Progress in Nutrition 2018; Vol. 20, N. 3: 318-322 DOI: 10.23751/pn.v20i3.6817

Original article

Determination of monthly changes in mineral content of Spiny Atraphaxis (*Atraphaxis spinosa* L.) as an alternative fodder crop

Bilal Keskin

Iğdır University, Faculty of Agriculture, Department of Field Crops, Iğdır, Turkey - E-mail: bilalkeskin66@yahoo.com

Summary. This study was conducted in 2015 with the aim of determining monthly changes in mineral content of Spiny Atraphaxis (*Atraphaxis spinosa* L.) as to growth phases. Wild plants grown spontaneously on the wind erosion site in Aralık district of Iğdır province were the subject of the study. Plant samples were collected and changes in N (Nitrogen), P (Phosphorus), K (Potassium), Ca (Calcium), Mg (Magnesium), Na (Sodium), Cu (Copper), Fe (Iron), Zn (Zinc) and Mn (Manganese) contents were determined according to months. Highest values for N, P, K, Ca, Mg, Na, Cu, Fe, Zn and Mn contents of Spiny Atraphaxis during the 7-month growth period within which this study was conducted were measured as, 1.27%, 0.98%, 1.46%, 1.17%, 0.46%, 0.19%, 2.66 ppm, 344.76 ppm, 42.46 ppm and 64.90 ppm, respectively.

Key words: *Atraphaxis spinosa* L., mineral content, growth phase

Introduction

Meadows and pastures are important sources of fodder crops in Turkey as well as in other parts of the world. There is an increasing demand for coarse fodder in Turkey in recent years due to an increasing animal population. However, meadows and pastures, which are the most important coarse fodder resources in Turkey, do not meet with this increasing demand because of decreasing productivity resulting from irregular grazing regimes, use of agricultural lands for non-agricultural purposes, mechanization of agriculture and ecological factors (1-4). Stockbreeding is an important source of income in the rural areas of Turkey. Thus, solving the problem of providing a regular supply of quality, cheap and abundant coarse fodder crops is important for a more economic and profitable conduct of stockbreeding in Turkey (5, 2).

Plants grown on pasture lands do not always have the same amount of mineral content during growth periods. High mineral contents at the beginning of the growth period of some plants decrease as the growth period progresses (6). It is reported that mineral contents of grass obtained from ravaged pasture lands which have low-yielding soils are much lower than the levels needed by ruminants (7). Species such as bushes and trees which are grown naturally in arid and semi-arid regions are important feed sources for ruminant during periods in which pasture plants grow pale and their mineral contents decline (8-10). Since quality losses occur lesser and more slowly in these species in comparison to herbaceous species, they can produce feed which has high energy and nutrient content and which is rich in vitamins and minerals (11, 12) .

During periods in which mineral contents of pasture plants are decreasing, deficiencies of nutritional elements occur in animals that are fed with these plants (13). These elements which are very important for living organisms and expressed in mg/kg and µg/kg terms are called trace elements (14). Such elements from these group as N, P, K, Ca, Mg, Na are called macro elements while Cu, Fe, Zn, Mn are called micro elements. Mineral elements have a quite important role in increasing rumen activity and enabling more effective fodder utilization in ruminants (15). Mineral substances have an important place in metabolic activities of animals, how-

ever, they cannot be synthesized within the animal body (16) and animals intake these needed minerals mostly from plants (13). Reproductive, growth, yield and immunity systems are adversely affected in case of an absence or excess of mineral substances (17, 18).

Atraphaxis spinosa (Spiny atraphaxis) is a member of *Polygonaceae* family. Approximately 30 species related to Atraphaxis genus of *Atraphaxis spinosa* are identified in Southern Europe, Southwest and Central Asia, South Siberia, Mongolia and China (19-21). *Atraphaxis spinosa* is found in the nature as scrubs; it is deciduous in winters and usually has thorns in its branches. Its fruits are either shaped trigonal or flat. It grows on sunny, arid, sandy-gravel soils and known as plants of step or desert climates (22).

The aim of this study is to determine mineral contents of Spiny Atraphaxis at different growth phases. Thus, it will be revealed whether Spiny Atraphaxis is an important feed source in the nutrition of animals, which grows well under relatively more microclimatic conditions of Iğdır province, in comparison to other provinces of Eastern Anatolia Region where continental climate is the dominant climatic system.

