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Research Article

QUALITY CHARACTERISTICS OF DIFFERENT FORAGE MIXTURES AFFECTED BY POULTRY GRAZING AND HARVESTING TIMES

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ABSTRACT. The effects of the pasture created with the different forage mixtures on forage quality and forage value were studied within the scope of this research. Three different forage mixtures (M_1: 40% smooth brome (*Bromus inermis* Leys.) + 20% alfalfa (*Medicago sativa* L.) + 40% bird's foot trefoil (*Lotus corniculatus*); M_2: 40% meadow fescue (*Festuca pratensis*) + 20% alfalfa + 40% bird's foot trefoil; M_3: 40% orchard grass (*Dactylis glomerata* L.) + 20% alfalfa + 40% bird's foot trefoil were prepared as 3 replications on 2000 m^2 land. The synthetic pasture was cut 7 times and grazed for 3-month periods in both experiment years by 6 turkey poultry in an area of 100 m^2 each. The best quality pasture was obtained at the first harvesting in both experiment years. The lowest ADF (22.78%, 22.09%), NDF (36.61%, 32.26%), ADL (6.39%, 5.49%) were determined during 2014 and 2015 during first harvesting time, in the same order. The highest forage values during 2014 and 2015; TDN (71.94%, 72.83%), DMI (3.28%, 3.90%), DDM (71.15%, 71.69%), RFV (180.64%, 216.77%), CP (19.35%, 15.96%) were obtained in the first harvesting time, in the same order. First harvesting time was the best suitable time for high forage quality and forage values under the Central Anatolian conditions. It was understood that forage quality and forage values decreased with on-going harvesting times. Mixture with meadow fescue (M_2) showed the best features of forage quality and forage values.

Keywords: *alfalfa, crude protein, meadow fescue, orchard grass, relative feed value, turkey*

INTRODUCTION

Turkey has a total grassland and pasture area of 14.6 million hectares, forage crops cultivation area of about 2.1 million hectares. Turkey's forage crop yield was around 55.5 million tons in 2019. Yield generated from grasslands and pastures was around 11.7 million tons in 2018 [1]. In addition to this; quality roughage deficit of Turkey in 2019 was about 30 million tonnes [2]. In order to meet the quality roughage needs for of the livestock, it is necessary to increase forage crop lands and use them for pastures and meadows, by improving agronomic techniques for production of cheap and quality forage [3, 4].

Today, the need for natural or artificial pasture grazing systems primed for poultry, are introduced and optimized by scientific studies to fit the climate and ecological condition of each region. This serves about 30% saving from forage exchange. Many factors may impact the quality and nutritional value of forage. Therefore, high quality roughage means harvesting forage plants at right time when they have maximum protein and minimum NDF (neutral detergent fiber) and ADF (acid detergent fiber) percentages. There is an inverse proportion between fiber compounds to forage quality and digestibility. Each increase in fibrous compounds (ADF, NDF) results in decrease of quality and digestibility.

Legume–grass mixtures are well-established in pastures, meadow or field conditions. Inter cropping of these plants is very important for sustainable forage production system. Legumes are substantial in the way of crude protein percentage, whereas grasses have more carbohydrate contents and can take advantage of the nitrogen fixed by legumes, when they are grown together. Therefore, inter cropping (legume-grass mixtures) might be more productive compared to mono cultured grasses. Forage legumes are becoming attractive for grassland utilization under different harvesting frequencies, particularly dairy and poultry farming [5]. By keeping its proportion in a mixture, legume based mixtures may maintain higher nutritional quality with a little or no N fertilization [5]. Studies have shown that the legumes have a high impact on the nutritional forage quality especially in alfalfa–grass mixtures [6, 7].

This study aimed to evaluate and monitor the trend of changing forage quality of the fodder in a mixed pasture created with different forage mixtures grazed for grazing season (May to October) by poultry in frame of this research.

