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FORAGE QUALITY TRAITS OF SOME ASTERACEAE FAMILY SPECIES FOUND IN NATURAL FLORA OF SOUTHEASTERN ANATOLIA

Mehmet Basbag[1*], Mehmet Salih Sayar[2]

[1]Dicle University, Faculty of Agriculture, Department of Field Crops, Diyarbakir, Turkey
[2]Dicle University, Bismil Vocational Training School, Department Crop and Animal Production Bismil, Diyarbakir, Turkey
[*]e-mail: mbasbag@dicle.edu.tr

ABSTRACT

This study was carried out in order to reveal the forage quality traits of twelve *Asteraceae* family species found in Natural Flora of Southeastern Anatolia in terms of animal nutrition. For this reason, forage samples of the species were taken with three replications during flowering periods of the plant species. According to statistical analysis results, there found highly significant (*P<0.01*) differences among the species in terms of all of the investigated traits. And the following ranges were determined among the species in the investigated traits; crude protein content (CP) 13.37%-26.90%, acid detergent fiber (ADF) content 21.78%-34.17, neutral detergent fiber (NDF) content 28.69%-40.52%, digestible dry matter (DDM) content 62.28%-71.94%, dry matter intake (DMI) 2.97%-4.21%, metabolizable energy (ME) 9.57-11.45 MJ/kg, relative feed value (RFV) 144.2-230.4, phosphor (P) content 0.27%-0.40%, potassium (K) content 1.97%-5.42, calcium (Ca) content 1.21%-1.78%, magnesium (Mg) content 0.32%-0.49%, Ca/P ratio 3.25-5.19 and K/(Ca+Mg) ratio 1.19-2.84. Result of the study revealed that *Notobasis syriaca* (L.) Cass. and *Onopardum acontium* L. species by far the highest CP content, and except for *Gundelia tournoforti* L. var. armata all of the examined species had the best forage quality, *Prime Forage Class*, by considering their RFV values. Moreover, it was determined that the macro mineral contents of the species were above the recommended values for livestock feeding. Additionally, it was determined that most of the examined species had below critical grass tetany value (2.2), away from risk of the grass tetany disorder. Finally, due to Ca/P ratio of the species well above recommended level, the danger of *Milk Fewer* or *Hypocalcaemia* disease should be taken into account when using forages of the *Asteraceae* family species in animal feed.

Key words: ADF, *Asteraceae,* crude protein, NDF, macro minerals, relative feed value.

INTRODUCTION

The *Asteraceae* or *Compositae* family is one of the largest flowering plant families, with over 1600 genera and 2500 species worldwide (Rolnik and Olas, 2021). The family known also as sunflower, daisy, or aster family (Nguyen et al., 2021). Asteraceae family has great diversity in terms of appearance forms (Mandel et al., 2019). Actually, the growth habits of *Asteraceae* species can include all plant forms and patterns as herbs, shrubs, vines, and trees (Nguyen et al., 2021). *Asteraceae* family is of wide range of climatic adaptability. There are some *Asteraceae* family species grow in warmer and tropical regions, while other *Asteraceae* members can grow in various polar- and dry-climate conditions, even extreme geographical regions such as Antarctica (Smith and Richardson, 2011) or deserts (Rebernig et al., 2010).

Asteraceae plants are used as food sources, medicinal uses, biocomposts sources, biopesticides, green manure uses and other various purposes. In addition to these uses, *Asteraceae* plants are of great importance in terms of animal nutrition (Nguyen et al., 2021). Many Asteraceae plants contain feed ingredients in different plant patterns, and they used to in animal feeding. For example, tubers and tops of *Helianthus tuberosus* L. are used as animal supplementary feed (Kays and Nottingham, 2007). Moreover, after being harvested this species, the none valuable parts could also be preserved to generate silage for sheep raising (Razmkhah et al. 2017). Additionally, *Helianthus annus* L. is an important plant in animal feeding. Its green biomass is used as roughage of livestock by making silage (Tan et al., 2015), its meal, remaining after removing the oil from its seeds, is an important concentrate feed as a protein source (Basbag et al., 2021). Another *Asteraceae* plant, *Silybum marianum* L. is used as feed source in raising of rabbits due to its higher protein and fiber contents (Stastnik et al., 2020). In native rangelands, many wild *Asteraceae* species are grazed by goats and sheep, such as musk thistle, spotted knapweed (Henderson et al. 2012). Hence, the *Asteraceae* family contributes greatly to animal feedings for the maintenance of sustainable agriculture.

