation period (P<0.001). In addition, the interaction of ash content of silages between varieties and periods was found to be statistically significant (P<0.001). It was observed that the ash content of Kahraman cultivar decreased more rapidly from the pre-flowering period to the soft dough period compared to the Kırklar cultivar.

Similar results were reported by Uzun (2010) and Gökkuş et al. (2013). In contrast, Khan et al. (2006) stated that the amount of ash in the oats harvested at early maturity, medium maturity, maturity periods were 11.2, 11.3 and 12.5%, respectively.

This results was higher than the findings for soft dough period. However, David et al. (2010) stated that there was no statistical difference between plant mineral content values in terms of cultivars and harvest periods.

Nutritive value

Kahraman variety (Table 3) had a higher amount of dry matter intake potential than the Kırklar variety (P<0.01). Also, the dry matter intake potential of both varieties before flowering period was higher than other harvest groups (P<0.01). When the harvest periods were compared in terms of feed intake; It was observed that the highest intake potential was in silages harvested pre-flowering period. This was followed by milk and dough periods and the lowest intake potential was found to be in the flowering period (P<0.01).

In addition, it was found that the interaction of cultivar x harvest periods on feed intake potential was also important (P<0.001). As the maturation progresses in plants, the increase of cell wall materials, that is, structural carbohydrates, as a result, causes a decrease in the amount of grass intake. In contrast, Wallsten & Martinsoon (2009) stated that when harvested at the heading stage of the oat silage was fed lower than the dry matter intake, harvested at early dough stage. Considering all harvest periods, NEL value of Kahraman silage was found higher than Kırklar variety (P<0.05). When harvest periods were compared for NEL value, silages had the highest value in the pre-flowering period. This was followed by the dough period. The lowest value was determined during the flowering and milk period (P<0.001). In addition, it was determined that the interaction of cultivar x harvest period was very important (P<0.001). The NEL value of silage tends to increase during the dough period. It is thought to be caused by the accumulation of nutrients in the grain. The energy content of feeds is one of the important factors that determine the feed quality. Similar results regarding the NEL value of oat in different periods were also reported by Rafiuddin et al. (2016).

In terms of the rate of digestible dry matter, it was determined that the silage of Kırklar variety was higher than the Kahraman variety. The highest digestion degree was observed in silages pre-flowering, while the lowest was found in silages harvested during flowering (Table 3). As the forage crops mature, the fiber content increases and fiber digestion generally decreases. This could be related to the declining leaf: stem ratio and increasing fiber contents (Mobashar et al., 2018). The relative feed value of the Kahraman variety was found to be higher than the other variety (P<0.05).

Table 3. Nutritive value of silage
Çizelge 3. Silajların bazı besin değerleri

Variety	Harvest stage	DMI (kg, %BW)	NE_L (Mcal kg^{-1})	DDM (%)	RFV
Kahraman	Pre-flowering	3.08±0.02	1.59±0.00	67.52±0.06	161.31±0.85
	Flowering	1.89±0.01	1.34±0.00	60.05±0.02	87.94±0.06
	Milk	2.06±0.01	1.31±0.00	58.94±0.08	94.05±0.70
	Soft dough	1.93±0.00	1.34±0.01	59.90±0.11	89.73±0.34
	Mean	2.24±0.015	1.39±0.03	61.60±1.04	108.26±9.24
Kırklar	Pre-flowering	2.76±0.04	1.56±0.01	66.79±0.31	142.97±2.72
	Flowering	1.97±0.02	1.31±0.01	59.03±0.27	90.04±1.14
	Milk	1.96±0.00	1.37±0.03	60.90±0.08	92.36±0.30
	Soft dough	2.09±0.00	1.39±0.02	61.55±0.57	99.64±0.97
	Mean	2.19±0.01	1.41±0.06	62.07±0.88	106.25±6.52
Harvest Stage	Pre-flowering	2.92±0.07 a	1.58±0.07 a	67.16±0.22 a	152.14±4.28 a
	Flowering	1.93±0.02 c	1.33±0.01 c	59.54±0.27 c	88.99±0.69 c
	Milk	2.01±0.02 b	1.34±0.02 c	59.92± 0.44 c	93.21±0.51 b
	Soft dough	2.01±0.04 b	1.37±0.01 b	60.73±0.45 b	94.69±2.26 b
	Mean	2.22±0.09	1.40±0.02	61.84±0.67	107.25±5.54
SEM		0.088	0.022	0.669	5.542
P value	Variety	**	*	*	*
	Harvest. stage	**	**	**	**
	V*HS int.	***	***	***	***