MATERIALS AND METHODS

The Features and the Setting of the Artificial Pasture

The experimental location lied between 39° 57' N latitudes and 32° 53' E longitudes. The total rainfall was 531.0 mm, the average temperature was 13.8°C, and the relative humidity was 61.3% during 2014 and the total rainfall was 518.2 mm, the average temperature was 12.6 °C and the relative humidity was 61.29% in 2015. Also, total rainfall of between May to October during 2014 and 2015 were 310.6 mm and 279.9 mm, in the same order [8]. The soil of the research site has argillaceous-loamy structure, is slightly alkaline (7.31), calcareous (5.59%), with a harmless total salt level (0.038%), moderate in phosphorus (5.45 kg da^{-1}), rich in potassium (179 kg da^{-1}), and insufficient organic matter (1.00%). The existing artificial pasture area was 2000 m^2 in size in total. It was divided into 9 different sub plots making 3 different pasture mixes in 3 replicates per treatment. The size of each sub plot was 100 m^2 (100 × 9 =900 m^2 A Main Plot; 100 × 9 =900 m^2 B Main Plot). The forages used in different mixtures and their percentages are as follows;

M_1 =40% Smooth brome+ 20% Alfalfa + 40% Bird's foot trefoil

M_2 =40% Meadow fescue + 20% Alfalfa + 40% Bird's foot trefoil

M_3 = 40% Orchard grass + 20% Alfalfa + 40% Bird's foot trefoil

Considering the competition indexes of the plants to be sowed; smooth brome (1.9 kg da^{-1}), meadow fescue (6 kg da^{-1}), orchard grass (3.5 kg da^{-1}), alfalfa (1.5 kg da^{-1}) and bird's foot trefoil (2.7 kg da^{-1}) were sown. The grazing season of the experimental years was between May to October, the artificial pasture was grazed by turkey breed namely American bronze.

Identifying the Forage Quality and Forage Values of the Pasture

In order to identify changes in the forage quality and forage values of the pasture, 3 random samples were taken after each fortnight (14 days) 7 times during the whole season from each plot (100 m^2) at random, using three iron circles of CSH caliber size (30 cm caliber). Thereafter, the plants lying in the CSH caliber were cut using pair of scissors at ground level, and these samples were kept in holed plastic bags [9]. The

samples were dried in an oven at 70 °C for 48 hours. With aim of identifying the ADF and NDF percentage of the dried and ground forage samples, some analysis [10] were run in ANKOM® fiber machine (NY, USA) and the results were calculated following by [10].

The ADL (acid detergent lignin) percentage of forage was determined with the analyses made over the samples used in ADF analysis. For this purpose, the bags after ADF were left in H_2SO_4 with 72% density for 3 hours. After this soaking, the bags were washed with hot tap water and the wash was repeated with the cold tap water. The drained bags were left in 250 ml acetone for 3 minutes and were dried in an oven at 105 °C for 3 hours. The samples taken from the oven, after the cooling process, were weighed with precision scales and the ADL percentage of the forage materials were calculated by putting the obtained information on the formula [10]. The values are an indication of total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and relative feed value (RFV), and were obtained following formulas by [11];

$$TDN = (-1.291 \times ADF\%) + 101.35$$

Eqn. 1

$$DMI = 120 / NDF\%$$

Eqn. 2

$$DDM = 88.9-(0.779 \times ADF\%)$$

Eqn. 3

$$RFV = DDM\% \times DMI\% \times 0.775$$

Eqn. 4

These forage values, which was presented above as equations, were analyzed according to percentages of ADF and NDF [11, 12, 13]. The RFV was calculated based on the two laboratory determined parameters, NDF and ADF percentages in a forage.

Statistical Analysis

The data obtained in the research was processed using variance of analysis according to completely randomized split plots design with three replications. The data belonging to the experiment was analyzed using computer program MSTAT-C [14] to compare significant differences among treatments. The significant differences ($p<0.05$) among the means were calculated using Duncan's Multiple Range Test. Information about F-values, coefficient of variance belonging to all statistically significant parameters were given in Table 1-2.

RESULTS AND DISCUSSION

Acid Detergent Fiber (ADF)

ADF percentage was significantly different ($p<0.01$) in both experimental years depend on the harvesting times (Table 1). ADF percentages ranged from 22.78-34.00% during 2014 and 22.09-30.46% during 2015, in the same vein. The lowest ADF percentage of 22.78% was noted in the first experiment year in the first harvesting time. The highest ADF of 34.00% was noted in the seventh harvesting time. If the forage quality

is considered, the first harvesting time had the best quality when the ADF percentage was the lowest. But forage quality decreased in towards the last harvesting times, due to the highest ADF percentage.

The different forage mixtures were non-significantly different during the first year, but it showed significantly different ($p<0.05$) effects in the second year (2015). ADF percentages were between 26.87-28.72% during 2014 and 24.79-27.09% during 2015, respectively (Table 2). It was noted that the M_2 was the best concerning the forage quality. The lowest percentage of ADF numerically means the ideal and quality forage for the turkeys. Therefore, the animals do not have a deficiency related to vitamin needs when they graze fresh green and nutritious forage. The results of this study are compatible with [15], [16], [17], [18] and [19]. The researchers agree that increasing doses of nitrogen negatively affect forage quality. [20] examined the important negative relationship between the leaf and crude cellulose percentage in alfalfa (ADF and NDF).

