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Effect of varieties and growth stages at harvest on forage quality and nutritive values of Italian ryegrass (*Lolium multiflorum* Lam. ssp. *westervoldicum*)

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Abstract

Ozkose, A., Acar, R., Inal, F., Alatas, M. S., Kahraman, O. & Ozbilgin, A. (2024). Effect of varieties and growth stages at harvest on forage quality and nutritive values of Italian ryegrass (*Lolium multiflorum* Lam. ssp. *westervoldicum*). *Bulg. J. Agric. Sci., 30*(5), 848–855

The effects of harvesting periods and cultivars on the nutritional values of forage crops are very important. In the present study, the effects of harvesting periods and varieties on the nutritional values of Italian ryegrass were investigated. The trial was conducted in the Randomized Complete Block Design with four replications under the environmental conditions of Central Anatolia in the growing season of 2015. Seven Italian ryegrass varieties were harvested at two different harvest times in the study (earing and dough forming period) and feed values were determined. As a result of the study, the crude protein content of Italian ryegrass was found to be 9.4 – 21.0%, crude ash was 0.22% – 0.48%, crude fat 0.11% – 0.26%, ADF 30.45 – 36.26%, NDF 49.99% – 57.11%, ADL 7.72 – 10.11%, TDN 49.31% – 53.55%, ME 1.68 – 1.86 Mcal/kg, NEL 0.99 – 1.12 Mcal/kg, NEM 0.87 – 1.04 Mcal/kg, and NEG 0.31 – 0.48 Mcal/kg compared to the beginning of earing and dough formation period. According to the statistical analysis results, the differences between variety averages, growth period averages, and cutting averages were found to be significant in terms of the analyzed characteristics (crude protein, crude fat, crude ash, ADF, NDF, ADL, TDN, ME, NEL, NEM, and NEG). According to the results of the present study, it is recommended to cut at the beginning of the heading to obtain quality grass in Italian ryegrass farming. It is also very important to choose the appropriate Italian ryegrass variety for each region.

Keywords: Annual ryegrass; variety; growth stage; forage quality; nutritive value

Introduction

Lolium multiflorum Lam. (annual ryegrass or Italian ryegrass) is native to central and southern Europe, north-west Africa and south-west Asia (Hubbard, 1968). It is a native plant of Turkey. It is grown almost all over the world, mostly in the cool climate zone. Italian ryegrass (*Lolium multiflorum* Lam.) is an annual or biennial herbaceous fodder plant that has intensive tillering and can be used for grazing, zero grazing, hay making, and silage. The fact that they establish rapidly, have a long growing season, are high yielding under favorable environments when supplied with adequate nutri-

ents, possess high nutrient contents (Aganga et al., 2004), can be mowed more than once a year, has a high nutritional value (Gul, 2023), is eaten with appetite by animals, is suitable for grazing and frequent mowing and it can be silage as a mixture or pure make this annual ryegrass valuable (Özköse & Acar, 2018). The nutrition contents, fermentation characteristics, digestibility, and microbial composition of forage in Italian ryegrass depend greatly on the growth stage at harvest (Valente et al., 2000; Fu et al., 2023; Yin et al., 2023).