This study was conducted to determine forage quality traits of some *Asteraceae* family species, found in natural flora of Southeastern Anatolia Region of Turkey. Thereby, revealing the possibility of these species using as an alternative quality roughage source.

MATERIAL AND METHODS

The plant materials of the study consisted of twelve *Asteraceae* family species. The Latin and English names and life span of the species indicated in the Table 1. Forage samples of the species were collected from natural flora of Dicle University Campus, Diyarbakır, Turkey in blooming stages of the species during spring of 2021.

Table 1. Plant materials of the study from *Asteraceae* family

	Latin name of the species	English name of the species	Life span
1	*Anthemis cotula* L.	Dog fennel, Stinking may weed	Annual
2	*Cichorium intybus* L.	Withloaf cichory	Perennial
3	*Circium arvense* (L.) Scop.	Creeping thistle	Perennial
4	*Crepis sancta* (L.) Babcock	Hawk's beard	Annual
5	*Gundelia tournofort*i L. var. *armata*	Tumbleweed	Perennial
6	*Matricaria recutita* L.	Chamomile	Annual
7	*Notobasis syriaca* (L.) Cass.	Syrian thistle	Annual
8	*Onopardum acontium* L.	Common cotton thistle	Biennial
9	*Senecio vulgaris* L.	Groundsel, Old-man-in-the-spring	Annual
10	*Sonchus oleraceus* L.	Spiny sowthistle, Hare's thistle	Annual or Perennial
11	*Sylbium marianum* (L.) Gaertn.	Blessed milkthistle	Biennial
12	*Taraxacum aleppicum* Dahlst.	Dandelion	Perennial

The analysis of soils showed that soils (0–30 cm) in the natural vegetation generally had a clay loam texture, with a slightly alkaline pH (7.4–7.9). Although the soils studied were rich in calcium ($CaCO_3$ of 7.5–13.4%) and potassium (440–560 kg K ha^{-1}), they were poor in organic matter (1.20-1.75%) and useful phosphorus (35-40 kg P ha^{-1}). The climate in the region is characterized as semi-arid (humid winters and dry summers), with variable rainfall distribution between years. Temperature and rainfall humidity records from the study area summarized in Figure 1. Mean annual precipitation is 483 mm based on the long-term average, of which approximately 80% occurs from November to May. Almost no precipitation falls during the period between June and September in all years. During this period, rising temperatures are associated with shorter vegetative growing periods in the natural area. The highest mean temperature in the region were recorded in July and August.

For determine dry matter rates and for chemical analysis, from each species 500 g fresh forage samples with three replicates were kept in oven at 70 °C for 48 hours. Afterwards the dried forage samples were well ground in a laboratory mill. Then, crude protein, ADF NDF, calcium (Ca), magnesium (Mg), phosphorus (P) and potassium (K) contents of the ground forage samples were determined in the Dicle University Science and Technology Application and Research Center Laboratory via the Foss Model 6500 NIRS (Near Infrared Reflectance Spectroscopy) analysis device using C-0904FE-Hay and Fresh Forage calibration (Starks et al., 2004; Basaran et al., 2011; Cınar, 2012; Basbag et al., 2018; Sayar et al., 2022a, Sayar et al., 2022b).

