Mineral and Protein Screening of Some Wild Legumes of Dilling area (South Kordofan State, Sudan)

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مسح للعناصر المعدينة والبروتينات في بعض النباتات البقلية بمنطقة الدلنج (جنوب كردفان – السودان)

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المستخلص

تم عمل مسح للمعادن الموجودة بأوراق سبعة نباتات بقلية برية وهي :
نبات العرديب ،نبات الكول ،نبات سمسم الدبيب،نبات اللوبيا البيضاء ونبات الصغيرة .
أوراق هذه النباتات ذات محتوى عال من البروتينات يتراح مداه بين21.6% للوبيا البيضاء و17.3% لسم الدبيب.العناصر المعدنية التي وجدت بكميات مقدرة هي الكالسيوم،الماغنزيوم،البوتاسيوم،الفوسفور ، الكبريت ،والحديد.محتوى الأوراق من المانجنيز كان منخفضاً جداً حيث يتراوح مداه بين 0.01% لسم الدبيب إلى 0.03% للعرديب والشباهى والصفيرة .أوضحت نتائج التحليل الكيميائي أن هذه الأنواع النباتية ذات مستويات مختلفة من العناصر المعدنية والبروتين الخام.

الكلمات المفتاحية: بقوليات برية ،عناصر معدنية.

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Abstract:

Mineral screening was carried out on leaves of seven wild leguminous plants namely: *Tamarindus indica, Albizzia amara, Acacia laeta, Senna obtusifolia, Senna occidentalis, Phaseolus adenanthus and Crotalaria saltiana.* The leaves have high protein content which ranges between 21.6% for *Phaseolus adenanthus* and 17.3% for *Senna occidentalis.* Mineral elements detected in appreciable quantities were Calcium, Magnesium, Potassium, Phosphorus, Sulfur and Iron. Manganese contents were very low and they range between 0.01% for *Senna occidentalis* and 0.03%for *Tamarindus indica, Acacia laeta* and *Crotalaria saltiana.* Analysis showed that these species had different levels of mineral and crude protein.

Key words: Wild legumes, Mineral elements.

1- Introduction:-

Legumes are one of the largest order of the flowering plants with some 690 genera and about 18,000species of herbs, climbers and trees (Hutchinson, 1964). Legumes are probably the second most important crops after cereals. It is an order which resolves itself according to structure of the flower into three families: *Caesalpiniaceae, Mimosaceae* and *Fabaceae* (Syn. *Paplionaceae*). The first two families are mainly tropical and are of little agricultural value while the *Paplionaceae*, which is the largest of the families with about 12,000 species, is widely distributed in both tropical and temperate regions and provide a large number of crop plants. *Leguminosae* is a very common and easily recognizable family. Leaves usually alternate and compound, pinnate or trifoliate. Flowers mostly hermaphrodite and usually with 5sepals and 5 petals. Ovary is superior with a single carpel. Fruit is a pod and is usually legume. The value of legumes in improving and sustaining soil fertility has been known since ancient times. At the end of 19^{th} century it was found that legumes had added nitrogen to the soil and that the way in which this occurred had been reported (Williams, 1967). Many species of legumes have nodules, on their roots, containing bacteria which have the power of fixing atmospheric nitrogen, some of which can be available to the host plant. In return, the bacteria are supplied with carbohydrates by the host. This mutual benefit is known as symbiosis, a phenomenon which made legumes of great importance in agriculture (Purseglove, 1982). Legumes also provide protein-rich food for man and his stock. They also play an important role in crop rotation and they are used in mixture with grasses in leys and pastures. They are also used as cover crops and green manures.

Dirar (1984) reported that *Cassia obtusifolia* leaves are among the richest plant materials with respect to nutrients for human diet. He added that the leaves of this plant have the highest phosphorus content. Duke (1981) reported that the leaves of *Cassia obtusifoli* have the highest calcium and riboflavin among 30 legumes. He added that the leaves of this plant rank second in iron and beta-carotene and third with respect to ash and ascorbic acid.

Dirar et al (1985) reported avalue of 24-3% protein for the *Cassia obtusifolia*. Pirie (1983) reported arrange of 20-30% crude protein for plant leaves in general.

Sharma et al (1996) studied the mineral and protein composition of wild legumes including *Tamarindus indica*. He concluded that the seeds had a high crude protein content ranging from 21-1% to 47-7%. They added that the mineral elements detected in appreciable amounts were Ca, Mg, K, Fe, Cu, Zn, P, and Na.