The nutritional value and chemical composition of forage crops depend on the region, where they are grown (climate), temperature, light intensity, precipitation, soil fertility, micro and macro mineral fertilizer applications, amount of fertilizer used, growth regulators, mowing time and frequency, plant species, cultivars and genotypes, leaf to stem ratio and physiological and morphological characteristic (Fariani et al., 1994; Tan & Mentese, 2003; Aganga et al., 2004; Huhtanen et al., 2006; Jančík et al., 2009; Türk et al., 2011; Katova et al., 2018; Calik, 2021; Sosnowski et al., 2023). The intracellular contents (soluble compounds) and the structure and size of the cell wall determine the degradability of forage (Bayatkouhsar et al., 2022). In other terms, as a result of cell wall lignification and a reduction in the leaf-to-stem ratio, increases in fiber concentrations and decreases in digestibility are common during plant growth (Bayatkouhsar et al., 2022). As forage plants mature, the cytoplasm rate of each cell decreases and the number of compounds (e.g., proteins, fats, soluble carbohydrates, and soluble minerals that make up the cytoplasm) decreases, the cell walls become more important and the fibrous constituents increase and become more lignified (Fariani et al., 1994). In general, the quality of forage plants is very high at the beginning of the development period, but the yield per unit area is low, while the digestibility of forage plants decreases with the progress of maturation, and the yield increases. The use of forage crops is closely associated with their quality, which emerges as a result of the interaction between genetics and environmental conditions. The genetic characteristics of the plant affect the feed value closely (Tan & Mentese, 2003). Yield and quality may vary within the same species. Choosing the right variety for each region can increase yield and quality.

It is necessary to know how the feeding values change according to cultivars, development periods, and the order of cutting so that the animal feeding programs (i.e., rations) created with Italian ryegrass can be made more accurately.

In the present study, the purpose was to determine how the nutritional values of Italian ryegrass change according to varieties, mowing periods and mowing order under Central Anatolian conditions.

Materials and Methods

The study was conducted at the Trial Field of Selcuk University, Faculty of Agriculture, Field Crops Department, Konya, Turkey, in 2015. The area where the study was conducted is located at the coordinates 38 02N and 31 30E and at an altitude of about 1016 m above sea level. Konya, where the trial was conducted, is located in the southern part of the Central Anatolian Region and has a continental climate with harsh, cold, and snowy winters and hot and dry summers. The average monthly temperature was the lowest in April at 10.1°C, the highest in July and August at 25.1°C, and the average temperature was 18.4°C during the trial period (Apr-Oct). The lowest temperature was -0.9°C in April, and the highest temperature was 35.1°C in July and September. The average relative humidity was 48.0% and the total amount of precipitation was 172 mm in the trial period. The soils of the trial area had clayey-loamy texture and alkaline properties (pH = 7.7), organic matter amount was 1.19%, EC (µS / cm) = 193, P_2O_5 = 10.86 ppm, K_2O = 221.16 ppm, Zn = 2.12 ppm, Fe = 1.30 ppm, Cu = 0.82 ppm, Mn = 4.95 ppm, Ca = 5800.00 ppm, and Na = 65.49 ppm.

Barspectra II (V1), Bartigra (V2), Barmultra II (V3), Pollanum (V4), Medoacus (V5), Rambo (V6), and Hellen (V7) tetraploid varieties of Italian ryegrass (*Lolium multiflorum* Lam. and V1, V2, 4 and 7 are ssp. *westervoldicum*) obtained from different companies were used as the plant material in the study. The trial was established on April 7, 2015, according to the design of the randomized block with 4 replications. The seedbed was well prepared, pressed, and cleared of weeds. A total of 20 kg/da of DAP fertilizer was given as base fertilizer and mixed with the soil during the soil preparation. Sowing was done by hand to a depth of 2–3 cm in rows that were opened with a marker. Sowing rows were closed and then pressed with a soil roller. Parcel dimensions were 5 × 2 (row spacing: 20cm × 10 rows) = 10 m^2. The data, yield, and samples were taken considering the edge effects at mowing. Fertilization, irrigation, and weed control were performed as cultural processes. After each mowing, 5 kg of pure nitrogen (N) per decare was given. Irrigation was carried out according to the plant's water need and rainfall.

A total of 7 different varieties of Italian ryegrass used in the study were mowed at 2 different stages (at the beginning of earing (reproductive stage; R1-R2 (Tu et al., 2010), and the dough stage). Mowing for the beginning of the earing stage was done on 17 June, 12 July, 11 August. Mowing for the dough stage was done on 1 July, 10 August, and 10 October.