The more ADF percentage, which is consists of lignin, cellulose, and structural carbohydrate (cell wall), results in decreasing in the forage quality, which is undesirable for the poultry. With each numerical increase in the ADF percentage, the cellulose percentage of the forage also increases, so the monogastric animals are unable to digest a large proportion of the food. The results of this study are compatible with the studies and confirm by [21] with 28.00% and 29.00%; [22]; between 36.72-39.62% and 36.19-38.92% for ADF percentages. The ADF percentages noted in previously reported literature is generally less than this literature. The reason for these differences may have been influenced by the amount of precipitation, vegetation stage, the difference in harvest time, being pure or different mixtures used, application differences, and the conditions of climate and soil of the field.

Neutral Detergent Fiber (NDF)

According to the different harvesting times, NDF percentage was significantly different ($p<0.05$) during 2014 and ($p<0.01$) during 2015, respectively. NDF percentages ranged 36.81-46.89% during 2014 and 32.26-47.42% during 2015 (Table 1). In terms of NDF percentage, the most quality forage was determined during the first harvesting time during 2015 with 36.26%. NDF percentage increased in on-going harvesting times. In terms of quality and digestibility, the forage quality decreased, when NDF increased.

The different forage mixtures were significantly different ($p<0.05$) during 2014, during 2015 it did not show any statistically different effect. The NDF percentages of three different forage mixtures ranged from 40.21-42.20% during 2014 and 38.58-40.24% during 2015 (Table 2). The highest NDF percentage was taken as 42.20% from M_2 mixture during 2014, whereas the lowest NDF percentage was taken as 38.58% from M_2 during 2015. Monogastric turkeys cannot digest the NDF consisting of structural carbohydrates (cell wall), hemicelluloses, cellulose, lignin, and more than 7% of its fractions. That is why low NDF percentages are desired for poultry. [15], [16], [17], [18], [19] have suggested that increasing the nitrogen level decreased the ADF and NDF percentage in confirmation to the results of this study. [23] suggests that the concentration of cell wall in forages increases with ongoing harvesting times and the leaves compared to the stems that contain less nitrogen (crude protein) and more crude cellulose. The results of this research are lower than the below-mentioned studies. And it is examined in the studies on NDF percentages that [24] 59.7%, [25] hairy vetch (*Vicia villosa*) 50.78-53.11%, common vetch (*Vicia sativa*) 49.47-57.35%. [26] stated that the NDF percentage in binary mixtures was upmost 70% and at least 51%.

Acid Detergent Lignin (ADL)

ADL percentage was significantly different ($p<0.01$) in both experimental years. ADL percentage ranged 6.39-13.37% during 2014, 5.49-10.28% during 2015 (Table 1). According to the ongoing harvesting times, with the increase of ADL percentage numerically it was confirmed that the forage quality decreased, in terms of quality and digestibility. Different forage mixtures on ADL had non-significant effects during 2014, but it showed significantly different ($p<0.01$) effects during 2015. The averages of three different forage mixtures ranged from 9.50-10.28% during 2014 and 7.48-9.14% during 2015 (Table 2). The highest ADL percentage was obtained from M_3 mixture with 9.14% during 2015, whereas the lowest ADL percentage was taken from M_1 mixture with 7.48% during 2015. In terms of ADL fraction, the best quality of the forage mixture was determined during first year of the research with 7.48% in M_1 mixture. ADL (lignin as an important part of the cell wall) causes the hardiness of plants. Moreover, like hemicelluloses, lignin also cannot be digested by monogastric poultry; the accessibility to the forage is lessening. In the previous studies ADL percentages 1.70-11.00% it was observed by [27] with 8.03-15.14%, [28] with 6.30-8.10%. The results of this study are by the literature information.