V:variety, HS: harvest stage, int: interaction, DMI: dry matter intake, DDM: digestible dry matter, RFV: relative feed value, NEl: net energy lactation, SEM: standart error of mean, Differences between mean values shown with different letters in the same column are statistically significant. (*):p<0.05; (**):p<0.01; (***):p<0.001

The highest RFV was obtained from harvested pre-flowering, while the lowest was obtained from the flowering period (P<0.01). Reative feed value is an important feed assessment criterion that combines important nutritional factors such as feed intake and feed digestibility. It can also be used to compare the quality of different feeds. It was observed that RFV of the silage harvested in the pre-flowering period was good, but, the feed value decreased after the flowering period. Linn & Martin (1999) reported similar results. Also, The forage value of the plants in the early development period, shows more suitable than the other development periods (Uzun, 2010). In addition, In terms of RFV, the interaction between cultivars and harvest period was statistically significant (P<0.001). Although the RFV value of Kahraman cultivar was higher than that of Kırklar cultivar in the pre-flowering period, it was observed that Kırklar cultivar had higher RFV value in the soft growing period.

Washing loss and ruminal dry matter degradation

Washing loss of the Kahraman variety (Table 4) was found to be higher than the Kırklar variety (P<0.001). In addition, although the most washing loss was observed in silages harvested pre- flowering period (Table 4), So, washing loss decreased as the vegetation progressed (P<0.05). Also, Variety x harvesting period interaction was statistically important on washing loss of dry matter (P<0.01). Kılıçalp et al. (2018) stated that in their study on corn, sorghum and sorghum sudan hybrids, the loss of washing varied between species and sorghum varieties, and the loss of washing decreased from the middle flowering period to the hard dough period. In terms of the degradability (Figure 2) of the dry matter in the rumen at the 8^{th} hour (Table 4), it was observed that the difference between the varieties was important (P<0.001). But, when the varieties were compared for other incubation hours, the difference between them was not significant. In contrast, Kafilzadeh & Heidary (2013) noted that there was a difference of about 20% between the highest and lowest values of different cultivar of oats. On the other hand, harvest periods significantly affected dry matter degradability (Table 4) at all incubation hours (P<0.001). In addition, dry matter degradability has gradually decreased in all incubation hours, from the pre-flowering period to the soft dough period (P<0.001). While dry matter degradability in rumen (48th hour) was 82.22% in the period pre-flowering, it decreased to 52.95% in the soft dough period. The dry matter degradability reduction was 36%. The higher digestibility of plants in the early stages is related to the ratio of cell wall materials to intracellular substances. Mazumder et al. (2004) and Zhang et al. (2007) reflected that the 48. hour in situ degradability of the oat plant was similar to the findings of this study.

