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Protein Contents and Metal Composition of Some Feed Crops from Turkey

HARUN CIFTCI*[1], EYUP BAGCI[2]
[1]University of Ahi Evran Science-Art Faculty Department of Chemistry Kırsehir-Turkey
[2]University of Firat Science-Art Faculty Department of Biology Plant Products and Biotechnology Res. Lab.Elazig-Turkey

Corresponding author, E mail: haruncifteci@yahoo.com,
Tel: +90 386 211 4552, Fax: +90 386 211 4525

Abstract: In this study, trace elements and protein contents of some feed crops (*Medicago* sp.) from Turkey were investigated. Inductively coupled plasma-optical emission spectrometry (ICP-OES) technique was used to determine elemental concentrations of major and trace elements in *Medicago sativa* L., *M. minima* (L.) var *minima, M. rotata* Boiss. var. *eliezeri, M. rigidula* (L.) var. *rigidula* and *Melilotus alba* Desr. (Fabaceae) species. This feed crops samples were digested by microwave system and analyzed. Nine elements (Cu, Mn, Cr, Ni, Zn, Fe, Mg, Al and Pb) were detected. Protein contents were determined between 18.40-45.54 percentage in the seed. The results showed that *M. minima* var. *minima's* seeds are a good source of essential and beneficial micronutrients required for healthy growth
Key words: Feed crops, Medicago, Fabaceae, Trace elements, Protein, ICP-OES

Introduction

There is an increasing awareness of the need to pay greater attention to the role of trace elements in plant and animal nutrition as we seek to explain the adverse effects of deficiencies and toxicities, and avoid suboptimal concentrations that limit the attainment of optimum economic yields of crops and animal productivity and welfare. The term trace element is useful but imprecise because it can refer to any element in the soil-plant-animal system regardless of its role [1].

The possible role of forage legumes in modern livestock production is being reconsidered [2]. Greater use of these species in pastures provides economic and agronomic benefits to agropastoral systems [3]. Biological nitrogen fixation by legumes results in high protein herbage and improved nutrient balance of the sward [4]. Legume - based pastures may increase the self provision of the protein sources, the feeding value of forages and sustainability of grazing systems [5].

The Fabaceae is a more important family of food plants, especially pulses (beans, gram, peas) and oil (soybean, ground nut), but also tanbarks, timber, copal, gums, insecticides and cultivated ornamentals, as well as medicinal plants [6].

The seed development and composition of *Medicago truncatula* Gaertn. was studied using nine genotypes of the specific complex, *M. truncatula – M. littoralis* (*M. truncatula*) [7]. *Medicago sativa* was announced as father of food in ancient time by arabic. Proteins represented the major class of storage compounds and their average amino acid composition was found to be very close to that of pea and robust in various environmental conditions.

The problems of industrial waste are becoming harder to solve, and much effort will be needed to develop the nutritional and industrial potential of by –products, waste and under –utilized agricultural products. Only a small portion of plant material is utilized directly for human consumption [8]. There is an increasing awareness of the need to pay greater attention to the role of trace elements in plant and animal nutrition. The term trace element is useful but imprecise because it can refer to any element in the soil-plant-animal system regardless of its role [1].

The objective of the present study was to determine the trace elements and protein contents of some seed crops Lucerne (*Medicago sativa* L.), *M. minima* (L.) var *minima, M. rotata* Boiss. var. *eliezeri, M. rigidula* (L.) var. *rigidula, Melilotus alba* Desr.). In addition during the course of this study, it is aimed to establish the nutritional value and to do contributions as the renewable resources of proteins and other chemical patterns in these crops.

Experimental

Seed samples

In this research, following plant seeds from Fabaceae family (*Medicago sativa* L., *M. minima* (L.) var. *minima, M. rotata* Boiss. var. *eliezeri, M. rigidula* (L.) var. *rigidula, Melilotus alba* Desr.*)* were collected from natural habitats in Eastern Anatolian region of Turkey in 2007-2008 years.