Table 1. *The averages of the quality and digestibility of the pasture forages in different harvesting times*

Year	Harvesting Times	ADF (%)	NDF (%)	ADL (%)	TDN (%)
2014	**1th**	22.78 **D**	36.81 **C**	6.39 **D**	71.94 **A**
	2nd	25.10 **CD**	38.18 **BC**	8.81 **C**	68.95 **AB**
	3th	26.85 **BC**	39.00 **BC**	8.47 **C**	66.68 **BC**
	4th	26.96 **BC**	41.45 **B**	10.23 **B**	66.54 **BC**
	5th	28.26 **BC**	41.13 **B**	10.78 **B**	64.87 **BC**
	6th	29.24 **B**	46.81 **A**	10.69 **B**	63.60 **C**
	7th	34.00 **A**	46.89 **A**	13.37 **A**	57.46 **D**
	Mean	27.60	41.47	9.82	65.72
	F-values	16.955**	22.996*	38.415**	16.956**
	CV (%)	9.30	6.05	10.86	5.04
2015	**1th**	22.09 **C**	32.26 **D**	5.49 **C**	72.83 **A**
	2nd	23.12 **BC**	34.95 **CD**	6.20 **BC**	71.50 **AB**
	3th	24.18 **BC**	37.08 **BC**	7.03 **BC**	68.18 **B**
	4th	25.69 **B**	38.95 **BC**	8.24 **AB**	70.14 **AB**
	5th	25.82 **B**	40.95 **B**	9.69 **A**	68.01 **B**
	6th	30.16 **A**	45.26 **A**	10.28 **A**	65.41 **C**
	7th	30.46 **A**	47.42 **A**	9.81 **A**	62.03 **C**
	Mean	25.93	39.55	8.11	68.30
	F-values	16.203**	26.487**	13.804**	16.205**
	CV (%)	9.40	8.01	18.98	4.64

Table 1. *continued*

Year	Harvesting Times	DMI (%)	DDM (%)	RFV (%)	CP (%)
2014	1th	3.28 **A**	71.15 **A**	180.64 **A**	19.35 **A**
	2nd	2.53 **D**	66.89 **BC**	134.39 **E**	16.86 **B**
	3th	3.16 **AB**	69.35 **AB**	169.85 **AB**	14.51 **BC**
	4th	3.10 **ABC**	67.98 **BC**	163.16 **BC**	10.97 **C**
	5th	2.94 **BC**	67.90 **BC**	155.41 **CD**	12.42 **BC**
	6th	2.92 **C**	66.12 **C**	149.51 **D**	10.12 **C**
	7th	2.58 **D**	62.41 **D**	124.66 **E**	7.45 **D**
	Mean	2.92	67.40	153.95	14.38
	F-values	22.563**	16.956**	34.920**	28.646**
	CV (%)	5.84	2.97	6.47	15.45
2015	1th	3.90 **A**	71.69 **A**	216.77 **A**	15.96 **A**
	2nd	3.47 **B**	70.89 **AB**	191.96 **B**	16.82 **A**
	3th	3.26 **BC**	68.88 **B**	174.28 **BC**	14.61 **AB**
	4th	3.11 **BC**	70.07 **AB**	168.62 **BC**	12.01 **BC**
	5th	2.95 **CD**	68.78 **B**	157.47 **CD**	12.69 **BC**
	6th	2.69 **D**	65.40 **C**	136.06 **DE**	10.71 **C**
	7th	2.57 **D**	65.17 **C**	129.66 **E**	7.20 **D**
	Mean	3.14	68.70	167.83	12.86
	F-values	19.424**	16.205**	24.199**	24.178**
	CV (%)	9.97	2.76	11.06	15.68

Capital letters were used for comparisons of harvesting times in year subgroups. ($p<0.05$)
* Show the difference at $p<0.05$ level, ** at $p<0.01$ level.

Total Digestible Nutrient (TDN)

Different harvesting times were significantly different ($p<0.01$) in both experiment years. The averages of TDN percentages ranged from 57.46-71.94% during 2014, 62.03-72.83% during 2015. While the highest TDN percentage determined in the first harvesting time with 72.83% during 2015, the lowest TDN percentage evaluated in the last harvesting time with 57.46% during 2014. From the first harvesting time to the last harvesting time, TDN percentages decreased (Table 1). The different forage mixtures had non-significant effect during 2014, but it had a significantly different ($p<0.05$) effect during 2015. The TDN percentages in three different forage mixtures changed among 64.28-66.66% during 2014 and 67.67-69.34% during 2015 (Table 2). The highest TDN percentage of the mixtures was 66.66% and 69.34% with M_2 in both experiment years, respectively. TDN percentage has an inverse correlation with ADF. The decrease in the ADF with the increase in administered fertilizer doses results in an increase in TDN percentage [29]. [30] examined the effects of sole, double and triple mixtures of alfalfa and sainfoin (*Onobrychis sativa* Lam.) with smooth brome, intermediate wheatgrass (*Agropyron intermedium* (Host). Beauv.), and crested wheatgrass (*Agropyron cristatum* L. Gaertn.) during 2008 and 2010 in to set a short-term artificial pasture under the dry conditions, so the TDN percentage was determined as 53.53%. The results which were obtained about the TDN percentages in this study were higher compared to the results of previous studies. This could be due to the difference of the forages in the mixtures and/or the difference of the climate conditions in the two experiments.