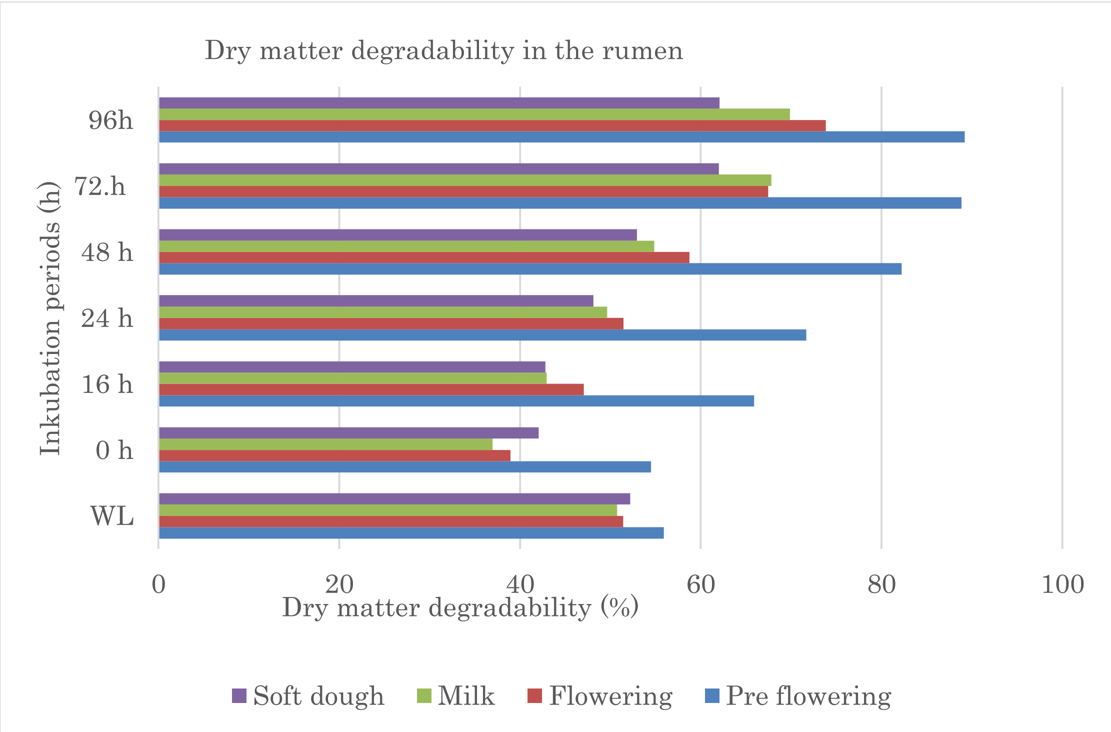

Figure 2. Dry matter digestibility of silage
Şekil 2. Silajların rumende kuru madde parçalanabilirliği

Dry matter degradation characteristics

Dry matter of Kahraman variety has higher water-soluble dry matter (a), lower (b) parameter, higher degradation rate and thus higher effective dry matter degradability than Kırklar (Table 5). The difference between cultivars in terms of parameter a was statistically significant (P<0.001). These results, It has been determined that the instant dissolvable part of Kahraman variety dissolves in water 15% more than Kırklar variety. Also, when oat silages (Table 5) were harvested pre-flowering period; the water-soluble dry matter (a), part that is insoluble in water but degradable by rumen microorganisms (b) and the rate of dry matter degradation (c) were higher than other harvest periods (P<0.001). The values of these dry matter parameters were found to be the lowest in the dough period. In addition, the (a) parameter of plants harvested pre-flowering period was found to be 18% higher than the soft dough period (Table 5).

Rosser et al. (2013) stated that effective dry matter disintegration decreased quadratically with the progression of growth periods of oats. In addition, in terms of parameters b and c, the interaction between cultivars and harvest periods was statistically significant (P<0.001). In terms of effective dry matter degradability in the rumen, although there was no difference at different transition rates between varieties, effective degradability in both varieties followed a progressively decreasing course from pre-flowering to soft dough.

In general, the effective degradability of the dry matter of oat varieties can be explained as having a neutralizing effect on the apparent degradation estimates, with the competitive positive effect of grain filling, the negative effects of lignification and leaf aging (Coblentz et al., 2018). The easily soluble protein (a) of the Kahraman variety was higher than the Kırklar variety and the difference between the varieties (Table 6) was important (P<0.05). The structure and amount of oat proteins vary according to the variety and environmental conditions (Karaman et al 2020), therefore it is thought that the solubility of oat protein in the rumen may also change. While there

Table 4. Rumen dry matter degradability of silages in different periods
Çizelge 4. Farklı periyotlarda silajların rumende kuru madde parçalanabilirliği