The samples, taken from the green herbage obtained after each mowing from each plot were passed through a

branch shredder (Bosch AXT25 D) and clipped as 4–5 cm and weighed and dried in a fan oven (VWR) set at 60°C until a constant weight was obtained. Dry matter contents were determined by weighing the dried samples. Protein analyses were performed in the Feed Analysis Laboratory of the Faculty of Veterinary Medicine. The samples, which were dried by passing through the shredder, were ground in a laboratory mill with a 1 mm sieve (Retsch SM 100) and stored in plastic jars until chemical analysis.

The analyses of dry matter, crude ash, crude fat, and crude protein of all samples were made according to AOAC (2003). Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL) levels were determined according to the method described by Van Soest et al. (1991) by using Ankom 200 device. Total Digestible Nutrients (TDN), Metabolic Energy (ME), Net Energy for Lactation (NEL), Net Energy for Growth (NEG), and Net Energy for Lactation Maintenance (NEM) values were calculated by using the feed analysis results with the equations reported in NRC (2001). In the evaluation of the results, the differences were determined by using the General Linear Model in the SPSS (2015) package program, and the Duncan test was used for the significance of the differences.

Results and Discussion

A total of 7 different varieties of Italian ryegrass were mown three times in two different growth periods (earing and dough stage) within the scope of the study. No earing was observed in the V3 cultivar during the study. Considering that the development period for earing was long, ears were expected to be seen, but when earing was not seen, it was mowed together with the dough stage of other cultivars. V6 was cut twice during the dough stage, as it could not withstand the summer temperatures, and a third cut could not be made. The results for each examined characteristic were evaluated separately.

Dry matter content, %

The differences between the variety averages, cutting averages, and growth period averages in terms of dry matter ratios were statistically significant. The highest dry matter ratio was detected in V6 with 26.84%, and the lowest in V3 with 17.83%. The dry matter ratios increased according to the cuttings (22.24% in the 1st cutting, followed by the 2nd and 3rd cuttings (Table 1). According to the development periods, the dry matter ratio, which was 21.81% at the beginning of the earing, increased to 24.56% in the dough formation period. Geren et al. (2003) reported that as the development period progressed, young tissues that had high water content in plants were replaced by old tissues that consisted of thick-walled and dense-core cells, and therefore, dry matter ratios increased. In their study, Borba, Alfredoe. S. & Joao M. C. Ramalho Ribeir (1996) found that the dry matter ratios increased as the growth period progressed (11.9% in the leafy period, 14.6% in the 5% earing period, and 21.6% in the 100% earing period). A similar dry matter change was detected in the study, and the dry matter ratios in the dough formation period were found to be higher compared to that at the beginning of the earing.

Crude protein, %

The differences between the variety averages, cutting averages, and growth period averages in terms of crude protein content were statistically significant. The crude protein content varied between 13.76% (V6) and 15.83% (V7) according to the varieties. Among the cuttings, the highest 16.25% was determined in the 2nd cutting and the lowest 12.51 in the 1st. As expected, the crude protein ratios were found to be higher at the beginning of the earing and lower during the dough formation period (Table 1). Fariani et al. (1994) reported the crude protein content of the Italian ryegrass they mowed in different periods as 17.1% before earing, 9.4% at the beginning of earing, and 7.8% after earing. Acar & Özköse (2023) determined crude protein ratios between 9.45% and 11.19% in Italian ryegrass varieties sown at different times. The values we obtained from this study are higher than the results of the researchers.Aganga et al. (2004) reported that the crude protein content of Italian ryegrass that was mowed at different times decreased with ripening. This study had similar to the results of the researchers in terms of decreasing protein ratios with the progression of cutting time.