Table 2. *The averages of the digestibility and quality of the different mixtures of forages*

Years	Mixtures	ADF (%)	NDF (%)	ADL (%)	TDN (%)
2014	**M_1**	27.21	40.21 **B**	9.50	66.23
	M_2	26.87	42.20 **A**	9.68	66.66
	M_3	28.72	42.00 **A**	10.28	64.28
	Mean	27.60	41.47	9.82	65.72
	F-values	3.083	3.975*	3.023	3.083
	CV (%)	9.30	6.05	10.86	5.04
2015	**M_1**	25.92 **AB**	39.84	7.48 **B**	67.89**A**
	M_2	24.79 **B**	38.58	7.70 **B**	69.34 **AB**
	M_3	27.09 **A**	40.24	9.14 **A**	67.67**A**
	Mean	25.93	39.55	8.11	68.30
	F-values	4.649*	1.575	7.212**	4.650*
	CV (%)	9.40	8.01	18.98	4.64

Years	Mixtures	DMI (%)	DDM (%)	RFV (%)	CP (%)
2014	**M_1**	3.03 **A**	67.71	159.20 **A**	13.02 **A**
	M_2	2.83 **B**	67.97	152.21 **B**	14.14 **A**
	M_3	2.91 **B**	66.53	150.43 **B**	11.23 **B**
	Mean	2.92	67.40	153.95	12.81
	F-values	4.160*	3.082	4.544*	11.034**
	CV (%)	5.84	2.97	6.47	15.45
2015	**M_1**	3.14	68.71 **AB**	168.30 **AB**	13.02 **AB**
	M_2	3.22	69.59 **A**	173.86 **A**	14.14 **A**
	M_3	3.04	67.80 **B**	161.32 **B**	11.44 **B**
	Mean	3.14	68.70	167.83	12.87
	F-values	1.423	4.650*	2.577*	9.498**
	CV (%)	9.97	2.76	11.06	15.68

Capital letters were used for comparisons of harvesting times in year subgroups. ($p<0.05$)
* Show the difference at $p<0.05$ level, ** at $p<0.01$ level.

Dry Matter Intake (DMI)

Different harvesting times were significantly different ($p<0.01$) in both experiment years. The DMI percentages ranged from 2.53-3.28% during 2014 and 2.57-3.90% during 2015. When the harvesting times passed, the decrease of dry matter intake by the animals can be seen in table 1. The different forage mixtures had a non-significant effect on DMI percentages during the second year, but it had a significantly ($p<0.05$) difference during 2015. DMI percentages of three different mixtures varied between 2.83-3.03% during 2014 and 3.04% - 3.22% during 2015 (Table 2). M_1 and M_2 have noted the best DMI percentages with 2.83% and 3.22%, in the same order. DMI parameter is a rate obtained with the mathematical operations over NDF, there is an inverse relation between NDF percent of forage and its DMI value. Moreover, different climate conditions may affect this difference. [31] found DMI percentages for sole alfalfa as 2.94%, smooth brome as 2.45%, and orchard grass as 2.44%. In this study, DMI percentages ranged from 2.91-3.22% in both experiment years, as a minimum and maximum, respectively. It is evident

that inter cropping or legume-grass mixtures affect positively to obtain higher DMI percentage.

Digestible Dry Matter (DDM)