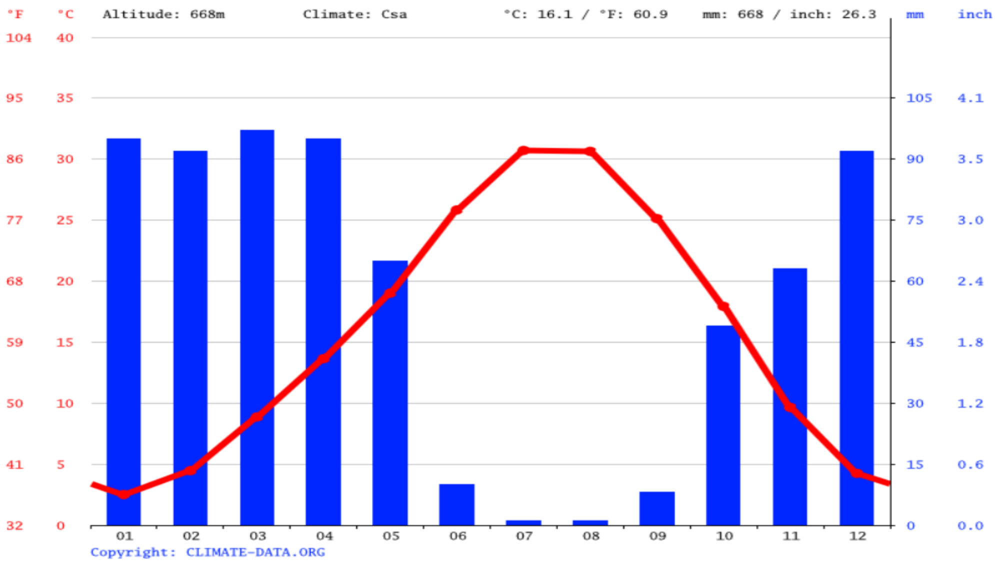

Figure 1. Monthly average temperature and total precipitation in Diyarbakir province

Dry digestible matter (DDM), dry matter intake, (DMI) and relative feed value (RFV) were calculated according to the follow equations; suggested by Schroeder (1994). On the other hand, metabolizable energy (ME) of the forages was determined according to suggested by Kirchgessner and Kellner (1981), Ozkul et al. (2005) and Gungor et al. (2008) with using the following equation and ADF content. Also quality classes of the forages were determined according to Lacefield (1988).

DDM% = 88.9 - (0.779 x ADF%)
DMI% = 120 / NDF%
RFV = (DDM% x DMI%) / 1.29
ME (MJ/kg DM)= 14.70-(0.150 x ADF)

In the study, the statistical analyses of data were made by using the JMP 5.0.1 statistical software package (SAS Institute, 2002), and the least significant difference (LSD) test at the 0.05 probability level (Steel and Torrie, 1980) was used for determining the differences between means.

RESULTS AND DISCUSSION

The results of variance analysis showed that there was statistically highly significant (P<0.01) differences between the *Asteraceae* family species in terms of all of the investgated traits. This indicated that there were significant variations among the species for the traits (Table 2, Table 3). Crude protein (CP) contents of *Asteraceae* species ranged from 13.37% to 26.90%. The highest CP content was determined in *Notobasis syriaca* and *Onopardum aconitum* species, while the lowest CP content was determined in *Anthemis cotula* species (Table 2). On the other hand, acid detergent fiber (ADF) contents of *Asteraceae* family species changed from 21.78% to 34.17%, whereas neutral detergent fiber (NDF) contents changed from 28.69% to 40.52%. Statistically, the highest ADF ratio was detected in *Anthemis cotula* species, while the highest NDF value was detected in *Anthemis cotula* and *Gundelia tournoforti* species. With the higher ADF and NDF contents, these species can be specified as having the lowest forage quality among the species. On the other hand, the lowest ADF content was recorded in *Cichorium intybus* species, and the lowest NDF content was recorded in *Cichorium intybus*, *Crepis sancta*, *Notobasis syriaca*, *Senecio vulgaris and Sylbium marianum* (Table 2). These species having lower ADF and NDF content can be specified as having the highest forage quality among the species. Accordingly, many researchers reported that there was inverse relationship between ADF, NDF contents and forage quality. Namely, when ADF and NDF decrease, forage quality increase (Schroeder 1994; Jeranyama and Garcia, 2004; Sayar et al., 2014; Sayar et al., 2022a; Sayar et al., 2022b)

Table 2. Forage quality traits of *Asteraceae* family species[+]