Material and Methods

This study was conducted to determine monthly changes in mineral content of Spiny Atraphaxis *(Atraphaxis spinosa)*. For this aim, sample materials were collected from the wind erosion site in Aralık district of Iğdır province between April 2015 and October 2015. Looking at climatic data of Iğdır province in 2015; total amount of annual precipitation is 302,4 mm, with the lowest temperature of -9,8°C recorded in January and the highest temperature of 41,4°C recorded in August 41,4 (23).

In order to determine mineral content of the plant, samples were taken totally 1 kg from the stems + leaf of the plant, imitating grazing habits of the animals. The research was established in 3 blocks according to randomized blocks trial design. Samples were taken from 5 plants in each block and a total of 15 samples were collected. Sample collection times were included as a factor of determining mineral contents of plants. In this respect, P, N, K, Ca, Mg, Na, Cu, Fe, Zn and Mn values were measured for 7 months between April and October and monthly changes in these values were recorded. Collected samples were analyzed for macro (P, K, N, Ca, Mg, Na,) micro (Cu, Fe, Zn, Mn) elements.

P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn contents of the plant samples were determined by reading in P, K, Ca, Mg, Fe, Mn, Zn, Cu, Na ICP OES spectrophotometer (Inductively Couple Plasma spectrophotometer) (Perkin-Elmer, Optima 2100 DV, ICP/OES, Shelton, CT 06484-4794, USA) (24), after samples were treated with nitric acid and hydrogen peroxide (2:3) in three steps (1st Step; 5 minutes at 75% microwave power at 145, 2nd Step; 10 minutes at 90% microwave power at 180' and 3rd Step; 10 minutes at 40% microwave power at 100) and processed at pressure tight microwave wet decomposition unit resistant to 40 bars of pressure (25).

Total nitrogen contents of the samples were determined by micro Kjheldahl method after subjecting to wet decomposition salicylic-sulphuric acid (26).

Results and Discussion

Mineral content of stem + leaf sample of *Atraphaxis spinosa* has shown differences according to sample collection times, defined in months, in the research. Changes in N, P, Na, Cu, Fe and Zn ratios were found to be very significant ($p<0.01$) while changes in K and Mn ratios were found to be significant ($p<0.05$) and changes in Ca and Mg ratios were found to be insignificant (Table 1 and Table 2). Although changes in Ca and Mg ratios were insignificant, it was observed that Ca and Mg contents of the plant were still over the level (0.1mg %) (27) required by ruminants.

Macro minerals

In the study, the effects of different growth periods on Ca and Mg content of *Atraphaxis spinosa* have been insignificant. Nitrogen (N) content was observed to change between 0.98-1.27%. The highest Nitrogen content of 1.27% was obtained in October and the lowest nitrogen content of 0.98% was recorded in August.

Phosphorus (P) content was observed to change between 0.43-0.98%. The highest P value of 0.98% was recorded in April and the lowest P value of 0.43%

was recorded in July. P content of plants varies according to phase of growth and sample collection time (12; 28). All mineral content, including that of phosphorus, of fodder crops decrease with as plants mature (29). P level must be between 0.12% and 0.48% in fodder in order to meet nutritional requirements of ruminants (30). The P levels obtained in the present study are above these values (Table 1). However, there is no possibility of occurrence of adverse effects of excess phosphorus since fodder crops in the region do not solely comprised of Spiny Atraphaxis.

Potassium (K) value varied between 1.08 and 1.46%. The highest K value was observed in May as 1.46% while the lowest K value was observed in October as 1.08%. K value is at the highest level between the months of April and August (13). It was also reported in another study that K ratio drops as fodder crops mature and reaches the lowest levels during winters (15). K level in ruminant rations must be between 0.5% and 1.0% (30). In our study K levels were observed to be over these values. However, K toxicity is not possible according to the obtained results because all values are determined below the 3% limit (31).