Item		Dry matter degradablity (%)					
Variety	Harvest stage	WL (%)	16. hour	24. hour	48. hour	72. hour	96. hour
Kahraman	Pre-flowering	60.20±0.92	70.18±0.55	71.92±3.93	83.86±0.16	90.03±1.36	90.89±0.37
	Flowering	59.48±0.98	49.01±0.84	50.14±3.53	57.29±1.17	65.73±0.99	72.48±1.04
	Milk	55.76±1.25	46.24±1.40	52.28±3.53	59.00±0.97	69.61±1.80	71.69±0.32
	Soft dough	53.88±1.20	44.04±2.27	50.87±4.75	53.87±2.76	63.23±1.45	62.74±1.02
	Mean	57.33±1.78	52.37±3.21	56.30±3.21	63.51±3.65	72.15±3.25	74.45±3.11
Kırklar	Pre-flowering	51.64±0.91	61.60±3.79	71.46±0.84	80.63±0.54	87.70±0.23	87.54±0.40
	Flowering	43.37±0.62	45.09±1.03	52.78±2.73	60.23±3.90	69.21±1.83	75.16±1.32
	Milk	45.73±1.25	39.66±1.07	47.02±2.17	50.69±2.03	66.03±1.83	68.06±2.84
	Soft dough	50.53±0.54	41.60±2.76	45.39±1.06	52.03±2.76	60.80±3.68	61.41±1.83
	Mean	47.82±2.45	46.99±2.82	54.16±3.22	60.90±3.78	70.94±3.21	73.04±3.02
Harvest stage	Pre-flowering	55.92±1.14 a	65.89±2.57 a	71.69±1.80 a	82.24±0.76 a	88.87±0.81 a	89.22±0.79 a
	Flowering	51.43±2.53 c	47.05±1.06 b	51.46±2.08 b	58.76±1.93 b	67.47±1.22 b	73.82±0.96 b
	Milk	50.75±2.33 c	42.95±1.67 b	49.65±2.19 b	54.85±2.11 b	67.82±1.40 b	69.88±1.51 b
	Soft dough	52.21±1.56 bc	42.82±1.69 b	48.13±2.49 b	52.95±1.80 b	62.02±1.85 c	62.08±0.98 c
	Mean	52.57±1.25	49.68±2.16	55.23±2.23	62.20±2.58	71.54±2.23	73.75±2.12
SEM		1.253	2.221	2.235	2.582	2.234	2.223
p value	Variety	***	**	0.343	0.106	0.376	0.173
	Harvest stage	*	***	***	***	***	***
	V*HS. int.	**	0.450	0.508	0.116	0.273	0.131

V:variety, HS: harvest stage, int: interaction, WL:washing loss, SEM: standart error of mean, Different letters, (a,b,c) in the same column are statistically significant. (*):$p<0.05$; (**):$p<0.01$; (***):$p<0.001$

Table 5. Dry matter degradability characteristics of silages
Çizlge 5. Silajların kuru madde parçalanabilirlik özellikleri

Variety	Harvest stage	a (%)	b (%)	a+b (%)	c (h^{-1})	$EDMD_2$ (k=0.02)	$EDMD_5$ (k=0.05)
Kahraman	Pre-flowering	55.79±0.68	35.10±0.39	90.89±0.37	0.0050±0.00	89.49±0.38	87.60±0.39
	Flowering	47.25±0.85	25.22±0.63	72.48±1.04	0.0043±0.00	71.30±0.99	69.76±0.95
	Milk	46.38±0.28	25.32±0.51	71.61±0.32	0.0047±0.00	70.60±0.38	69.15±0.44
	Soft dough	44.56±1.64	18.19±1.01	62.74±1.01	0.0037±0.00	61.76±1.01	60.48±1.00
	Mean	48.50±1.37	25.96±1.84	74.45±3.11	0.0044±0.00	73.29±3.06	71.75±2.99
Kırklar	Pre-flowering	48.37±0.35	39.16±0.12	87.54±0.40	0.0060±0.00	86.20±0.39	84.40±0.39
	Flowering	38.61±2.02	36.55±0.74	75.16±1.32	0.0067±0.00	74.04±1.28	72.51±1.23
	Milk	36.97±2.39	31.09±0.60	68.06±2.84	0.0063±0.00	67.05±2.77	65.69±2.69
	Soft dough	41.01±1.73	20.40±0.22	61.41±1.83	0.0040±0.00	60.39±1.82	59.07±182
	Mean	41.24±1.37	31.80±1.84	73.04±3.11	0.0058±0.00	71.92±3.06	70.42±2.99
Harvest Stage	Pre-flowering	52.08±1.69 ^{a}	37.13±0.93 ^{a}	89.22 ±0.79 ^{a}	0.0055±0.00 ^{a}	87.85± 0.78 ^{a}	86.00±0.76 ^{a}
	Flowering	42.93±2.17 ^{b}	30.89± 2.57 ^{b}	73.82±0.96 ^{b}	0.0055±0.00 ^{a}	72.67±0.95 ^{b}	71.13±0.93 ^{b}
	Milk	41.67±2.36 ^{b}	28.21±1.34 ^{c}	69.88±1.51 ^{b}	0.0055±0.00 ^{a}	68.83± 1.48 ^{b}	67.42±1.45 ^{b}
	Soft dough	42.79±1.33 ^{b}	19.29±0.68 ^{d}	62.08±0.98 ^{c}	0.0038±0.00 ^{b}	61.08±0.99 ^{c}	59.78±0.98 ^{c}
	Mean	44.87±0.95	28.88±1.27	73.75±2.15	0.0051±0.00	72.61±2.11	71.08±2.07
SEM		1.256	1.522	2.223	0.0003	2.093	2.049
P value	Variety	***	***	0.173	***	0.178	0.181
	Harvest stage	***	***	***	***	***	***
	V*HS int.	0.226	***	0.131	**	0.124	0.119