	***Asteraceae* Family Species**	**CP (%)**		**ADF (%)**		**NDF (%)**		**DDM (%)**		**DMI (%)**		**ME**		**RFV**	
1	*Anthemis cotula* L.	13.37	g	34.17	a	37.75	a-b	62.28	f	3.18	c-d	9.57	f	153.5	P
2	*Cichorium intybus* L.	20.55	b-c	21.78	f	30.19	d	71.94	a	3.97	a-b	11.43	a	221.7	P
3	*Circium arvense* (L.) Scop.	14.99	f-g	30.28	b-c	35.27	b-c	65.31	d-e	3.42	b-d	10.16	d-e	173.8	P
4	*Crepis sancta* (L.) Babcock	15.54	f-g	25.55	d-e	29.92	d	68.99	b-c	4.03	a	10.87	b-c	216.1	P
5	*Gundelia tournoforti* L. var. armata	21.72	b	33.80	a-b	40.52	a	62.57	e-f	2.97	d	9.63	e-f	144.2	1st
6	*Matricaria recutita* L.	16.90	e-f	28.22	c-d	32.91	c-d	66.92	c-d	3.67	a-c	10.47	c-d	190.6	P
7	*Notobasis syriaca* (L.) Cass.	25.69	a	23.14	e-f	29.46	d	70.88	a-b	4.08	a	11.23	a-b	224.1	P
8	*Onopardum acontium* L.	26.90	a	23.69	e-f	28.69	d	70.44	a-b	4.21	a	11.15	a-b	230.4	P
9	*Senecio vulgaris* L.	18.63	c-e	25.20	d-f	29.61	d	69.27	a-c	4.07	a	10.92	a-c	219.0	P
10	*Sonchus oleraceus* L.	17.97	d-e	22.89	e-f	32.41	c-d	71.07	a-b	3.70	a-c	11.27	a-b	204.1	P
11	*Sylbium marianum* (L.) Gaertn.	18.59	c-e	24.61	d-f	30.38	d	69.73	a-c	4.05	a	11.01	a-c	219.3	P
12	*Taraxacum aleppicum* Dahlst.	19.37	b-d	22.03	e-f	32.70	c-d	71.74	a-b	3.67	a-c	11.40	a-b	204.1	P
	Mean	19,18		26,28		32,48		68,43		3,75		10,76		200,07	
	LSD (0,05)	2,37**		3,72**		4,38**		2,90**		0,56**		0,55**		37,51**	
	CV (%)	7,29		8,33		7,97		2,49		8,80		2,97		11,07	

+, means with different letters in the same column are significantly different (P < 0.05); significant at; **, P ≤ 0.01

Results of the study showed that digestible dry matter (DDM) contents of *Asteraceae* family species changed from 62.28% to 71.94%, whereas dry matter intake (DMI) changed from 2.97% to 4.21%. Statistically, DDM and DMI values of *Cichorium intybus, Crepis sancta, Notobasis syriaca, Onopardum aconitum, Senecio vulgaris, Sonchus oleraceus, Sylbium marianum and Taraxacum aleppicum* were found to be higher than the other species. On the other hand, the lowest DDM value was found in *Anthemis cotula species*, and the lowest DMI value was found in *Gundelia tournoforti.* Amiri and Mohamed Shariff (2012) reported that lower DDM and DMI values in forages indicated decreasing in digestion and consumption of forages by livestock.

The metabolizable energy (ME) value of *Asteraceae* family species ranged from 9.57 MJ kg^{-1} DM to 11.43 MJ kg^{-1} DM. The lowest ME value was recorded in *Anthemis cotula* species, ME values of *Cichorium intybus, Notobasis syriaca, Onopardum aconitum, Senecio vulgaris, Sonchus oleraceus, Sylbium marianum and Taraxacum aleppicum* species were found to be higher than the other species. Relative feed value (RFV) widely accepted an index for forage quality. RFV determined with using ADF and NDF contents of forages (Sayar et al. 2014). Therefore, it is a good indicator for comparing consumption and digestion status of similar forages easily. Results of the study showed that RFV means of the *Asteraceae* family species was ranged from 144.2 to 230.4. According to Lacefield (1988) forage classification scale, only *Gundelia tournoforti* species took part in 1st forage class. The other all of the examined species took part in *Prime Forage Class* (Table 2).