Sodium (Na) concentration of the samples collected in the study varied between 0.12% and 0.99%. The highest Na value was recorded in April as 0.99% and the lowest value was recorded in July as 0.12%. Recommended Na concentration in fodders must be in the range of 0.06-0.18% (30). Previous studies confirm that the most common mineral deficiency for the ruminants over the world is Na deficiency (32). Na deficiency was also reported for many different regions around the world (33). The results obtained from this study suggest that using *Atraphaxis spinosa* in feed rations may be a solution to overcome this deficiency.

Micro minerals

Copper (Cu) content of the samples varied between 0.86 and 2.66 ppm. the highest Cu content of 2.66 ppm was observed in June while the lowest content of 0.86 ppm was observed in August. Cu content of *Atraphaxis spinosa* varied significantly according to sample collection times. According to data reported by (30), Cu content of the ruminant feed must be in the range of 6-12 ppm. Cu content was found to be lower than these values in our current study. This means that Cu deficiencies may occur in case animals are grazed only with Spiny Atraphaxis. However, this is a very low possibility for the region since feed rations contain other plants.

Iron (Fe) content of the samples varied between 112.03 and 344.76 ppm. The highest Fe content was recorded in August as 344.76 ppm and the lowest value was recorded in April as 112.03 ppm. Fe content of the ruminant feed must be in the range of 30-60 ppm (30). Fe values observed in this study are much higher than the recommended limits. An abundance of Fe causes iron toxicity and this situation results in disfigurement in the bone and teeth structures of ruminants (17). Grazing of animals solely with Spiny Atraphaxis may cause iron toxicity and the ratio of this plant in the rations must be adjusted carefully.

Table.1. Macro mineral contents and F values of Spiny Atraphaxis harvested at different growth periods

Months	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)
April	1.02 c	0.98 a	1.42 a	0.90	0.33	0.99 cd
May	1.21 ab	0.66 b	1.46 a	0.86	0.32	0.80 d
June	1.02 c	0.46 c	1.44 a	1.06	0.27	0.13 b
July	1.00 c	0.43 c	1.13 b	1.03	0.41	0.12 bc
August	0.98 c	0.51 c	1.13 b	1.07	0.41	0.18 a
September	1.10 bc	0.50 c	1.15 b	1.17	0.46	0.19 a
October	1.27 a	0.51 c	1.08 b	1.06	0.35	0.13 bc
F values and significance	6.588**	25.675**	3.798*	2.308in	2.288in	2.371**

** denotes very significant F values at 1% confidence level; * denotes very significant F values at 5% confidence level; in: denotes insignificant F values.

a, b, c, and d Different letters in the same column indicate significant differences in the mineral contents between the growing periods.

Table.2 Micro mineral contents and F values of Spiny Atraphaxis harvested at different growth periods

Months	Cu (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
April	1.46 b	112.03 d	42.46 a	44.13 b
May	1.40 b	160.80 cd	33.00 bc	54.76 ab
June	2.66 a	208.73 bcd	35.76 b	47.23 b
July	2.53 a	236.53 bc	25.30 d	62.00 a
August	0.86 b	344.76 a	28.03 cd	59.43 a
September	0.93 b	280.66 ab	33.70 bc	64.90 a
October	1.53 b	193.13 bcd	32.73 bc	58.86 a
F values and significance	9.261**	5.472**	10.102**	4.653*

** denotes very significant F values at 1% confidence level; * denotes very significant F values at 5% confidence level; in: denotes insignificant F values.

a, b, c, and d Different letters in the same column indicate significant differences in the mineral contents between the growing periods.

Zinc (Zn) content of the samples collected in the study varied between 25.30 and 42.46 ppm. The highest Zn content was recorded in April as 42.46 ppm and the lowest Zn content was recorded in July as 25.30 ppm. Zn content required in feeds of ruminants varies between 7.0 and 100.0 ppm (30). Results obtained in the presents study for Zn content fall within this range.

Manganese (Mn) content varied between 44.13 and 64.90 ppm. The highest Mn content for *Atraphaxis spinosa* was recorded in September as 64.90 ppm and the lowest content was recorded in April as 44.13 ppm. Mn ratio recommended by (30) for all ruminant classes is between 18 and 36 ppm. Mn content obtained in the research was higher than the recommended values.