Plant distribution in relation to mineral nutrients in the soil was studied by many researchers. Mclender and Redente (1991) studied the effect of increased nitrogen and phosphorus levels on plant species in arid zones and found a close correlation between these soil element and distribution of plant species. Hayati & Proctor (1990) found a close correlation between the distribution of soil Ca, Mg & pH and the distribution of the investigated plant species. Yahia (1992) reported a high correlation between the distribution of some wild plant species of semi-arid zones and the availability of mineral nutrients in the soil.

This study aims to:

1/ study the mineral and crude protein composition of the soils of Dilling area.

2/ study the distribution of leguminous plant species in Dilling area.

3/study the correlation between soil minerals and crude protein and the distribution of the leguminous plant species in the study area.

2- Material and Methods:-

Seven leguminous species were selected for determining nutrients and crude protein. These were characterized by broad range of distribution and utilization in the study area. The species of family *Caesalpiniaceae* were:

Tamarindus indica, Senna obtusifolia and *S.occidentalis*. The species of family *Papilionaceae* were: *Crotalaria saltiana* and *Phaseolus adenanthus*. The species of family *Mimosaceae* were: *Albizzia amara* and *Acacia mellifera*. The plant samples were oven- dried at $45C^0$ for several hours until the samples were dry enough for grinding. The samples were ground and homogenized for elemental chemical analysis. Organic matter was digested by the use of an acid digestion solution composed of 60% percholoric acid ($HCLO_4$), concentrated nitric acid (conc. HNO_3) and concentrated Sulphuric acid (conc. H_2SO_4). The digestion solution was prepared as follows:

1ml of 60% $HCLO_4$ was added to 5 ml of conc. HNO_3 and 0.5 ml of conc. H_2SO_4. The mixture was cooled and digestion was done as follows:

2mls of the digestion mixture were added to 0.25g of the dry ground plant sample in a digestion tube. The plant material was digested at

60C^0. The temperature was then increased to 100C^0 and the digestion continued until a colorless solution was obtained. The digestion mixture was then cooled and completed to 10ml.

The atomic absorption was used for determining the elements K, Ca, Mg, Mn, Fe, S and O.N. for both soils and plants while the visible spectrophotometer (Hach 2000) was used for determining P. Stock solution standard (primary standard) and range of working standard (range of secondary standard) were prepared as follows (Table 1) :

Table (1): Stock solutions and working standards used for elemental analysis in Plants.

Element	Preparation of stock solution	working standards
Ca	1000mg Ca was prepared by dissolving 2.4973g of dry CaCO3 in 200ml water containing 5ml conc. HCl The solution was heated to drive off CO_2, cooled and diluted to one litre	0.0-100mg L–
K	100mg K stock solution was prepared by dissolving 1.9068g of dry KCl in a litre of deionized water.	0.0-100mgK L^-
Mg	100g Mg solution was prepared by dissolving 1.0136g $MgSO_4.7H_2O$ in water containing 1ml H_2SO_4 and then diluted to one litre.	0.0-3mgMg L-
Mn	100mg Mn solution was prepared by dissolving 0.406g $MnSO_4.4H_2O$ in water containing one ml conc. H_2SO_4 and then diluted to one litre.	0.0-3mgMn L^-
Fe	100mg Fe solution was prepared by dissolving 0.1gFe in one ml of H_2SO_4 (10%). The solution was warmed, cooled and diluted to one litre	0.0-20mg Fe L^-
S	100mg S solution was prepared by dissolving 0.3844g of $MgS0_4.7H_2O$ in water and diluted to a litre.	0.0-0.4mgSL-
N	200mg N prepared by dissolving 0.764g dry NH_4Cl in water and diluted to one litre	0.0-40mgNL-

The procedures used for determining Ca, K, Mg, Mn, S and O.N. were as follows:
P was determined by the molybdenum blue method using a visible spectrophotometer (Hach 2000).
The absorbance was measured at 200nm using (Hach 2000). A calibration curve from the standards was drawn and used to determine P in the sample aliquot.
Crude protein determination:
Crude protein was determined for the seven investigated plant species according to A.O.A.C.(1984), using a micro-Kjeldahl method The total organic nitrogen was determined and then multiplied by a factor (6.25) to determine the total crude protein.

3- Results and Discussion

3.1. Results

3.1.1. Soil Chemical Analysis

Fandama (2004) reported three soil types in Dilling area, namely: inceptisols, alfisols (gardud). and vertisols (Table 2).

Table(2): Particle size analysis of Dilling soils.

