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SPECTROSCOPIC INVESTIGATION OF METAL LEVEL (K, Ca, Mg, Na AND Ni) IN CACTUS PLANT IN AROUND ADIGRAT TOWN

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ABSTRACT

Cactus is the most important succulent plant which grows in warm climate with enormous nutrient. It is widely used in medicinal and food staff in this world. It also used as coagulant in treatment of hard and polluted water. This plant has the capability to absorb different metal ions from soil that are required in small amount for the development of the plants and animals as well as human health. But, too low or too high concentration of metal ions in plant can affect the quality of plant products, enzymatic activities of both plants and animals. Therefore, the assessment of metal levels in this plant is too vital regarding to human health, drugs quality and their chemotherapeutic activities. Therefore, this study is designed to determine the metal level (K, Ca, Mg, Na and Ni) In Cactus Plant using Flame Atomic Absorption Spectrometr and flame photomere. The result reveals that cactus sample contains the metal levels in the order of: K (23.88 mg/ Kg), Ca (17.440mg/Kg), (Mg 7.890 mg/Kg), Na (2.335 mg/Kg) and Ni (2.033 mg/Kg).Hence, the highest amount of K (23.88 mg/ Kg) is obtained among the analyzed metals.

KEY WORDS: cactus, FAAS (Flame Atomic Absorption Spectrometr), metal ion.

INTRODUCTION

Cactus is succulent plant that grows in warm climate mainly tropical and subtropical countries such as Egypt, India, Mexico, South Africa, Nigeria and Ethiopia [1, 2]. It has a fatty green leaves with enormous nutrient available in it. There are different type's cactus species in the world [2, 3].

Fig1 Different type of cactus plant along with their fruit, stems or cladodes) species Opuntia fecus indica.

Cactus is the most versatile and nutritional store house nature favor to it by giving enormous nutrients and bioactive compounds [1-4]. Most portions of the plants have been used as medicine and in modern times have also been commercially prepared as capsules, drinks, pills or powders [1, 2]. These are used for anti-diabetic, anti-inflammatory, analgesic, hypoglycemic, measles, nosebleed, snakebite, antiviral and anti-oxidant [1, 3]. It has been used to regulate weight, blood sugar, increase fiber intake and facilitate childbirth. It also used in the treatment of asthma, fatigue, liver injury following alcohol abuse, corns, diarrhea, dysentery, gastritis, colitis and other gastrointestinal disorders [1, 2, 4]. The pulp of the pads has been used by many cultures as a dressing for burns, cuts, wounds, and fractures and is believed to deaden pain and promote healing [1, 4]. Besides, cactus is being consumed as food or beverages in many countries [2, 3]. The important of cactus is laborious and wide as summarized in fig2.