Different harvesting times were significantly different ($p<0.01$) in both experiment years. DDM percentages ranged 62.41-71.15% during 2014 and 65.17-71.69% during 2015 (Table 1). The highest DDM percentage was calculated in the first harvesting time with 71.69% during 2015, whereas the lowest DDM percentage was determined in the last harvesting time with 62.41% DDM during 2014. Different forage mixtures had non-similar significant effects during 2014, but during 2015, it had a significantly different ($p<0.05$) effects. The DDM percentages differed from 66.53-67.97% during 2014 and 67.80-69.59% during 2015. The highest DDM percentage was 69.59% in M_2 mixture during 2015 and the lowest DDM percentage was 66.53% in M_3 mixture during 2014 (Table 2). There is an inverse relation between ADF of forage and its DDM. The mixtures with meadow fescue (M_2) produced more digestible dry matter than smooth brome (M_1) and orchard grass (M_3). [32] suggested that the highest DDM was produced by sowing 80% triticale (× *Triticosecale Wittmack*.) + 20% common vetch mixtures. It is showed that grass mixtures positively influenced DDM in legume-grass mixtures. In the research [33] made on 14 *Trifolium* species taken from the natural pastures of the South-Eastern Anatolian area, the DDM percentage was 70.99%. The results on DDM percentage in this study was slightly higher than the ones compared to the previous studies. The difference may be the result of the differences among used forages and climate conditions.

Relative Feed Value (RFV)

Different harvesting times were significantly different ($p<0.01$) in both experiment years. It ranged from 124.66-180.64% during 2014 and 129.66- 216.77% during 2015. The highest RFV percentage was 216.77% in the first harvesting time during 2015 (Table 1). The different forage mixtures were significantly different ($p<0.05$) in composition during both experiment years. It ranged 150.43-159.20% during 2014, 161.32-173.86% during 2015. The highest RFV percentage was 173.86% in M_2 mixture during 2015 and the lowest RFV percentage was 150.43% in M_3 mixture during 2014 (Table 2). [34] suggested that the forage quality decreased when the RFV percentage decreased fewer than 100. Therefore, the 1st, 2nd 3rd 4th and 5th quality forages have RFV of >150, 103-124, 87-102, 75-86, and <75 in the same order [35]. The RFV results of this study are >150 and it makes the best quality of forage for the poultry. In the previous studies on the RFV percentages, [27] and [33] found it as 313.17% and 120.3-159.9% respectively. Some of the results of RFV percentages obtained in this study are higher compared to previously reported findings, but some of them are comparatively lower. The reason of these differences could be surrounding climatic and soil conditions of the experimental area, different mixtures, harvesting times, vegetation stage, and the forage species.

Crude Protein (CP)

The different harvesting times were significantly different ($p<0.01$) in both years. The average rates of crude protein ranged from 6.85-16.82% during 2014, 7.20-16.82% during 2015 (Table 1). The highest and lowest CP percentage was determined in the first experiment year with 19.35%, 10.12%, respectively. It is showed that CP percentage decreased from the first harvesting time to the last harvesting time. The different pasture

forage mixtures were significantly different ($p<0.05$) in both experiment years. The crude protein percentage ranged 11.23-14.14% during 2014 and 11.44-14.14% during 2015 (Table 2). In terms of quality, the M_2 mixture was the best with 14.14% crude protein. Each increase in CP also increased forage quality. Increasing of the protein and energy content of the forages and the decrease of the ADF, NDF, and ADL percentages are desired on feeding poultry otherwise forage consumption of the animals is restricted and the digestion of poultry is slowed down [36; 37]. [7] mention that with ripening in alfalfa, red clover (*Trifolium pratense*), and bird's foot trefoil, the indigestible matters like NDF and ADF increase; whereas, the crude protein decrease. The crude protein percentage in this study is in agreement with other studies having crude protein percentage of 16.32-16.79% by [22], 14.89-19.00% by [27], 7.2-8.8% by [28], 12.3-24.1% by [33], 16.9% by [38]. The results of this study are generally in accordance with this literature with small differences. These differences might be attributed to the environmental conditions (rainfall, vegetation stage, harvesting time, different mixtures, and the soil features of the application and plantation area) and genetic factors (forage types and species).

CONCLUSION

The study aimed to identify the forage plants that can co-exist and withstand grazing pressure of poultry on synthetic manual made artificial pastures. It is very important to know the plantation potentials of the selected forages their regeneration abilities under grazing pressure, determine their strength for grazing of animals', the quality, digestibility, and the nutritional value. The difference in the growing way of the selected forages (with floc or rhizome) is also an important selection criterion. The harvesting time of the forage is one of the most important features that affected the quality.

It was concluded that the plants belonging to the *Graminae* like smooth brome and meadow fescue that are less prone to quality losses. They should be preferred and harvested earlier in artificial pasture mixtures. Moreover, late harvesting and due to an increase in the crude cellulose percentage with on-going harvesting times affected the forage quality negatively. In order to reveal the advantages of artificial pastures, the early harvest will provide more positive results in terms of forage quality and forage values. Considering the possible positive effects of using legumes, as in this study for inter cropping, it is recommended that it should be definitely included in artificial pasture mixtures for future research. In the lights of these inferences; first harvesting time and M_1 and M_2 mixtures were found most favorable and usable under Central Anatolian Conditions. It was determined that mixtures containing 3 different species could be preferably used for creating artificial pasture. Meadow fescue (M_2) was desired compared to smooth brome (M_1) and is recommended for effective use in the pasture mixtures for the artificial pastures.