Particle fraction %				
Description	Depth(cm)	Clay	Silt	Sand
Incepttisols	0-30	40	25	33
	31-60	41	37	21
	61-	33	42	23
Alfisols	0-30	12	20	68
	31-60	33	18	49
	61-	36	23	41
Virtisols	0-30	50	12	38
	31-60	51	16	33
	61-90	22	28	50

The values of pH and extractable ions of the three soil types have been presented in Table(3). It can be seen that the vertisols and inceptisols soils were richer in alkaline earth element (Ca,Mg,K) than the alfisols and so they are alkaline in nature while the alfisols soil is acidic . The alkalinity may be attributed to the high Ca:Mg ratio, since there is a high concentration of Ca due to the presence of Ca:Mg ratio has also resulted in a high ph value (8.3-8.5) in the two soil types . This agrees with

(Thompson and Torne,1978). The reverse is true for the alfisols soils where their pH is low (6.8).
The distribution of P was in the following descending order : inceptisols vertisols and alfisols . S level were or less similar in the three soil types.
The levels of O.N. was in the following descending order : vertisols , inceptisols .The high levels of O.N. in the vertisols and inceptisols soils had been found by Allen (1989).
The data of chemical soil analysis for each of the three soil types has been statistically analysed using the principal component analysis (PCA).

Table (3) : pH and extractable ions (mg/100g) of the three soil types.

Elements / Soil types	Ca	Mg	K	Fe	Mn	P	S	O.N.	pH
Vertisols D1	800.39	34.05	62.07	0.35	0.3	3.4	0.11	2.8	8.39
D2	800	38.01	64.5	0.3	0.28	2.8	0.1	2.6	8.39
D3	780.02	32.03	63.01	0.28	0.3	2.6	0.09	2.4	8.61
Inceptispls D1	780.2	36.23	66.14	0.36	0.45	3.6	0.12	1.8	8.25
D2	780	34.09	68.36	0.3	0.4	3.1	0.08	2.4	8.37
D3	740.17	36.01	67.41	0.3	0.42	2.4	0.09	2.2	8.16
Alfisols D1	420.01	28.21	34.93	0.86	0.36	0.8	0.12	1.6	7.01
D2	400.12	3003	37.88	0.86	0.3	1.6	0.12	0.86	6.71
D3	380.12	28.06	37.01	0.84	0.28	1.3	0.1	0.82	6.92

D =Depth ,O.N = Organic nitrogen

3.1.2. Chemical analysis of plant material

Leaf samples of the investigated plant species were analysed for crude protein and certain elements(Table 4).

Table (4): Percentage of crude protein and certain elements of some legumes in the study area :

Elements / Plant species	Ca	Mg	K	Fe	Mn	P	S	C.P
Phaseolus adenanthus	0.63	0.28	0.38	0.08	0.02	0.12	0.05	21.6

Tamarindus indica	0.68	0.38	0.81	0.07	0.03	0.14	0.05	18.3
Acacia laeta	0.8	0.36	0.72	0.05	0.03	0.1	0.05	18.8
Senna obtusifolia	0.38	0.18	0.34	0.03	0.02	0.1	0.08	20.6
Crotalaria saltiana	0.28	0.16	0.36	0.04	0.03	0.1	0.06	18.4
Senna occidentalis	0.28	0.18	0.32	0.03	0.015	0.08	0.04	17.3
Albizzia amara	0.65	0.3	0.68	0.05	0.034	0.08	0.04	19.1

C.P= crude protein

Table (4) showed different averages among the investigated plant species. In general, *Acacia laeta* showed high levels of Ca uptake; *Phaseolus adenanthus, Tamarindus indica* and *Albizzia amara* showed intermediate levels whereas *Senna obtusifolia, S. occidentalis* and *Crotalaria saltiana* showed the lowest levels.

Tamarindus indica, Acacia laeta and *Albizzia amara* showed high levels of Mg uptake; *Phaseolus adenanthus* showed intermediate levels while *Senna obtusifolia, S. occidentalis* and *Crotalaria saltiana* showed the lowest levels. *Tamarindus indica* showed high level of K uptake while *Senna occidentalis, S. obtusifolia, Crotalaria saltiana* and *Phaseolus adenanthus* showed the lowest levels.

Phaseolus adenanthus showed high levels of Fe uptake and *Albizzia amara* showed high levels of Mn uptake.

All of the seven species were more or less similar in the levels of the S and P uptake. As for crude protein, *Phaseolus adenanthus* showed the highest levels followed by *Senna obtusifolia* and *Albizzia amara. Tamarindus indica, Acacia laeta* and *Crotalaria saltiana* had more or less similar levels of crude protein whereas *Senna occidentalis* showed the lowest levels of all of the seven investigated plants species.