Table 3. Phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) contents and Ca/P, K/(Ca+Mg) ratios in forage of *Asteraceae* family species+

	***Asteraceae* Family Species**	**P (%)**		**K (%)**		**Ca (%)**		**Mg (%)**		**Ca/P**		**K/(Ca+Mg)**	
1	*Anthemis cotula* L.	0.27	c	2.14	e	1.40	b-d	0.32	e	5.19	a	1.25	c
2	*Cichorium intybus* L.	0.30	b-c	2.79	c-e	1.46	b-c	0.40	b-c	4.82	a-b	1.50	b-c
3	*Circium arvense* (L.) Scop.	0.27	c	3.06	c-e	1.26	d	0.43	a-b	4.59	a-b	1.80	b-c
4	*Crepis sancta* (L.) Babcock	0.30	b-c	3.19	b-e	1.38	b-d	0.39	b-d	4.62	a-b	1.80	b-c
5	*Gundelia tournoforti* L. var. armata	0.40	a	2.55	d-e	1.38	b-d	0.45	a-b	3.48	c	1.40	c
6	*Matricaria recutita* L.	0.30	b-c	1.97	e	1.33	c-d	0.32	e	4.51	a-b	1.19	c
7	*Notobasis syriaca* (L.) Cass.	0.38	a	4.02	b-c	1.78	a	0.49	a	4.69	a-b	1.77	b-c
8	*Onopardum acontium* L.	0.40	a	3.03	c-e	1.55	b	0.40	b-c	3.91	b-c	1.56	b-c
9	*Senecio vulgaris* L.	0.35	a-b	2.77	c-e	1.40	b-d	0.36	c-e	4.01	b-c	1.58	b-c
10	*Sonchus oleraceus* L.	0.38	a	3.49	b-d	1.21	d	0.36	c-e	3.29	c	2.25	a-b
11	*Sylbium marianum* (L.) Gaertn.	0.34	a-b	5.42	a	1.54	b	0.43	a-c	4.60	a-b	2.84	a
12	*Taraxacum aleppicum* Dahlst.	0.39	a	4.41	a-b	1.28	c-d	0.32	e	3.25	c	2.77	a
	Mean	0.34		3.24		1.41		0.39		4.25		1.81	
	LSD (0,05)	0.05**		1.27**		0.18**		0.07**		0.94**		0.84**	
	CV (%)	8.82		13.20		7.09		10.52		12.97		11.07	

+, means with different letters in the same column are significantly different (P < 0.05); significant at; **, P ≤ 0.01

Phosphorus (P) contents of the *Asteraceae* species were ranged from 0.27% to 0.40%. P contents of *Gundelia tournoforti*, *Notobasis syriaca*, *Onopardum aconitum*, *Senecio vulgaris*, *Sonchus oleraceus, Sylbium marianum and Taraxacum aleppicum* Species were found to be higher than the other examine species. However, the lowest P content was determined in *Anthemis cotula* and *Circium arvense* species. According to cited in many literatures, 0.25% P content in forage dry matter is sufficient for the livestock needs (NRC, 2000; McDowell and Arthington, 2005; Márquez-Madrid et al., 2017). Accordingly, P contents determined in the species were found to be sufficient to livestock requirements (Table 3). On the other hand, Potassium (K) content of the examined *Asteraceae* species varied from 1.97% to 5.42%. The highest K content was determined in *Sylbium marianum* and *Taraxacum aleppicum,* while the lowest K content *Anthemis cotula* and *Matricaria recutita* species. The National Research Council (NRC, 2000) recommended that K content of forages shouldn't be under the 0.65% DM. Also, Tajeda et al. (1985) reported that for livestock requirements K content of forages should be at least 0.80% of DM. In Fact, K contents determined in the forages of the species were found to be quite above the references data, and the K contents found to be sufficient to meet potassium requirements of livestock (Table 3).