V:variety, HS: harvest stage, int: interaction, a: easly soluble part, EDMD: effective dry matter degradability, c: degradation rate, b: potentiel degradable portion, SEM: standart error of mean, different letters (a,b,c) in the same column are statistically significant. (*):$p<0.05$; (**):$p<0.01$; (***):$p<0.001$

Table 6. Crude protein degradation characteristics of silages

Çizelge 6. silajların ham proteinlerinin rumende parçalama özellikleri

Variety	Harvest stage	a (%)	b (%)	a+b (%)	c (h^{-1})	$ECPD_2$ (k=0,02)	$ECPD_5$ (k=0,05)
Kahraman	Pre-flowering	83.02±0.58	12.11±0.80	95.13±0.22	0.0014±0.0	93.39±0.45	91.61±0.57
	Flowering	74.33±1.19	3.98±0.01	78.31±0.73	0.0006±0.0	77.08±0.79	76.52±0.69
	Milk	73.21±0.76	7.40±0.45	80.61±0.91	0.0012±0.0	79.32±0.69	78.08±0.52
	Soft dough	67.53±1.47	1.04±0.01	68.57±0.52	0.0002±0.0	68.45±0.56	68.26±0.75
	Mean	74.52±1.73	6.13±0.03	80.65±2.88	0.0009±0.0	79.56±3.84	78.62±2.54
Kırklar	Pre-flowering	81.14±0.21	11.82±0.09	92.96±0.30	0.0015±0.0	91.24±0.56	89.49±0.72
	Flowering	68.13±1.96	9.10±0.05	77.23±2.88	0.0016±0.0	75.65±2.72	74.12±2.56
	Milk	69.86±2.33	2.82±0.04	72.68±1.82	0.0005±0.0	70.88±1.47	70.67±1.63
	Soft dough	66.98±3.17	2.59±0.02	69.57±2.81	0.0005±0.0	68.98±2.80	68.57±2.85
	Mean	71.53±1.95	6.58±0.02	78.11±4.05	0.0010±0.0	76.69±2.79	75.71±2.63
Harvest stage	Pre-flowering	82.08±0.50[a]	11.97±0.03 [a]	94.05±0.51 [a]	0.0015±0.0 [a]	92,31± 0.58 [a]	90.55±0.63 [a]
	Flowering	71.23±1.31[b]	6.54±0.02 [b]	77.77±1.35 [b]	0.0011±0.0 [ab]	76,36±1.30 [b]	75.32±1.30 [b]
	Milk	71.54±1.23 [b]	5.11±0.01 [b]	76.64±1.99 [b]	0.0009±0.0 [b]	75,10±2.02 [b]	74.38±1.82 [b]
	Soft dough	67.26±1.15 [b]	1.82±0.00 [c]	69.07±1.30 [c]	0.0004± 0.0 [c]	68,71±1.28 [c]	68.42±1.32 [c]
	Mean	73.03±1.72	6.36±0.00	79.38±2.00	0.0010±0.0	78,12±1.92	77.17±1.81
SEM		1.310	0.897	2.006	0.0002	1,925	1.814
p value	Variety	*	0.531	*	0.178	*	*
	Harvest stage	***	***	***	***	***	***
	V*HS int.	0.425	**	0.076	***	*	0.133

V:variety, HS: harvest stage, int: interaction, a: easly soluble part, ECPD: effective crude protein degradability, c: degradation rate, b: potentiel degradable portion, SEM: standart error of mean, different letters (a,b,c) in the same column are statistically significant. (*):$p<0.05$; (**):$p<0.01$; (***):$p<0.001$

was no difference between cultivars in terms of (b) parameter for crude protein, the highest (b) parameter value was seen in the pre-flowering, followed by the flowering, milk and soft dough periods (P<0.001). The interaction of cultivar x harvesting period was also important (P <0.01). David et al. (2010) reported that (b) fraction proteins (albumin and some globulins) are real proteins and break down rapidly in the rumen. In addition, David et al. (2010) similar to in this findings, parameter (b) was affected by the interaction between cultivars and harvest periods.