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REFERENCES

[1] Anonymous. (2019a): Statistics of Plant Production (Bitkisel Uretim Istatistikleri). https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr . Access date: 01.02.2020.

[2] Ozkan, U. (2020): Comperative Overview and Evaluation of Turkey's Forage Crops Agriculture. Turkish Journal of Agricultural Engineering Research 1(1): 29-43.

[3] Serin, Y., Tan, M. (2001): Introduction of Forage Crops Culture. Ataturk University Publications of Faculty of Agriculture. Turkey, pp: 206-217.
[4] Yolcu, H., Tan, M. (2008): An Overview of Forage Crops In Our Country. Tarım Bilimleri Dergisi 14(3): 303-312.
[5] Gierus, M., Kleen, J., Loges, R., Taube, F. (2012): Forage legume species determine the nutritional quality of binary mixtures with perennial ryegrass in the first production year. Animal Feed Science and Technology 172(3-4): 150-161.
[6] Frame, J., Charlton, J.F.L., Laidlaw, A.S. (1998): Temperate Forage Legumes. CAB International, Wallingford, UK.
[7] Cassida, K.A., Griffin, T.S., Rodriguez, J., Patching, S.C., Hesterman, O.B., Rust, S.R. (2000): Protein degradability and forage quality in maturing alfalfa, red clover, and birdsfoot trefoil. Crop Science 40(1): 209-215.
[8] Anonymous. (2019b): Republic of Turkey Ministry of Agriculture and Forestry, Turkish State Meteorological Service. Access date: 21.10.2019 (In Turkish)
[9] Castle, M.E. (1976): A simple disc instrument for estimating herbage yield. Grass and Forage Science 31(1): 37-40.
[10] Van-Soest, P.J., Robertson, J.B., Lewis, B.A. (1991): Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. Journal of Dairy science 74 (10): 3583-3597.
[11] Horrocks, R.D., Vallentine, J.F. (1999): Harvested Forages. Academic Press, London, UK.
[12] Assefa, G., Ledin, I. (2001): Effect of variety, soil type and fertilizer on the establishment, growth, forage yield, quality and voluntary intake by cattle of oats and vetches cultivated in sole crops and mixtures, Animal Feed Science Technology (92): 95-111
[13] Caballero, R., Goicoechea, E.L., Hernaiz, P.J. (1995): Forage yields and quality of common vetch and oat sown at varying seeding ratios and seeding rates of common vetch. Field Crops Research (41): 135-140.
[14] Russell, D.F. (1986): MSTAT-C package programme. Crop and Soil Science Department, Michigan State University, USA.
[15] Adeli, A., Varco J.J., Sistani, K.R., Rowe, D.E. (2005): Effects of swine lagoon effluent relative to commercial fertilizer applications on warm-season forage nutritive value. Agronomy Journal 97(2): 408-417.
[16] Sanz, J., Muntifering, R.B., Bermejo, V., Gimeno, B.S., Elvira, S. (2005): Ozone and increased nitrogen supply effects on the yield and nutritive quality of *Trifolium subterraneum*. Atmospheric Environment 39(32): 5899-5907.
[17] Almodares, A., Jafarinia, M., Hadi, M.R. (2009): The effects of nitrogen fertilizer on chemical compositions in corn and sweet sorghum. *J. Agric. Environ. Sci*, 6(4), 441-446.
[18] Albayrak, S., Yuksel, O. (2010): Effects of nitrogen fertilization and harvest time on root yield and quality of forage beet (*Beta vulgaris* var. crassa Mansf.). Turkish Journal of Field Crops 15(1): 59-64.
[19] Carpici, E.B., Celik, N., Bayram, G. (2010): Yield and quality of forage maize as influenced by plant density and nitrogen rate. Turkish Journal of Field Crops 15(2): 128-132.
[20] Juan, N.A., Sheaffer, C.C., Barnes, D.K., Swanson, D.R., Halgerson, J.H. (1993): Leaf and Stem Traits and Herbage Quality of Multifoliolate Alfalfa. Agronomy Journal 85: 1121-1127.
[21] Kunelius, H.T., Durr, G.H., McRae, K.B., Fillmore, S.A.E. (2006): Performance of Timothy-based Grass/Legume Mixtures in Cold Winter Region. Journal of Agronomy and Crop Science 192(3): 159-167.
[22] Yavuz, T. (2011): Determination of artificial pasture mixtures for dryland conditions of transitional climate zone of Black Sea region. PhD Thesis. Gaziosmanpasa University Graduate School of Natural and Applied Sciences. Unpublished PhD Dissertion, Tokat, Turkey.
[23] Jung, H.G., Sheaffer, C.C., Barnes, D.K., Halgerson, J.L. (1997): Forage Quality Variation in the U.S. Alfalfa Core Collection. Crop Science 37: 1361-1366.

