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The Feed Values of Three Forage Kochia Phenotypes at Different Growth Periods

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Abstract

Forage kochia is one of the shrub species naturally growing in the flora of Turkey. The three kochia genotypes included in this study were collected from the pastures of Konya province. We investigated the feeding values of three kochia genotypes namely; red, green and intermediate forms at various growth stages; flowering (July), seed setting (September) and seed ripening (November). The research was designed in Split Plots in Randomized Block Design with three replications in 2018. We analyzed the Dry Matter, Ash, Ether Extract, Crude Protein, NDF, ADF, and ADL. Out of the figures we derived from the laboratory analyses we figured out the Relative Feed Value (RFV) using NDF and ADF. According to the result DM percentage ranged between 55.07% and 61.78%, crude protein percentage between 9.22% and 9.75% depending on the cutting periods. Maximum NDF value was obtained in seed ripening stage with an average of 64.35% while the maximum ADF value was obtained in bloom stage with an average of 44.28%.

The ADL received from July (i.e., 14.56%) and November (i.e., 13.16%) was the maximum ADL value, and these values were statically in the same group. The RFV of forage kochia in September (Seed Settings) is higher quality (i.e., 92.2) than other periods. We can express that the Intermediate phenotype during the dry feed period in July provides higher feed quality than the two phenotypes. The research results show that forage kochia stands out by obtaining feed from rangelands in drought areas because of delivering the 4th quality standard to livestock in July, which is in the dry feed period for Central Anatolian.

Keywords: ADF, forage kochia *(Bassia prostrata),* crude protein, NDF

Farklı Gelişme Dönemlerindeki Üç Bozkır Otu Fenotipinin Yem Değerleri

Öz

Bozkır otu Türkiye'nin florasında doğal olarak yetişen çalı türlerinden biridir. Bu çalışmaya konu alınan üç bozkır otu genotipi Konya ilindeki meralardan toplanmıştır. Kırmızı, yeşil ve geçit tipi olarak adlandırılan üç bozkır otu genotipinin çiçeklenme (Temmuz), tohum bağlama (Eylül) ve tohum olgunluğu (Kasım) büyüme dönemlerindeki yem değeri incelenmiştir. 2018 yılında yapılan bu çalışma tesadüf bloklarında bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak yürütülmüştür. Araştırmada kuru madde, kül, ham yağ, ham protein, NDF, ADF ve ADL oranları belirlenmiş ve NDF ve ADF değerleri kullanılarak Göreceli Yem Değeri (GYD) hesaplanmıştır. Araştırma sonucuna göre, bozkır otunun biçim dönemine ait kuru madde oranı %55.07 ve %61.78 arasında, ham protein oranı %9.22 ve %9.75 arasında değişmektedir. En yüksek NDF oranı ortalama olarak %64.35 ile tohum olgunluğu döneminde elde edilmiş iken en yüksek ADF değeri ortalama olarak %44.28 ile çiçeklenme döneminden elde edilmiştir.

Temmuz (14.56%) ve Kasım (13.16%) aylarında elde edilen ADL, en yüksek ADL değeridir ve bu değerler istatistiki olarak aynı grupta yer almaktadırlar. Eylül ayında (tohum bağlama döneminde) bozkır otunun göreceli yem değerinin (92.2) diğer aylardaki yem kalitesinden yüksek olduğu belirlenmiştir. Geçit tipi, Temmuz ayındaki kuru yem periyodu döneminde diğer tiplerden daha yüksek kaliteli yem sunduğu ifade edilebilir. Araştırma sonuçlarına göre Orta Anadolu için kuru yem periyodu içerisinde yer alan Temmuz ayında bozkır otu hayvanlara 4. kalite sınıfında yem sağlaması sebebiyle kurak alanlardaki meralardan yem elde etmede bozkır otunun ön plana çıktığını göstermektedir.

Anahtar Kelimeler: ADF, bozkır otu (*Bassia prostrata),* ham protein, NDF

Introduction

The most important and economical feed source in Turkey is the pastures. Yield and quality of the rangelands are steadily decreasing since our meadow are not grazed according to management rules, and nowadays, estimated average pasture yield of Turkey is below 700 kg ha^{-1} (Babalık, 2008; Gür and Şen, 2016). Rangeland improvement is getting progressively challenging because of current grazing conditions and climate change, drought, etc. For this reason, new pasture rehabilitation strategies need to be considered. One approach is to replace herbaceous plants with bushy species that are better adapted to dry conditions due to their long and deep root systems. Another advantage of using shrub species is that they generally provide extended grazing for livestock during all the seasons. They help reduce or prevent erosion with their deep root systems underground and established canopy on the ground. Shrubs produce more forage. By using water effectively, they are resistant to drought and sometimes to salinity. They create a suitable environment for other plants. Main disadvantage of the shrubs is their reduced digestibility despite having high protein content. Thus, their energy values are partially low (Aygün and Olgun, 2015). Most of the time it is only the shrub species that remain on the pastures after a long-lasting drought period. Improvement of the pastures of dry areas by means of the drought tolerant shrub species with adequate forage yield is given top priority (Acar et al., 2011; Acar, 2013).