Conclusions

In this study conducted on Spiny Atraphaxis (*Atraphaxis spinosa*), samples were taken at different growth phases in order to determine changes in the mineral content of the plant. It was observed that sample collection times (growth phases) have affected the mineral content. The highest Nitrogen content was obtained in October and the lowest nitrogen content was recorded in August. While Phosphorus, Potassium, Sodium and Zinc contents were high at the beginning of the growth, they observed to decrease gradually through the end of the growth period. However, these contents were still over the levels required by ruminants despite this decline. Mn contents were observed to increase through the end of the growth period. Changes in Ca and Mg contents were found to be insignificant, while Na content was observed to be compatible with levels recommended in the literature. While the highest copper content was obtained in June and July, the copper content of the plant was similar in the initial stages (April and May) of development and in the late stages of development (August, September and October). Fe contents of the plant increased in comparison with the start of the growth period as the growth phases progressed, and then decreased through the end of the growth period. Cu content was found to be lower than recommended while Fe and Mn content were observed to be higher than the required level. According to the obtained results, the mineral content decreased to an extent as the plant matured. Nevertheless, Spiny Atraphaxis may be a good source of alternative feedstuff in the areas with extreme climatic and soil conditions during times when feedstuff cannot be supplied in desired amounts and quality due to paling of pasture plants and the decline in their mineral content.

References

1. Alcicek A, Kilic A, Ayhan V. Ozdogan, M., Roughage Production and Problems in Turkey. http://www.zmo.org.tr/resimler/ekler/819fb9034f79627_ek.pdf, 2003.
2. Kara N, Yuksel O. Can We Use Buckwheat as Animal Feed?. Turkish Journal of Agricultural and Natural Sciences, 2014; 1(3): 295-300.
3. Lemus R. Utilization of annual ryegrass, Forage News. Mississippi State University. Extension Service, 2009; pp: 1-5
4. Ozturk M, Guvensen A. Studies on the Halophytic Vegetation