Determination of protein contents and metals

Seed samples were cleaned and protein content were analysed acoording to the method AOAC [9]. Seeds sample were also analysed for metal determination. For this purpose, They have digested by domestic microwave oven (Premier). 2.0 portion of each sample dried at 80°C was accurately and 0.50 g directly weighted into PTFE bombs. For the samples decomposition concentrated 4 mL HNO_3 (%65 w, Merck, Darmstadt), and 1 mL $HClO_4$ (%60 Merck, Darmstadt) acid were added. In a tightly closed system, the following six-step microwave digestion program was applied according to literature [10, 11]. PTFE bomb was waited for an hour to cool and was carefully opened. Colorless solution was transferred into beaker and evaporating to dryness with hot plate. Afterwards final volume was diluted 10 mL with 0,1M HNO_3. The blank digests were carried out in the same way. Stock standard solutions of the metals (1000 mg L^{-1}) were supplied by Merck. Sample solutions were analyzed with method of direct calibration curve by ICP-OES. The samples were analyzed in triplicate.

Results and Discussion

In this study, the total protein amount and trace elements of some feed crops from Turkey were determined. The results of the amounts of total protein and trace elements are shown in Table 1. All data are the results of average of three measurements on each sample. The levels of metals were calculated on dry weight ($\mu g.g^{-1}$). Nine elements (Cu, Mn, Cr, Ni, Zn, Fe, Mg, Al and Pb) were detected in the crop seed.

Total protein amounts of feed crops studied were found between 18.40-45.54 percentage in *Medicago sativa* and *M. minima* var. *minima.* The others has 44.67, 44.84 and 38.40 percentage respectively in *M. rigidula* var. *rigidula, M. rotata* var. *eliezeri* and *Melilotus. alba* respectively. The protein contents of some legumes from Turkey were reported as; 20.09, 21.2, 25.4, 28.6, 26.1 in *Vicia ervilia, Lotus corniculatus, Onobrichys fallax, Trifolium aureum* and *T. repens* respectively [12], Proteins were found to be the main storage material in mature *M. truncatula* seeds, representing 30-40% of the seed [7].

The protein content concentrations of the seeds of legumes studied, suggest that they can contribute to the daily protein need of 23.6 g/100 for adults as recommended by the National Research Council [13]. Proteins represent the major storage compound, a common trait of most legume seeds. Their relative amino acid composition was found very close to that of pea seeds [7].

Ukhun and Ifebigh [14] reported that, compared with other plant foods and exclusive of the legumes, the 15% protein content of the *Cassia alata* seeds is high. However, compared with other legumes [15] its protein content is somewhat low.

Among the metals analysed; the magnesium contents of feed crops were found to be higher than other metals, ranging from 291 $\mu g.g^{-1}$ for *Melilotus alba* Desr, 335.8 $\mu g.g^{-1}$ for *M. rigidula* var. *rigidula*, 737.5 $\mu g.g^{-1}$ for *Medicago sativa*, 750 $\mu g.g^{-1}$ for *M. minima* var. *minima*, and 766.7 $\mu g.g^{-1}$ for *M. rotata* var. *eliezeri*. It is reported that it arrives at 258.2, 476.7, 593.5, 650.6, 793.2 amounts in *Vicia ervilia, Lotus corniculatus, Onobrichys fallax, Trifolium aureum* and *T. repens* respectively [12]. The magnesium is a critical structural component of the chlorophyll molecule and is necessary for functioning of plant enzymes to produce carbohydrates, sugars and fats.

The contens of iron was found range of 51.60 and 372.8 $\mu g.g^{-1}$ in feed samples studied (Table 1). The amount of the iron in seeds of *Vicia ervilia, Lotus corniculatus, Onobrichys fallax, Trifolium aureum* and *T. repens* were reported as 34.40, 91.37, 136.88, 68.67, 518.91 respectively [12]. Iron is necessary for many enzyme functions and as a catalyst for the synthesis of chlorophyll.

Manganese is involved in enzyme activity for photosynthesis, respiration, and nitrogen metabolism [16,17]. The highest manganese level was obtained as 21 $\mu g.g^{-1}$ in *M. minima* (L.) var. *minima,* whereas the lowest manganese content was found in *M. rotata* Boiss. var. *eliezeri* and *M. rigidula* (L.) var. *rigidula* (10.17 and 10.44 $\mu g.g^{-1}$). The zinc content of samples was in the range of 33.67 and 54.48 18.97 $\mu g.g^{-1}$, whereas the copper content of feed crops were in the range of 4.93 and 14.59 $\mu g.g^{-1}$. The contents of other metals in the crop seed were determined as Cr: 0.91-5.54; Ni: 2.83-5.02; Al: 10.38-15.50 and Pb: 1.39-5.46 $\mu g\ g^{-1}$ (Table 1). Zinc is a component of enzymes or a functional cofactor of a large number of enzymes including auxins (plant growth hormones). It is essential to carbohydrate metabolism, protein synthesis and internodal elongation [18].