[24] Berdahl, J.D., Karn, J.F., Hendrickson, J.R. (2004): Nutritive quality of cool-season grass monocultures and binary grass–alfalfa mixtures at late harvest. Agronomy Journal 96(4): 951-955.
[25] Bingol, N.T., Karsli, M.A., Yilmaz, I.H., Bolat, D. (2007): The effects of planting time and combination on the nutrient composition and digestible dry matter yield of four mixtures of vetch varieties intercropped with barley. Turkish Journal of Veterinary and Animal Sciences 31(5), 297-302.
[26] Atis, I. (2006): Research on the determination of proper perennial forage grasses and their mixture rates for the pasture mixtures with white clover (*Trifolium repens* L.) under irrigated conditions of Cukurova. MSc Thesis, Cukurova University, Graduate School of Natural and Applied Sciences, Adana, Turkey.
[27] Canbolat, O., Karaman, S. (2009): Comparison of in vitro gas production, organic matter digestibility, relative feed value and metabolizable energy contents of some legume forages. Tarim Bilimleri Dergisi 15(2): 188-195.
[28] Canbolat, O. (2012): Comparison of in vitro Gas Production, Organic Matter Digestibility, Relative Feed Value and Metabolizable Energy Contents of Some Cereal Forages. Kafkas University Veterinary Faculty Journal 18(4): 571-577.
[29] Kering, M.K., Guretzky, J., Funderburg, E., Mosali, J. (2011):Effect of nitrogen fertilizer rate and harvest season on forage yield, quality, and macronutrient concentrations in midland Bermuda grass. Communications in soil science and plant analysis 42(16): 1958-1971.
[30] Albayrak, S., Turk, M., Yuksel, O., Yilmaz, M. (2011): Forage yield and the quality of perennial legume-grass mixtures under rainfed conditions. Notulae Botanicae Horti Agrobotanica Cluj-Napoca 39(1): 114-118.
[31] Sayar, M.S., Yavuz, H., Yolcu, H., Yucel, H. (2014): Yield and quality traits of some perennial forages as both sole crops and intercropping mixtures under irrigated conditions. Turkish Journal of Field Crops 19(1): 59-65.
[32] Yucel, C., Avci, M. (2009): Effect of different ratios of common vetch (*Vicia sativa* L.)-triticale (*Triticosecale Whatt*) mixtures on forage yields and quality in Cukurova plain in Turkey. Bulgarian Journal of Agricultural Science 15(4): 323-332.
[33] Basbag, M., Cacan, E., Aydın, A., Sayar, M.S. (2011): Determination forage quality traits of some vetch species collected from native flora Southeastern Anatolia. International Participation I. Ali Numan Kirac Agricultural Congress and Fair. April 27-30. Eskisehir, Turkey.
[34] Moore, J.E., Undersander, D.J. (2002): Relative forage quality: An alternative to relative feed value and quality index. In Proceedings 13th Annual Florida Ruminant Nutrition Symposium, Vol. 32, pp: 16-29.
[35] Rohweder, D.A., Barnes, R.F., Jorgensen, N. (1978): Proposed hay grading standards based on laboratory analyses for evaluating quality. Journal Animal Science 47: 747-759.
[36] Van-Soest, P.J. (1994): Nutritional ecology of the ruminant. Cornell University Press.
[37] Yavuz, M. (2005): Determination of some rumimants feeds relative feed value and in vitro digestion values. Gaziosmanpasa University, Faculty of Agriculture Journal 22: 97-101.
[38] Tekeli, A.S., Ates, E. (2005): Yield potential and mineral composition of white clover (*Trifolium repens* L.)- tall fescue (*Festuca arundinacea* Schreb.) mixtures. Journal of Central European Agriculture 6(1): 27-34.