Calcium (Ca) content of *Asteraceae* family species varied from 1.21% to 1.78%. The highest Ca content was determined in *Notobasis syriaca* species, whereas the lowest content was determined in *Circium arvense* species (Table 3). According to many researchers, there should be at least 0.30% Ca content in dry matter of forages in order to avoid any Ca deficiency in livestock feeding (NRC, 2000; McDowell and Arthington, 2005; Onal Asci et al., 2018). According to Sabah and Celik (2001), Basbag et al. (2011) and Sayar (2016) Ca deficiency leads to bone softening in young animal and bones deformations in the elderly ones. Additionally, they noted that it leads to the eggs to be thin-shelled in poultry. Moreover, McDowell (1992) and Spears (1994) cited that Ca deficiency causes reducing of growth and milk production in livestock. Accordingly; the determined Ca contents in the different plant species in the study were found to be quite higher than the reported reference Ca contents, and it was found to be easily sufficient for livestock Ca requirements. On the other hand, Magnesium (Mg) contents determined in forages of the species were ranged from 0.32% to 0.49% of DM. Statically, Mg contents of *Circium arvense*, *Gundelia tournoforti* and *Notobasis syriaca* species were found higher than the other species. In contrast, the lowest Mg content was determined in *Anthemis cotula*, *Matricaria recutita* and *Taraxacum aleppicum* species (Table 3). Meanwhile, according to reported in many studies, in order to avoid abnormalities caused by mg deficiency in livestock, amount of Mg in livestock feeds should be over the 0.10% of DM (ARC, 1980; Spears, 1994; NRC, 2000, McDowell and Arthington, 2005; Márquez-Madrid et al., 2017). Accordingly, it was determined that the Mg contents of the studied species were quite above this specified value (Table 3).

Presence of mineral elements in certain proportions in animal feeds is of great importance in animal feed in terms of animal health (Abbasi et al., 2009; Basaran et al., 2011). And, Ca:P ratio is one of the important ratio to be taken into account in livestock diets for the animal health. Accordingly, the Ca:P ratios determined in the species were changed from 3.25 to 5.19. While the highest Ca:P ratio was determined in *Anthemis cotula*, the lowest one determined in *Taraxacum aleppicum* species (Table 3). Generally, the desired Ca:P ratio in livestock feeds is from 1:1 to 2:1 (Underwood, 1981). However, this ratio up to 10:1 can be tolerated without any adverse effect, provided there is sufficient P intake in livestock feeds (Ternouth, 1990; Judson and McFarlane, 1998). According to Acıkgoz (2001) and Basaran et al. (2011) if the Ca:P ratio is higher than 2:0, it probably causes *Milk Fewer* or *Hypocalcaemia* parturient paresis, is the most common metabolic disease affecting dairy cows. Milk fewer disease occurs when the dairy cow has lowered levels of blood calcium. Milk fever generally occurs within the first 24 hours post-calving, but can still occur two to three days post-calving. In the study, It was determined that Ca:P ratios of all of the examined *Asteraceae* family species were found to be higher than the desired ratio (2:0). Therefore, if the forages of these species are to be used extensively in animal nutrition, it is necessary to be careful about the possibility of the emergence of Milk Fewer disease.

Grass Tetany or *Hypomagnesaemia* is one of the most important disorder seen in livestock (Ayan et al. 2010). The disorder is caused by low Mg content in the blood, and its symptoms appear when this ailment is combined with *Hypocalcemia* (Milk Fewer) (Grass Tetany, 2022). According to Ensminger et al. (1990), spasm of the legs and head backwards removal symptoms are seen in the livestock, when they suffer from grass tetany disease. It has been reported that Mg deficiency caused by grass tetany mostly derived from imbalance of mineral elements (Judson and McFarlane, 1998; Ayan et al 2010; Basaran et al 2011). Many researchers reported that grass tetany ratio (K/(Ca+Mg)) of a forage shouldn’t exceed 2.2 in livestock feeds in order to avoid risk of grass tetany disorder (Kemp and Hart, 1957; Sleper et al., 1989; Basbag et al., 2020; Tenekecier, 2021). Accordingly, the study results showed that grass tetany ratios of the *Asteraceae* family species from 1.19 to 2.84. Furthermore, grass tetany (K/(Ca+Mg)) values of *Sonchus oleraceus*, *Sylbium marianum* and *Taraxacum aleppicum* species were found to be above the critical value (2.2) of grass tetany disorder. This indicated that grass tetany risk of the species were high, when the livestock heavily fed with the forages of these three species. On the other hand, except for the three species, all of the examined *Asteraceae* family species had below the critical value (2.2) of grass tetany disease. This indicated that with lower grass tetany values, the risk of grass tetany disease was hardly absent for using forages of the species in livestock feeding.

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