of Saline-Alkaline Habitats in West Anatolia-Turkey, Proc. of the International Symposium on Optimum Resources Utilization in Salt-Effects Ecosystems in Arid and Semiarid Regions (eds. A.M. Hegazi et al.). 241-244, DRC, Cairo, Egypt., 2002.
5. Ayan I, Asci OO, Basaran U, Mut H. Quality Characters of Some Turnip (Brassica rapa L.) Cultivars. J. of Fac. of Agric., OMU, 2006; 21(3): 310-3.
6. Underwood EJ, Suttle NF. The Mineral Nutrition of Livestock (3rd Edition)..CAB International Publishing, Wallingford, UK. 1999,.pp. 614.
7. Abdullah M, Khan RA, Yaqoob S, Ahmad M. Mineral Profile of Browse Species Used as Feed by Grazing Livestock in Cholistan Rangelands. Pakistan. Pak. J. Nutr., 2013; 12(2): 135-143.
8. Dokulgen H, Temel S. Seasonal Nutrient Content Changes of Leaf and Leaf + Shoots in Deciduous Christ's thorn (Palirus spina-christi Mill.). Iğdır Univ. J. Inst. Sci. and Tech. 2015; 5(3): 57-65.
9. Tan M, Temel S. Alternative Feed Crops. Ataturk University Agricultural Faculty Course Publications No: 246, 2012; pp 195-207.
10. Temel S, Tan M. Fodder Values of Shrub Species in Maquis in Different Altitudes and Slope Aspects. J. Anim. Plant Sci., 2011; 21(3): 508-12.
11. Ahmad K, Ashraf M, Khan ZI, Valeem RE. Evaluation of Macro-Mineral Concentrations of Forages in Relation to Ruminants Requirements: A Case Study in Soone Valley, Punjab. Pakistan. Pak. J. Bot, 2008; 40(1): 295-9.
12. Ghazanfar S, Latif A, Mirza IH, Nadeem MA. Maro-Minerals Concentrations of Major Fodder Tree Leaves and Shrubs of District Chakwal, Pakistan. Pak. J. Nutr, 2011; 10(5): 480-4.
13. Gokkus A, Parlar AO, Baytekin H, Hakyemez BH. Change of Mineral Composition of Herbaceous Species at the Mediterranean Shrublands. Journal of Tekirdag Agricultural Faculty (JOTAF). 2013; 10 (1): 1-10.
14. Forstner U, Wittmann GTW. Metal Pollution in the Aquatic Environment. Springer-Verlag, Berlin, Heidelberg, New York, Tokyo, 1983.
15. Spears JW. Minerals in Forages. In: Fahey, G.C.J., Moser, L.E., Martens, D.R. and Collins, M., Eds., Forage Quality, Evaluation, and Utilization. ASA. CSSA. SSSA. Madison, 1994; pp. 281-317.
16. Kutlu HR, Gorgulu M, Celik LB. General Animal Feeding Lecture Notes, ZM-208. Çukurova University, Faculty of Agriculture, Department of Animal Science, Feeds and Animal Feeding , Adana, 2005; pp:69-84.
17. Altintas A. Mineral Materials. Disability-Overdose Diseases. Ankara University Lecture Notes on Biochemistry Department. 2013; pp.15-16.
18. McDowell LR. Minerals in Animals and Human Nutrition, Department of Animal Science, University of Florida, Gainesille, Academic Press San Diego New York, USA, 1992.
19. Borodina AE. Polygonaceae. In: Borodina, A.E., Grubov, V.I., Grudzinskaja, I.A. and Menitsky, J.L. (Eds.) Plantae Asiae Centralis. vol. 9. Nauka, Leningrad, 1989; pp. 77–129. (in Russian).
20. Lovelius OL. Synopsis generic Atraphaxis L. (Polygonaceae). Novitates systematicae plantarum vascularium. Novosti Sist. Vyssh. Rast., 1979; 15: 127.
21. Pavlov NV. Atraphaxis L. In: Komarov VL (ed) Flora URSS. URSS Acad. Sci. Publ. Moscow, Leningrad. 5: 501-527(in Russian), 1936.
22. Guven M. Some Important Tree and Shrub Forms in Use of Wastershed Improvement in Eastern Anatolis Region. Journal of Eastern Anatolia Forestry Research Institute Erzurum-Turkey, 1997; 1: 28-40.
23. Anonymous. Iğdır Meteorology Provincial Directorate Data, 2015.
24. Mertens D. AOAC Official Method 975.03. In: Horwitz, W., Latimer, G.W. (Eds) Metal in Plants and Pet Foods. Official Methods of Analysis, 18th ed. AOAC-International Suite, Gaitherburg, Maryland USA, Chapter 3), 2005a; pp. 3-4.
25. Mertens D. AOAC Official Method 922.02. In: Horwitz, W., Latimer, G.W. (Eds.) Plants Preparation of Laboratuary Sample. Official Methods of Analysis, 18th ed. AOAC-International Suite Gaitherburg, Maryland USA, 2005b; pp 1-2.
26. AOAC (Association of Official Analytical Chemistry). Official Methods of Ana-lysis of AOAC International, 18th ed. Association of Official Analytical Chemists, Washington DC, 2005, USA.
27. Anonymous. Nutrient requirements of beef cattle. N.A.S. Washington D.C. 55 p, 1971.
28. Minson DJ. Forages in Ruminant Nutrition. Academic Press Inc. , San Diego, California, USA, 1990; pp. 230.
29. McDowell LR. Geographical distribution of nutritional diseases in animals. Department of Animal Science, University of Florida, Gainesille. Academic Press San Diego New York, USA, 1977.
30. NRC. Nutrient requirements of domestic animals. Nutrient Requirements of Beef Cattle. 6th edition. National Academy of Sciennces, Washington, DC. USA, 1985.
31. NRC. Nutrient Requirements of Dairy Cattle. Ed., National AcademyPress, National Research Council, Washington, DC.USA, 1980.
32. McDowell LR, Conrad JH, Hembry FG. Minerals for Grazing Ruminants in Tropical Regions. Animal Science Department, Center for Tropical Agriculture, University of Florida, 1993.
33. Pastrana R, McDowell LR, Conrad JH, Wilkinson NS. Mineral status of sheep in the Paramo region of Colombia II. Trace Minerals. Small Ruminant Research, 1991; 5 (1-2): 23-34

Correspondence:
Bilal Keskin
Iğdır University, Faculty of Agriculture,
Department of Field Crops, Iğdır, Turkey
E-mail: bilalkeskin66@yahoo.com