There was a difference between both cultivars (P<0.05) and harvest periods (Table 6) in terms of the (a + b) parameter of crude protein (P<0.001). Although there is no difference between the varieties in terms of the breakdown rate (c) of the crude protein in the rumen, it has been determined that the effect of different harvest periods on the breakdown rate of the crude protein is significant (P<0.001).

Effective crude protein degradability of the Kahraman variety (Table 6) was higher than the Kırklar variety at the different transition speeds (k = 0.02 h^{-1} and k = 0.05 h^{-1}) from rumen (P<0.05). While silages which harvested pre-flowering period had the highest effective crude protein degradability. The lowest effective degradability was found in silages harvested during the soft dough period (P<0.001).

Similar to the results of this study, Rosser et al. (2013) stated that as the phenological period of the oat plant progresses, the digestible CP fraction decreases linearly from 55.5% to 33.0%, and the Undeg fraction increases with progressive maturity. Also, effective crude protein degradability values showed a similar situation at different rumen transition rates. The results of effective crude protein degradability of this study were similar to reflected by Ammar et al. (2010).

CONCLUSION and RECOMMENDATIONS

The CP level of Kahraman cultivar was 14.5% higher than that of Kırklar cultivar, and the CP content of cultivars decreased from the pre-flowering period to the soft dough period. In addition, while the NDF content of the cultivars increased with the progression of the growing period, the ash content of the cultivars decreased. The NEL level of Kırklar cultivar was higher than Kahraman cultivar. However, the NEL level of the cultivars decreased with the progression of the growing period. On the other hand, RFV value of Kahraman cultivar was higher than Kırklar cultivar. Water solubility of DM and CP proteins of Kahraman cultivar was higher than that of Kırklar cultivar. In addition, EDMD decreased with growth period in both cultivars. It was observed that the ECPD rate of Kahraman cultivar was higher than that of Kırklar cultivar, and the ECPD rate of cultivars decreased with the progression of the growing period. As a result, Kahraman cultivar may be preferred more than Kırklar cultivar, since it has higher EDM and ECP digestibility in the rumen and also has higher RFV value.

Researchers Contribution Rate Declaration Summary

The authors declare that they have contributed equally to the article.

Conflict of Interest Statement

The authors of the article declare that there is no conflict of interest between them.

REFERENCES

Ammar, H., López, S., & Andrés, S. (2010). *Influence of Maturity Stage of Forage Grasses and Leguminous on Their Chemical Composition and İn Vitro Dry Matter Digestibility*. In:Porqueddu C. (Ed.), Ríos S.(Ed.). *The Contributions of Grasslands to The Conservation Of Mediterranean biodiversity*. Zaragoza :CIHEAM / CIBIO /FAO / SEEP, p. 199-2 03 (Options Méditerranéennes :Série A. Sémin Aires Méditerranéens; n . 92)

Anonymus, (2007a). *Nutrient Requirements of Small Ruminants* (NRC). *National Academy of Sciences*, Washington, DC.

Anonymus, (2007b). *Official Method of Analysis* (AOAC). Washington, DC. USA.

Anonymus, (2007c). *Statistical Package for Social Sciences Study. SPSS for Windows*, Version 20. Chicago.

Assefa, G. & Ledin, I. (2001). Effect of Variety, Soil Type and Fertilizer on the Establishment, Growth, Forage Yield, Quality and Voluntary İntake by Cattle of Oats and Vetches Cultivated in Pure Stands and Mixtures. *Animal Feed Science Technology,* 92, 95-111.

Aydoğan, S., Işık, Ş., Şahin, M., Akçacık, A. G., Hamzaoğlu, S., Doğan, Ş., Küçükcongar, M. & Ateş, S. (2014). The Effect of Different Form Times on the Nutrient Composition of Forage Crops. *Selçuk Journal of Field Sciences*, 1(2), 45-49.