3.1.3. Correlation between soil and plant nutrients

Correlation coefficients between extractable ions and soil pH on one hand and the mineral nutrients of the leaves of the collected plans have been calculated. A summary of these correlation studies have been made for each soil type (Tables 5, 6 and 7).

Table (5) :Summary of the significant correlations between soil and plant elements in the vertisols soils

Acacia melifera		Mn**	S*					
Phaseolus adenanthus	Fe*							

	P*							
Senna occidentalis			K*					
			Mg*					
			Mn**					
Senna obustifolia							Ca*	Ca*
								P*
								S**
								O.N*
Crotalaria saltiana			Ca**			P*		
			Mg**			Fe*		
			Mn*			O.N*		
			pH**					
Albizzia amara								
Tamarindus indica	Ca*							Mg*
								pH*

P*=significant < 0.05 ; P**= significant < 0.01 .

Table (6): Summary of the significant correlations between plant and soil elements in the inceptisols soils:

Elements plant species	Ca	Mg	k	Fe	Mn	P	S	O.N.
Acacia mellifera								
Phaseolus adenanthus	Fe*							
Senna occidentalis			pH*					
Senna obtusifolia							Ca*	Ca*
								P**

Crotalaria saltiana	Mg**		Mg**			Fe*		
			Ca**					
			pH***					
Albizza amara								
Tamarindus indica								pH*

P*=significant < 0.05; P**significant < 0.01; P***significant < 0.000 .

Table (7) : Summary of the significant correlations between soil and plant elements in the Alfisols soil :

Elements / Plant species	Ca	Mg	K	Fe	Mn	P	S	O.N.
Acacia mellifera			K*					
Phaseolus adenanthus	pH**			K**				
	O.N.*							
Senna occidentalis								
Senna obtusifola							Fe*	Ca*
							S*	S**
								Mn*
								Fe**
Crotalaria saltiana			Mg**			Mn*		
			Fe**			Ca*		
			S**					
Albizzia amara					Fe*			
					S*			
Tamarindus indica	Mg**		K**					Mg*

	K*							

3.2. Discussion:-

3.2.1. Macronutrients:

a- Calcium (Ca)

Nearly all of the investigated plant species showed high levels of Ca compared to other macronutrients. This may be due to the presence of high Ca concentration in the soil which is needed for the synthesis of pectin in the middle lamella of plant cell walls.This finding agrees with Carson (1990). Calcium is also responsible for membrane permeability and maintenance of cell integrity. It is also involved in the vital processes of metabolism and the formation of nucleus and mitochondria (Bidwell, 1979). Moreover, Ca plays an important role in the uptake of cations in general (Black, 1968).

b- Potassium (K)

Most of the investigated plant species showed high levels of K uptake. This may be attributed to the high K concentration in plant cells which is needed for biochemical functions such as enzymes activation, protein synthesis and energy metabolism (Allen, 1989; Goldberg and Miller,1990). Potassium also plays two indirect roles related to photosynthesis namely: stomatal opening and promotion of photosynthates from leaves to other tissues of plants (Neales and Incoll, 1968).

c- Magnesium (Mg)

All of the investigated plant species showed normal ranges of Mg levels uptake (0.1-0.5%). This is expected because Mg is the structural component of the chlorophyll pigment that activates many enzyme systems and it is involved in ATP-dependent reactions (Clarkson and Harson, 1986; Hayati and Proctor, 1990).

d- Phosphorus (P)

All of investigated plant species had shown normal ranges of P uptake (0.05-0.3%). This agrees with the findings of Mclender and Redente (1991). Phosphorus has both structural and metabolic functions (Daniel et al, 1990). Organic phosphorus is a constituent of nucleic acids, certain esters and lipids. Inorganic phosphorus has a key role in metabolism (Allen, 1989).

e- Sulfur (S)

Six of the investigated plant species showed low ranges (0.04-0.06) of S uptake. This may be due to the fact that the element is not so vital to plant metabolism.This finding disagrees with Deboer and Duke (1982) who reported that sulfur deficiency depresses nitrogenous activity in root nodules .

3.2.2. Micronutrients:

Iron (Fe) and Manganese (Mn)

The seven investigated plant species had low levels of Fe and Mn uptake. This is because of all micronutrients, only a few micrograms per gram (ug\g) are needed by plant species.This finding agrees with Hettiarachi et al (2002).

3.2.3. Crude protein:

All of the investigated plant species showed different ranges of crude protein. This may be due to the different levels of organic nitrogen uptake by plant species.These results are supported by many studies (Duke, 1981; Pirie,1983; Dirar et al,1985; Sharma et al,1996).

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