Crude ash, %

The differences between variety averages, cutting averages, and growth period averages in terms of crude ash contents were statistically significant. According to the average crude ash values of the cultivars, the highest crude ash ratio was 18.72% in V3, followed by V2, V1, V7, V5, V4 and V6, respectively (Table 1). The crude ash contents of the cuttings were 3rd cutting (12.55%), 2nd cutting (11.60%), and 1st cutting (10.23%), respectively. As the number of cuttings increased, increases were detected in the crude ash content. Mowing at the beginning of the earing increased the crude ash content when compared to mowing during the dough formation period. When the dry matter was burned properly, all the remaining unburned materials are called “crude ash” (Kutlu, 2008). Çolak (2015) found the crude ash content of

Table 1. DM, CA, CF and CP of the Italian ryegrass plants harvested in different growth stages, % in dry matter

		DM		CA		CF		CP	
	n	x	Sox	x	Sx	x	Sx	x	Sx
Varieties									
V1	24	22.38	0.54 bc	11.46	0.3 b	2.52	0.22 b	14.69	0.74 ab
V2	24	22.23	0.57 c	11.47	0.29 b	2.47	0.23 b	14.56	0.79 ab
V3	12	17.83	0.49 d	13.72	0.48 a	3.45	0.26 a	15.63	0.83 a
V4	24	23.76	0.65 b	10.93	0.22 bc	2.58	0.23 b	14.77	0.73 ab
V5	24	23.35	0.54 bc	11.25	0.36 bc	2.41	0.19 bc	14.88	0.65 ab
V6	20	26.84	0.83 a	10.83	0.41 c	2.10	0.15 c	13.76	0.64 b
V7	24	22.93	0.47 bc	11.40	0.25 bc	2.30	0.11 bc	15.83	0.67 a
Mowing									
1st Cut	52	22.24	0.40 b	10.23	0.12 c	3.06	0.19 a	12.51	0.39 b
2nd Cut	52	23.34	0.61 a	11.60	0.27 b	1.90	0.06 c	16.25	0.51 a
3rd Cut	48	23.58	0.39 a	12.55	0.12 a	2.50	0.07 b	15.85	0.30 a
Harvesting stages									
Beginning of earing	84	21.81	0.34 b	12.10	0.18 a	2.88	0.12 a	16.72	0.26 a
Dough	68	24.56	0.39 a	10.60	0.15 b	2.00	0.06 b	12.53	0.36 b

Differences between groups with different letters in the same factor and in the same column are statistically significant ($P < 0.05$).
DM: Dry Matter; CA: Crude Ash; CF: Crude Fat; CP: Crude Protein

Italian ryegrass between 9.63% and 9.86% and argued that it varied according to years and varieties. The crude ash values obtained in the present study were higher than the aforementioned studies. Borba et al. (1996) found that the crude ash content decreased as the mowing time progressed and varied between 7.7 and 16.8%. Ertekin et al. (2022) determined that the ash content in Italian ryegrass varies between 12.3% and 12.6% depending on the variety and between 11.9% and 13.0% depending on mowing. These results were found to be compatible with the present study.

Crude fat, %

Differences between variety averages, mowing averages, and growth period averages in terms of crude fat contents were statistically significant. According to the cultivars, the highest crude fat ratio was obtained in the V3 variety with 3.45%, followed by V4, V1, V2, V5, V7 and V6, respectively (Table 1). Among the cuttings, the crude fat contents were highest in the 1st form (3.06%), followed by the 3rd form (2.50%) and the 2nd form (1.90%). Mowing at the beginning of the earing increased the crude fat content when compared to mowing during the dough formation period. Crude fat gives information on the total lipid content of the feed (Kutlu, 2008). Fariani et al. (1994) reported that the fat ratio decreased with the progression of the mowing time. In another study, it was reported that the crude fat content of Italian ryegrass decreased continuously as the winter progressed (Kobayashi et al., 2008). These studies show similarity with our study.