Forage kochia or prostrate summer-cypress [*Bassia prostrata* (L.) A.J. Scott (Syn. *Kochia prostrata*)], which is a C4 subshrub plant is a member of *Chenopodiaceae* family (Su et al., 2011). It grows in the pastures of dry areas in Turkey and elsewhere in the natural pastures of the world. There are a lot of ecotypes of forage kochia adapted to different environments (Kitchen and Monsen, 2008). Forage kochia has genotypes with vertical or sub-horizontal habitus, and the stem colors are mainly red, yellow and green. Plant height ranges between 60 and 80 cm, and their roots can grow up to 10 m deep in the soil (Figure 1). This plant adapted to areas with 100-350 mm annual precipitation and persist in such environments for long years are suitable for rangeland improvement (Acar and Özköse, 2012; Acar, 2013).

Figure 1. Images of canopy diameter (R) and plant cover (L) of forage kochia (15.06.2020).

We conducted the experiment in Konya province under rainfed conditions. Different phenotypes of prostrate summer-cypress yielded between 1075 kg ha^{-1} and 4090 kg ha^{-1}, and this differences were statistically significant (Acar et al., 2016; Acar and Koç, 2019). Positive correlation has been observed between hay yield, hay yield per plant, and thousand seed weight (Acar and Koç, 2019). As crude protein increased, forage quality improved correspondingly. Increasing ADF and NDF contents were reflected as decrease in forage

quality (Rivera and Parish, 2010; Güney et al., 2016). Feed quality significantly decreased in time being the lowest at the end of cutting season (Güney et al., 2016).

This research aims at showing the changes in feed quality at different development periods of three forage kochia genotypes that has been recently being used in rangeland improvement.

Material and Methods

The material of the experiment consisted of three forage kochia genotypes that have been previously collected from dry pastures of Konya provinces in 2013 and reproduced in research plots of Department of Field Crops, Selçuk University. We neither irrigated nor applied fertilizers to the plants. Soil characteristics of the experimental area is given in Table 1.

Table 1. Soil characteristic of experimental field

Parameter	Values	Proficiency level	Parameter	Values	Proficiency level
Soil Texture		Clayey	K (%)	0.03	High
pH	8.12	Slightly Alkaline	P (mg kg^{-1})	1.83	Insufficient
Organic matter (%)	1.98	Low	B(mg kg^{-1})	3.07	Sufficient
Elect. Conduct. (dS m^{-1})	0.88	Non-Saline	Cu (mg kg^{-1})	2.07	Medium
$CaCO_3$ (%)	25.0	Very High	Fe (mg kg^{-1})	1.19	Insufficient
Ca (%)	0.69	Very High	Zn (mg kg^{-1})	0.91	Medium

The mean temperatures were 12.9 ºC in 1980-2013; the average temperature of the year of the plantation (i.e., 2013) was 12.3 ºC; 12.6 ºC in 2014; 11.5 ºC in 2015; 12.8 ºC in 2016; 11.4 ºC in 2017, and 2018 which was the cutting year was 13.7 ºC. The total precipitation was 283.1 mm from long years (from1980 to 2013); 237.9 mm in the year of the plantation (i.e., 2013); 523.7 mm in 2014; 375.6 mm in 2015; 293.5 mm in 2016; 314.0 mm in 2017, and total precipitation of the cutting year (i.e., 2018) was 375.0 mm.

Measurements and observations have been taken on three prominent types namely red, green and intermediate genotypes. The morphological characterization results are given in Table 2.

Table 2. The morphological properties of forage kochia phenotypes

The morphological properties	Red genotype	Green genotype	Intermediate genotype
Stem color	Red & Dark Red	Yellow & Green	Orange & Red
Leave color	Bluish Green	Green	Green
Leave hairiness	Hairy (Dense)	Hairy	Hairy
Fresh shoot hairiness	Hairy	Hairless	Hairy

The research was designed in Split Plots in Randomized Block Design with three replications. Plants were harvested in three growing periods namely bloom (July), seed setting (September) and seed ripening (November) periods in 2018. Due to unsynchronized character of the genus, not all the plants reached at the above-mentioned growth stages simultaneously, therefore we moved the plants when majority of the plants arrived at the designated stages. Doing so we moved the plants on July 2 (bloom), September 3 (seed setting) and November 5 (seed ripening).