Ayhan, V. Balabanlı, C., Avcıoğlu, R. & Ergül, M. (2004). Effects of Harvest Period on Yield and Nutrient Content in Some Legume Forage Crops. 4th National Animal Science Science Congress, Isparta. Turkey, 2004 p:2, 166-172,

Başbağ, M., Çaçan, E. & Sayar, M.S. (2018). Bazı Buğdaygil Bitki Türlerinin Yem Kalite Değerlerinin Belirlenmesi ve Biplot Analiz Yöntemi ile Özelliklerarası İlişkilerin Değerlendirilmesi. *Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi* , *27* (2), 92–101.

Çeri, S. & Acar, R. (2019). Use of Cool Climate Cereals as Green and Dry Forage in Animal Feeding. *Journal of Bahri Dagdas Crop Research*, *8* (1), 178-194.

Cherney, J.H. & Cherney, D.J.R. (2003). *Assessing Silage Quality* In: Buxton, D.R.; Muck, R.E.; Harrıson, J.H. (Eds.) *Silage Science and Technology*, Madison, 141-198.

Coblentz, W.K., Akins, M. S., Kalscheur, K. F., Brink, G. E, & Cavadini, J. S. (2018). Effects of Growth Stage and Growing Degree Day Accumulations on Triticale Forages: 1.Dry Matter Yield, Nutritive Value and İn Vitro Dry Matter Disappearance, *Journal of Dairy Science*, *101*, 8965–8985.

David, D.B., Nörnberg, J. L., Azevedo, E.B., Brüning, G., Kessler, J.D. & Skonieski, F.R. (2010). Nutritional Value of Black and White Oat Cultivars Ensiled in Two Phenological Stages. *Revista Brasileira Zootecnia*, *39*, 1409-1417.

Gökkuş, A., Parlak, A.Ö., Baytekin, H, & Hakyemez, B.H. (2013). Akdeniz Kuşağı Çalılık Meralarında Otsu Türlerin Mineral İçeriklerinin Değişimi. *Tekirdag Ziraat Fakültesi Dergisi*, *10* (1),1-10.

Güngör, H., Dokuyucu, T., Dumlupınar, Z. &Akkaya, A. (2017). Yulafta (*Avena* spp.) Tane Verimi ile Bazı Tarımsal Özellikler Arasındaki İlişkilerin Korelasyon ve Path Analizleriyle Saptanması. *Tekirdağ Ziraat Fakültesi Dergisi*, *14* (1),61-68.

Jaranyama, P. & Garcia, A.D. (2004). *Understanding Relative Feed Value (RFV) and Relative Forage Quality (RFQ)* College of Agric and Biological Science, South Dakota State University, USA,

Kafilzadeh, F. & Heidary, N. (2013). Chemical Composition, *İn Vitro* Digestibility and Kinetics of Fermentation of Whole-Crop Forage from 18 Different Varieties of Oat (*Avenasativa* L.). *Journal of Applied Animal Research*, *41*(1), 61-68.

Karaman, R. Akün, İ. & Türkay, C. (2020). Alternative Food Source in Human Nutrition: Oat *Turkish Journal of Science and Engineering, 2*(2), 78-85.

Khan, M., Sarwar, A.M., Nisa, M., Iqbal, Z., Khan, M.S., Lee, W.S., Lee, H.J. & Kim, H. S. (2006). Chemical Composition, *In situ* Digestion Kinetics and Feeding Value of Oat Grass (*Avena sativa*) Ensiled with Molasses for Nili-Ravi Buffaloes. *Asian-Aust. Journal of Animal. Science*, *19*(8), 1127 –1133.

Kim, W. H., Seo, S., Jeong, K. H., Kim, J. G., Shin, D. E. & Shin, J. S. (1999). Effects of Harvest Date and Cultivar on the Growth, Forage Yield and Quality of Spring Sown Oats at the Middle Mountain Area. *Journal of Korean. Grassland. Science. 19*,89-94.

Kim, J. D., Kim, S. G., Abuel, S. J., Kwon, C. H., Shin, C. N., Ko1, K. H. & Park, B. G. (2006). Effect of Location, Season, and Variety on Yield and Quality of Forage Oat. *Asian-Australian. Journal of Animal Science*, *19*(7), 970 – 977.

Kılıçalp, N., Hızlı, H., Sümerli, M. & Avcı, M. (2018). In Situ Rumen Degradation Characteristics of Maize, Sorghum and Sorghum-Sudan Grass Hybrids Silages as Affected by Stage of Maturity, *Iranian Journal of Applied Animal Science*, *8*(2), 231-239.