Neutral detergent fiber, %

In terms of NDF values, the differences between variety averages, mowing averages, and growth period averages were statistically significant. The lowest rate of NDF was determined in V3 at 49.99%, and the highest in V6 at 57.11% (Table 2). According to the cutting averages, the NDF ratios were the 2nd cutting, 1st cutting, and 3rd cutting, respectively. Mowing at the beginning of the earing had a statistically significant effect on the lower NDF ratio when compared to mowing in the dough setting period. High NDF contents limit dry matter intake (Abraha et al., 2015) and low NDF contents increase its consumption because of faster fermentation and shorter stay in the rumen (Ozkul et al., 2012). Alende et al. (2020) in a study of four annual ryegrass cultivars found that tetraploid ones tended to have lower NDF content and the hemicellulose fraction was also significantly lower. Kavut et al. (2014) determined an increase in NDF values as the mowing time progressed in the spring. Fariani et al. (1994) found an NDF rate of 49.4% in Italian ryegrass mown before earing in the late period after the spike, which they determined as 64.4%. Aganga et al. (2004) stated that the NDF ratios increased with maturity in the Italian ryegrass they mow in 5 different periods, from 52% at the time of the first mowing to 60% at the time of the last mowing. The results of this study are in agreement with the present study.

Acid detergent fiber, %

The differences between variety averages, cutting averages, and growth period averages in terms of ADF content were

Table 2. NDF, ADF and ADL contents of the Italian ryegrass plants harvested in different growth stages, % in dry matter

		NDF		ADF		ADL	
	n	x	Sx	x	Sx	x	Sx
Varieties							
V1	24	55.12	0.61 b	32.16	0.69 c	8.21	0.78 cd
V2	24	54.73	0.67 b	32.47	0.66 c	7.81	0.44 cd
V3	12	49.99	0.66 c	30.45	0.9 d	7.72	0.71 d
V4	24	55.72	0.76 ab	34.04	0.66 b	8.38	0.4 cd
V5	24	54.99	0.63 b	34.42	0.7 b	8.88	0.42 bc
V6	20	57.11	0.69 a	36.26	0.56 a	10.11	0.52 a
V7	24	55.13	0.66 b	33.91	0.67 b	9.48	0.68 ab
Mowing							
1st Cut	52	54.61	0.63 b	33.09	0.53 b	8.14	0.45 c
2nd Cut	52	56.06	0.44 a	34.96	0.54 a	9.26	0.42 a
3rd Cut	48	54.24	0.30 b	32.49	0.28 b	8.68	0.21 b
Harvesting stages							
Beginning of earing	84	53.15	0.32 b	32.18	0.35 b	7.80	0.25 b
Dough	68	57.26	0.34 a	35.23	0.38 a	9.79	0.35 a

Differences between groups with different letters in the same factor and in the same column are statistically significant ($P < 0.05$).
NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; ADL: Acid Detergent Lignin

statistically significant. Among the variety averages, the lowest rate of ADF was detected in V3 at 30.45%, and the highest in V6 at 36.26% (Table 3). According to the average number of cuttings, the ADF ratios were detected in the 2nd cutting (34.96%), 1st cutting (33.09%), and 3rd cutting (32.49%), respectively. Katova & Naydenova (2017), who conducted research on a similar species, perennial ryegrass, determined the average ADF values as 33.84% in the 1st mowing, 34.41% in the second mowing and 30.30% in the 3rd mowing. While the results were close to each other in terms of value, they also showed a similar trend in terms of changes throughout the year, with ADF values being highest in the summer period. Mowing at the beginning of the earing had a statistically significant effect on the lower ADF ratio when compared to mowing in the dough setting period. The digestibility and energy value of the feeds that have high ADF contents, which gives an idea about the quality of the feed, are low (Kutlu, 2008).