All the samples were cut into 4-5 cm length with a shredder (Bosch AXT25 D). The dry matter (%) was determined by drying the samples at 60 ºC in ventilated incubator until they reach at a constant weight (AOAC, 2003). These samples were ground on a mill (Retsch SM 100) and sieved in 1 mm diameter sieve to make the samples ready for chemical analysis.

Chemical analysis was made in Animal Nutrition and Nutritional Diseases Feed Analysis Laboratory, Veterinary Medicine Faculty of Selçuk University. According to AOAC (2003), chemical analysis (i.e., ash, ether extract, and crude protein) in the whole sample was made in two parallels. NDF, ADF, and ADL were made by Van Soest et al. (1991) by using an ANKOM200 device.

Relative Feed Value (RFV) was calculated using the following formulas to estimate the roughage value (Tremblay, 1998; Güney et al., 2016).

$$RFV = DDM \times DMI / 1.29 \quad \text{[Eq.1]}$$

$$DDM\ (\text{Digestable Dry Matter}) = 88.9 - (0.779 \times \%ADF) \quad \text{[Eq.2]}$$

$$DMI\ (\text{Dry Matter Intake}) = 120 / \%NDF \quad \text{[Eq.3]}$$

The data was analyzed by using JMP 7 software packet program. LSD test was performed to determine the result of analysis of variance using MSTAT-C software packet programs for grouping.

Results and Discussion

The analysis of variance results is summarized in Table 3, and the average values are given in Table 4. As shown in Table 3 ash, ether extract, NDF, ADL, and Relative Feed Value values were significantly different. On the other hand, cutting period, genotype and their interaction of ether extract values were significantly significant.

Table 3. The mean square values of three forage kochia phenotypes at different cutting periods

Source	DF	Dry matter	Ash	Ether extract	Crude protein	NDF	ADF	ADL	Relative feed value
T	26	-	-	-	-	-	-	-	-
R	2	21.054	1.696	0.023	0.159	3.809	15.235	1.095	49,170
A	2	102.319	14.947**	0.191**	0.666	98.798*	38.627	21.406*	425,371*
E (1)	4	24.814	0.773	0.005	1.133	7.041	7.459	1.208	44,256
B	2	155.590*	3.182*	0.117**	0.986	2.041	1.434	3.289*	12,071
A*B	4	65.930	0.983	0.093**	0.716	14.421*	0.827	0.202	40,522
E (2)	12	26.852	0.676	0.012	0.682	4.619	2.235	0.632	21,878
CV %		11.80	15.92	19.47	9.03	6.02	5.95	12.08	9.17

A: Cutting Periods, B: Genotype, T: Total, R: Replication, E: Error, DF: Degree of Freedom
**p < 0.01; *p < 0.05

The highest dry matter content was obtained in final cutting period with 61.78% while maximum ash content was found in bloom period with 10.23%. The highest average ash content was obtained in intermediate genotype with 9.80%. For the ether extract highest values were obtained from September and October cuttings with 1.19%. Intermediate genotype had the highest ether extract content with 1.24%. The crude protein content of green genotype moved in November, and intermediate phenotype moved in September, exceeded 10%. The maximum NDF was obtained from Seed Ripening period with 64.35%. The red genotype moved in Bloom period had the maximum ADF with 44.91%. The maximum ADL was obtained from July cut with 14.56% and November cut with 13.16%. Both of the values were in the same group.

Feeding value of the forage plants differ in growth periods. In alfalfa plant ADF values were expressed as 29% and 40% at early flowering and maturity periods respectively. The

NDF values at the same periods were expressed as 36% and 51% respectively. It represents a decrease in RFV through time. The quality standard of alfalfa is reported as 170 in prime standard during early bloom period, while in the full bloom period, it decreases to 3rd quality standard with 100 RFV (Stallings, 2006; Güney et al., 2016).

Shenkoru et al. (2015) investigated the feed value of forage kochia hay at different times. In September and November, dry matter contents were determined as 93% and 94% respectively. It was also reported that dry matter content increased all the way through ripening period. The following values have also been measure in the research: ether extract 1.5-5.6%, crude protein 10-23%, NDF 38-54%, ADF 19-32%, and ADL 5.9-7.5% in September and January respectively. Waldron et al. (2006) observed the feed value of forage kochia in fall and winter. In November, December and January, they reported 9.6%, 5.7%, 4.7% crude protein, 55%, 63%, and 66% NDF values respectively.