Lai, N.V. & Thu Huong, N. T. (1999). Comparison of the *İn Sacco* Rumen and Washing Loss Methods to Estimate the Potential Energetic Value for Livestock of Leaves from Tropical Trees, Shrubs and Crop Residues. *Lıvestock Research. Rural Development, 11*, 1-6.

Linn, J. G. & Martin, N.P. (1999). *Forage Quality Tests and İnterpretations*. Univ. of Minnesota Ext. Ser. Publ. FO-02637, Univ. of Minnesota, St. Pau.

Mazumder, M.A.R., Kumagaı, H. & Mıtanı, K. (2004). Diversity of Chemical Composition Dry Matter İntake, *İn Vivo* Digestibility and *İn Situ* Dry Matter Degradability of Oat Hay (*Avena sativa*). *Animal Science Journal*, *75*, 333–338.

Mobashar, M., Tahir M., Javaid, S., Anjum, I.M., Gul, I., Ahmad, N. & Sami, S. (2018). Nutritional Evaluation of Various Stages of Maturity of Oat Hay and its Effect on Milk Production and Composition in Lactating Holstein Friesian Cows. Pakistan Journal of. Zoology., *50*(6), 2209-2216.

Ørskov, E.R. & Mc Donald, I. (1979). The Estimation of Protein Degradability in the Rumen from İncubation Measurements Weighed According to Rate of Passage. *Journal of Agricultural Science (Camb.), 92*, 499–503.

Rafiuddin, A.M., Javed, K., Jabbar, M.A., Shahıd, M.Q., Jan, P.S., Khan, M.A. & Ramzan, M.H. (2016). Impact of Flowerıng Stage on Nutrıtıve Value, Physıcal Qualıty and Digestıbılıty of Sılages Made from Cereal Fodders. *Applıed Ecology and Envıronmental Research, 14*(5), 149-157.

Rosser, C.L. (2014). *Effect of the Maturıty at Harvest of Whole-Crop Barley and Oat on Dry Matter İntake, Forage Selectıon, and Digestıbılıty When Fed to Beef Cattle* In the Department of Animal and Poultry Science University of Saskatchewan, Saskatoon, SK (Master thesis).

Rosser, C.L., Górka, P., Beattie, A.D., Block, H.C., McKinnon, J.J., Lardner, H.A. & Penner, G.B. (2013). Effect of Maturity at Harvest on Yield, Chemical Composition and *in-Situ* Degradability for Annual Cereals Used for Swath Grazing. *Journal of Animal Science*, *91*, 3815–3826.

Sarı, N. (2012). *Between the Yield and Yield Components of Oats (Avena sativa l.) Relationships.* Adnan Menderes University, Institute of Science, Aydın (Master's thesis).

Shoaib, M., Ayub, M., Shehzad, M., Akhtar, N., Tahir, M. & Arif, M. (2014). Dry Matter Yıeld and Forage Quality of Oat Barley and Canola Mıxture. *Pakistan Journal Agricultural Science*, *51*, 433-439.

Strychar, R. (2011). *World Oat Production, Trade, and Usage. In Oats: Chemistry and Technology*, 2nd ed., pp. 77–94 Webster, FH and Wood, PJ, editors. Washington, DC.

Uzun, F. (2010). Changes in Hay Yield and Quality of

Bulbous Barley at Different Phenological Stages. *Turkish Journal of Agricultural Forest, 34*, 1-9.

Van Soest, P.J., Robertson JB, & Lewis, B.A. (1991). Methods for Dietary Fiber Neutral Detergent Fiber and Non-Starch Polysaccharides in Relation to Animal Nutrition. *Journal of Dairy Science*, *74*, 3583-3597.

Wallsten, J., & Martinsoon, K. (2009). Effects of Maturity Stage and Feeding Strategy of Whole Crop Barley Silageon Intake, Digestibility and Milk Production in Dairy Cows. *Livestock Science*, *121* (2), 155-161.

Zhang, X., Dong, S., Yun, X. & Hu, Z. (2007). Variation of Productivity and Nutritive Values of Oat *(Avena sativa)* with Geographical Locations in Gansu Province of Northwest China under İrrigation and Fertilization Conditions. *African Journal of Biotechnology*, *6*(5), 553-560.