Plants grown without additional nickel will gradually reach a deficient level at about the time they mature and begin reproductive growth. If nickel is deficient plants may fail to produce viable seeds. The high quantity of potassium, magnesium and calcium together with the quantity of sodium plus the content of the essential elements iron, manganese, zinc and copper allow the seeds to be considered as excellent sources of bioelements [19]. It is recommended that these seeds be used in the preparation of diets of individuals with low levels of these mineral elements. As shown in the table 1, *M. minima* (L.) var. *minima* is a good source of trace element and protein.

According to our results, Fe, Mg and Zn contents were high in all studied feed crops. Ni, Cr, and Pb contents of same samples were low. In addition, Mn, Cu

and Al elements were found in a similar range for all of feed samples. Nickel has just recently won the status as an essential trace element for plants. It is also required for iron absorption and seeds need nickel in order to germinate. Copper is also concentrated in roots of plants and plays a part in nitrogen metabolism [20].

In the *Cassia alata* seeds (Fabaceae) has Ca, Mg, Na, Mn and Zn elements as 17, 14.4, 13,3 and 3.8% (mg/100g, wet wt basis) respectively [14]. Three underutilized legumes from Nigeria, the seeds of *Brachystegia eurycoma, Tamarindus indica, Mucuna flagellipes* (Fabaceae) from Nigeria has 11.82, 24.28 and 24.94 g/100g.(dry matter) protein amount respectively. A value within the range 8.40g -14.8g /100g dry matter reported for cereal seeds, such as corn, triticale and wheat [21] and also it is higher than the protein contents in seeds of important legumes, 18.0, 25.0g/100g [22]. These are close to the seed contents of underutilized legumes such as *Ganavaila ensiforms*, 26g/100g. dry matter [23].

Legumes occupy an important place in human nutrition and also animal nutrition. Legumes are rich in proteins and complex carbohydrates and are important source of minerals and vitamins [24]. Therefore it is important to study the chemical composition of these plants from differnt region of the world. The ratios of the chemicals might be difference among the origin of the plants according to the geographical origin, ecological conditions and genetical factors. Grain legumes are potential sources of energy and micronutrients but their use is still limited because of certainty about the amount and the effect of any anti nutritional factors they may contain [25].

In the Demir et al. [26] study, the protein levels of *Medicago noeana, Medicago orbicularis, Medicago polymorpha var.vulgaris, Medicago rigidula* var.*submitis* and *Medicago rigidula* var. *rigidula* were determined which belong to fruit, leaf and steam. According to deats, the protein levels studied were found between 20% and 30%. The protein levels of fruits were found higher than leaf and steam in samples compared with each other. The other hand, the protein contents of fruit of *Medicago noeana, Medicago orbicularis, Medicago polymorpha* var.*vulgaris* were found the higher than fruits of other species.

It is obvious, assuming high in vivo bioavailability, even if only partially, to the overall daily dietary intakes of the elements. The intake of the minerals may be related to the soil type in which the legume plant was found growing and / or to the efficiency of uptake from the soil by legume plants as described in this study.

Table 1. Total Protein and Trace Elements Amounts of Some Feed Crops from Turkey

Plants	Total protein (%)	Mg	Mn	Cr	Ni	Zn	Fe	Cu	Al	Pb
Medicago sativa L.	35.21	737.5±45.7	12.89±0.58	4.06±0.20	5.02±0.16	33.67±1.96	213.7±12.6	14.59±0.62	15.50±0.95	5.46±0.36
M. minima (L.) var. *minima*	45.54	750.0±38.6	21.0±0.96	5.54±0.18	4.35±0.25	42.20±2.75	372.8±18.2	8.30±0.42	12.39±0.65	1.52±0.08
M. rotata Boiss. var. *eliezeri*	44.84	766.7±44.5	10.17±0.55	1.87±0.10	2.83±0.16	54.48±2.46	78.22±4.20	12.12±0.54	15.18±0.82	2.51±0.11
M. rigidula (L.) var. *rigidula*	44.67	335.8±21.4	10.44±0.48	0.91±0.08	3.39±0.09	54.02±3.15	51.60±2.87	11.05±0.52	13.14±0.68	1.39±0.06
Melilotus alba Desr..	18.40	291.0±14.7	17.04±0.84	1.32±0.08	3.16±0.14	43.21±2.47	62.14±3.51	4.93±0.18	10.38±0.56	2.43±0.14

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