Table 4. Average values and groupings belonging to forage kochia varied phenotypes at different cutting periods

Cutting periods	Genotype	Dry matter (%)	Ash (%)	Ether extract (%)	Crude protein (%)	NDF (%)	ADF (%)	ADL (%)	Relative feed value	Forage quality standards[1]
July (Bloom)	Intermediate	55.52	11.60	0.99^{B-D}	8.92	58.20^{c}	43.15	14.14	88.4	3rd
	Red	56.25	9.42	0.90^{D}	9.50	62.08^{ab}	44.91	15.14	80.8	4th
	Green	53.44	9.66	0.92^{CD}	9.23	62.40^{ab}	44.79	14.39	80.5	4th
	Average	55.07	10.23^{A}	0.94^{B}	9.22	60.89^{ab}	44.28	14.56^{a}	83.1^{b}	4th
September (Seed settings)	Intermediate	58.71	9.89	1.48^{A}	10.07	59.89^{bc}	40.43	11.39	89.2	3rd
	Red	68.71	9.37	1.19^{BC}	9.10	56.13^{c}	40.73	12.25	94.7	3rd
	Green	49.62	9.03	0.89^{D}	10.08	57.15^{c}	40.83	10.79	92.9	3rd
	Average	59.01	9.43^{AB}	1.19^{A}	9.75	57.72^{b}	40.66	11.48^{b}	92.2^{a}	3rd
November (Seed ripening)	Intermediate	62.41	7.91	1.23^{AB}	9.72	63.26^{ab}	44.20	13.14	80.1	4th
	Red	62.97	7.36	1.07^{B-D}	8.89	65.29^{a}	44.06	13.82	77.8	4th
	Green	59.95	7.84	1.26^{AB}	10.14	64.49^{a}	44.38	12.52	78.4	4th
	Average	61.78	7.70^{B}	1.19^{A}	9.58	64.35^{a}	44.21	13.16^{a}	78.7^{b}	4th
Averages	Intermediate	58.88^{ab}	9.80^{a}	1.24^{A}	9.57	60.45	42.60	12.89^{b}	85.7	4th
	Red	62.64^{a}	8.71^{b}	1.05^{B}	9.16	61.17	43.23	13.74^{a}	84.0	4th
	Green	54.34^{b}	8.84^{b}	1.02^{B}	9.82	61.35	43.33	12.57^{b}	83.6	4th
LSD Cutting time		-	1.909	0.155	-	3.473	-	1.438	8.707	
LSD Genotype		5.322	0.845	0.161	-	-	-	0.816	-	
LSD Cutting Time x Genotype		-	-	0.278	-	3.823	-	-	-	

[1] Prime RFV ≥ 151; 1st quality standard 125 ≤RFV ≤150; 2nd quality standard 103 ≤RFV ≤124; 3rd quality standard 87 ≤RFV ≤102; 4th quality standard 75≤RFV ≤86; 5th quality standard RFV≤ 74 (Rivera and Parish, 2010; Güney et al., 2016)

A, B, … p<0.01; a, b, …p <0.05

Waldron et al. (2002), who studied feed values of forage kochia genotypes, showed varying values among forage kochia populations such as Otavny, Karnabchulsky, Sahro, and Pustinny in terms of crude protein between 11 and 16%. Ralphs et al. (2011) stated that in August, variety Immigrant and Otvsel line had 51% and 56% dry matter, 14.5% and 9.4% crude protein, 47% and 59% NDF respectively.

In the USA, Stonecipher et al. (2004) determined that forage kochia yields digestible low-quality feed throughout winter period for feeding the livestock. Furthermore, forage kochia hay contained crude protein of 9.6% DM, NDF of 53.8% DM, and ADF of 32.2% DM.

In dry fodder period of Central Anatolian it was determined that crude protein content of the leaves of forage kochia grown in Konya was 12.93%, the stems was 7.16%, and the average crude protein was about 10% (Koç et al., 2020). It was mentioned that minimum 7% of crude protein is needed to maintain the rumen microorganism's activity (Waldron et al., 2006). In the light of this information, crude protein of forage kochia was determined the

minimum 8% in our research's results, and this protein content is adequate to rumen microorganism activity. Our results showed high degree of similarity with many of the research results with this regard. The differences may have originated from growing periods of plants (phenology), plant varieties used in the experiments, climate and soil conditions where these studies were carried out.

Conclusions

In our research, relative feed values of all three genotypes in September ranked as 3rd quality standard in regard with cutting periods. Being in critical periods (i.e., critical summer period, critical fall period) for Central Anatolian regions, forage yield of rangelands drop tremendously from July to November. Forage kochia proves to be a significant feed source during this period by providing 4th quality standard to livestock in these critical periods.

In results of the research showed varying feed values of forage kochia phenotypes moved in different periods. As a summary of the experiment, we can advise the Intermediate genotype during the dry feed period in July with higher feed quality than other genotypes (i.e., red and green phenotypes).

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