Kavut et al. (2014) reported increased ADF values as the mowing time progressed in the spring. In Italian ryegrass, even the diurnal cutting time of mowing can affect ADF content. Wang et al. (2020) found that the ADF values of Italian ryegrass cultivars varied between 38.4% and 41.4% according to the diurnal cutting time (sunrise, noon, sunset), and the responses of the cultivars in terms of ADF content according to the diurnal cutting time (sunrise, noon, sunset) were different. Fariani et al. (1994) reported that the ADF contents changed significantly according to cutting times and was 30.0% before the earing, 35.4% at the beginning of the earing, and 46.4% after the earing. Aganga et al. (2004) reported that the ADF ratios increased with ripening in the Italian ryegrass that was mowed in 5 different periods. Our results showed a similar trend to the results of other studies.

Wang et al. (2020) found that the ADF values of Italian grass varieties varied between 38.4% and 41.4% depending on the cutting time during the day, and the responses of the varieties in terms of ADF content were different depending on the cutting time during the day.

Acid detergent lignin, %

The differences between variety averages, cutting averages, and growth period averages were statistically significant in terms of ADL contents. The lowest rate of ADL was determined in V3 with 7.72%, and the highest in V6 with 10.11%. According to the cutting averages, the ADL ratios were determined in the 2nd cutting, the 3rd cutting, and the 1st cutting, respectively. Mowing at the beginning of the earing had a statistically significant effect on the lower ADL ratios when compared to mowing in the dough setting period (Table 2). Bozhanska (2023) determined that there was a significant difference between ADL values among the Italian ryegrass varieties used in the study and ADL values varied between 6.12% and 10.82% according to the varieties. Aganga et al. (2004) reported that ADL rates increased with ripening in Italian turf. The progression of cutting time and the increase of ADL content were similar to the present study.

Energy contents (TDN, %; ME, NEL, NEM, NEG, Mcal kg^{-1})

The differences between variety averages, mowing averages, and growth period averages in terms of TDN, ME, NEL, NEM, and NEG were found to be statistically significant (Table 3). The TDN, ME, NEL, NEM, and NEG contents were the highest in V3 and lowest in V6. According to the average number of cuttings, the contents of TDN, ME, NEL, NEM, and NEG were in the 1st cutting, 3rd cutting, and 2nd cutting, respectively. Mowing at the beginning of the earing had a statistically significant effect on the higher TDN, ME, NEL, NEM, and NEG contents when compared to mowing at the dough setting period.

The TDN refers to the sum of digestible nutrients in the feed. Some of the energy in the digestible energy is thrown out with both urine and methane gas. After subtracting this lost amount from digestible energy, the remaining energy is called Metabolic Energy (ME). Net Energy (NE) is the difference between Metabolic Energy and Heat Energy. Net energy is the energy used by the organism to maintain life, produce products (meat, milk, eggs), and for mechanical work (Kutlu, 2008). NE is also referred to as NEL, NEM, and NEG. Gursoy et al. (2022) reported that there were significant differences between the Italian ryegrass plants harvested in different periods in terms of ME, NE, and TDN. Working on a similar subject, Gürsoy et al. (2022) found that harvest time positively or negatively affects nutrient content and digestibility; the lowest ME and NEL values were found in the 2nd harvest period during full flowering, and the highest were found in the 1st harvest period before flowering; ME and NEL values ranged from 8.39 to 9.86 Mj kg^{-1} (DM) and 5.02 to 6.46 Mj kg^{-1} (DM), respectively. Again, the same researchers found TDN values in the range of 51.00% – 62.03%, with the lowest value obtained in the 1st harvest after the flowering period and the highest value in the 1st harvest after the full flowering period. ME and NEL values obtained in this study were slightly lower than the results of the researchers, while TDN values were similar. The differences in the varieties used, agricultural practices, soil and ecological conditions in which the studies were carried out may have been effective in the similar or different results. Metabolic Energy and Net Energy derivatives should be high. For this reason, as seen in the results of the study, it would be more appropriate to mow at the beginning of earing, which has high energy content. In the 1st cutting, the energy values of the Italian ryegrass varieties were higher, followed by the 3rd cutting and the 2nd cutting. It will be useful to consider that the energy content varies according to the number of cuttings in ration preparation. The average energy content of the cultivars also differed at significant levels. For this reason, considering dry matter yields and crude protein yields, priority must be given to cultivating varieties that have high energy content.

Table 3. TDN, ME, NEL, NEM and NEG contents of the Italian ryegrass plants harvested in different growth stages

		TDN %		ME Mcal kg^{-1}		NEL Mcal kg^{-1}		NEM Mcal kg^{-1}		NEG Mcal kg^{-1}	
	n	x	Sx	x	Sx	x	Sx	x	Sx	x	Sx
Varieties											
V1	24	52.83	1.19 ab	1.83	0.05 ab	1.09	0.04 ab	1.01	0.05 a	0.45	0.05 a
V2	24	52.97	0.88 ab	1.83	0.04 ab	1.10	0.03 ab	1.02	0.04 a	0.45	0.03 a
V3	12	53.55	1.80 a	1.86	0.06 a	1.12	0.05 a	1.04	0.06 a	0.48	0.06 a
V4	24	52.53	0.97 ab	1.82	0.04 abc	1.09	0.03 abc	1.00	0.04 ab	0.44	0.04 ab
V5	24	51.62	0.88 bc	1.79	0.03 bc	1.06	0.03 bc	0.97	0.03 ab	0.41	0.03 ab
V6	20	49.31	0.97 d	1.68	0.04 d	0.99	0.03 d	0.87	0.04 c	0.31	0.04 c
V7	24	50.51	1.12 cd	1.76	0.05 c	1.04	0.03 cd	0.94	0.05 bc	0.38	0.04 bc
Mowing											
1st Cut	52	54.40	0.85 a	1.86	0.04 a	1.12	0.03 a	1.04	0.04 a	0.47	0.03 a
2nd Cut	52	50.01	0.61 c	1.74	0.03 c	1.03	0.02 c	0.93	0.03 c	0.37	0.02 c
3rd Cut	48	51.05	0.46 b	1.78	0.02 b	1.06	0.01 b	0.96	0.02 b	0.40	0.02 b
Harvesting stages											
Beginning of earing	84	53.37	0.59 a	1.87	0.02 a	1.13	0.02 a	1.06	0.02 a	0.49	0.02 a
Dough	68	49.95	0.48 b	1.69	0.02 b	1.00	0.01 b	0.88	0.02 b	0.32	0.02 b

Differences between groups with different letters in the same factor and in the same column are statistically significant ($P < 0.05$).

TDN: Total Digestible Nutrients; ME: Metabolic Energy; NEL: Net Energy for Lactation; NEG: Net Energy for Growth; NEM: Net Energy for Lactation Maintenance

Conclusion

In determining feed quality, important criterions are crude protein, crude fat, crude ash, ADF, NDF, ADL, TDN, ME, NEL, NEM, and NEG. It is desired that the ADF, NDF and ADL values are low and crude protein, crude ash and crude fat, TDN, ME, NEL, NEM, and NEG values are high. In this context, V3 comes to the forefront among the varieties. Between the growth periods, the cutting should be preferred at the beginning of the earing. It should be taken into account which cutting of the Italian ryegrass is obtained while preparing the ration because the nutritional properties of the grasses vary according to the cuttings. It is also very important to choose the appropriate Italian ryegrass variety for each region.

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Author Contributions

The authors confirm contribution to the paper as follows; study conception and design: A.Ozkose, R.A., F.I., M.S.A., O.K., A.Ozbilgin; field studies and data collection: A.Ozkose, R.A.; laboratory studies and data collection F.I., M.S.A., O.K., A.Ozbilgin; analysis and interpretation of results, and draft manuscript preparation: A.Ozkose, R.A., F.I., M.S.A., O.K., A.Ozbilgin. All authors reviewed the results and approved the final version of the manuscript.

The authors declare that they have no conflicts of interest to report regarding the present study.

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