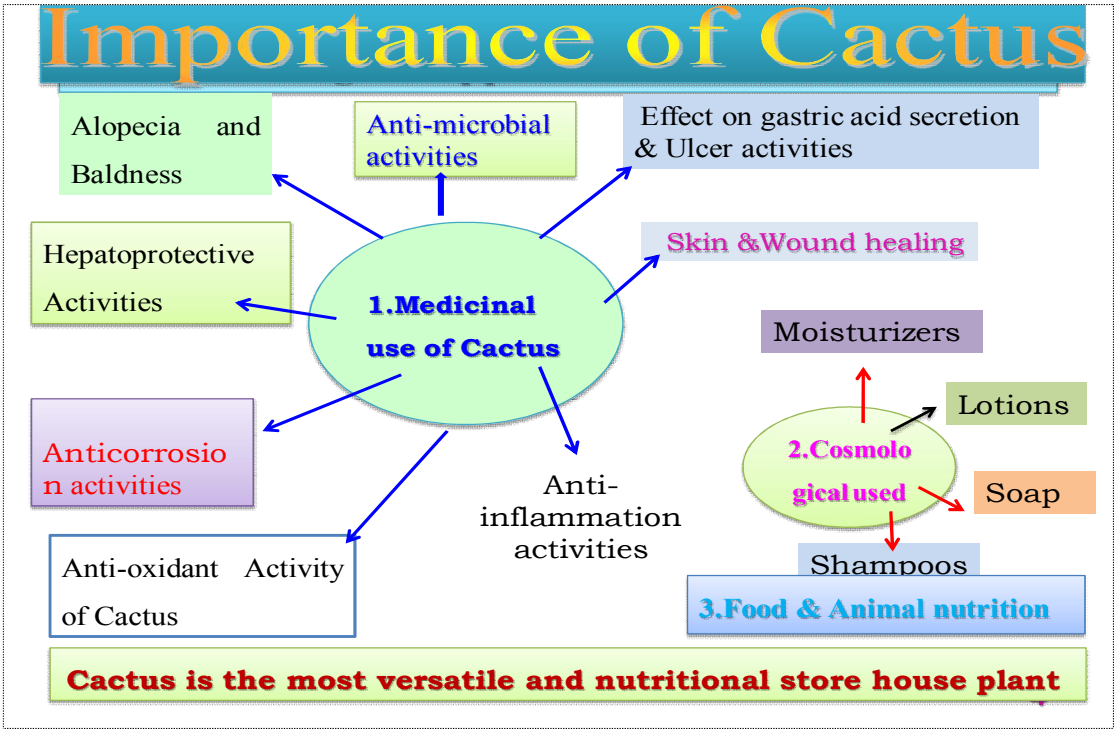


Fig2 the important of cactus in many sectors

As many literatures indicate that this plant has become important for fodder in many parts of the world by utilizing as both natural and cultivated population [2, 5]. It is cultivated in Africa, Italy, US, Mexico, Brazil, china, and other country [3, 4]. In many arid areas the farmers use cactus extensively as emergency forage that is harvested from both wild and cultivated populations to prevent the disastrous consequence of frequency and severe droughts [5, 6, 7].

The cactus plant has been used in agro-forest system with legumes and annual crops [6, 7]. It can plays a stabilizing role in agriculture as it can prevent stock losses during droughts, saves natural grazing over grazing, increase farm income and alleviate poverty in rural area [4, 5].

The use of cactus as a source of food for domestic animals and wild life has been very important of green forage in the dry season capable of providing vitamins [1, 2]. It is Precursors for animal feed as well as human food. Cactus fruits also collected from wild plantations are utilized for subsistence and are sold at the local market [1]. It is also use for medical purposes [3, 5, 7]. Cactus is one of the most intriguing plant families of the world which grows in arid and semi arid regions the covering about 30% of the world's continental surface [3, 5]. This is due to their peculiar adaptations to water scarcity and sun irradiation by the reduction of leaf tissue and utilizes waxes covering the cladodes and fruit surfaces which allow them to grow year round and stay every green despite harsh environmental condition [3,

[6]. It also encountered from temperature (Italy, Israel), sub tropical Africa and America, china South Korea to in cold region with winter snow falls as in Canada or Argentina [7.8].

Cactus contains inorganic elements such as Calcium, Sodium, Zinc, Chromium, Manganese, Magnesium, and selenium that play vital role in our normal ways of life [4]. These elements found in cactus plant may be classified as macro and micro nutrients that have vital role in biological and physiological function in human health and animal nutritional as well as plants and plant products as described in the following sub sections [3].

Sodium (Na); Na is one of the essential element in appropriate amount to regulate the blood pressure, it stabilizes body fluid and for transmitting signaling path way in nervous system [2, 4]. Its deficiency cases hyponatremia while excessive intake of Na leads blood pressure, heart disease and stroke [4, 8].

Potassium (K); K is one of the essential elements of human diet which plays an important role in cellular mechanism ,optimal insulin secretion as cofactor in the conversion of ADP to ATP and in metabolism of carbohydrates and proteins[2, 4]. Potassium depletion results in a reduction of glucose tolerance while excessive intake of K causes hyperkalemia [4].

Calcium (ca); is essential to health in the osteoarticullar system in development and maintenance of the skeleton system and in the cardio muscular system by providing structural strength [6, 8]. A high calcium intake leads urinary stone formation, rickets and osteoporosis, inhibit the intestinal absorption of iron, zinc and other essential elements and its deficiency causes thinning and weakening of the bones, osteoporosis and hypocalcemia diseases [6, 8].

Phosphorus (P); it plays an important role in energy metabolism, bone and teeth formation. It also serves as a component of proteins in the soft tissues [4].

Magnesium (Mg); used as a cofactor of many enzymes involved in carbohydrate and fat metabolism ,protein synthesis, RNA and DNA synthesis and photosynthesis [5, 6]. Excessive intake of Mg leads to hypomagnesaemia while its deficiency enhances diabetes mellitus and gastrointestinal tract abnormalities [7].

Nickel (Ni): Nickel is bivalent in its familiar and forms a number of complex compounds [2, 5]. It occurs in combination with sulfur as millerite and with iron as pentlandite [5]. It involved in enzyme systems in the human body and plant like urease (an enzyme that assists in the

hydrolysis of urea), NiFe-hydrogenases (oxidise H_2). It plays a crucial role in physiological processes as a co-factor in the absorption of iron from the intestine [2, 5].

Excess intake of nickel becomes toxic resulting allergic reactions, digestion problems, high red blood cell counts, kidney failure, lung cancer, nose cancer, respiratory failure, birth defects, asthma and chronic bronchitis [3, 6]. On the other hand, its deficiency causes kidney problems, disrupts metabolism of amino acids and organic acids, lung fibrosis, respiratory tract cancer and cardiovascular diseases [2, 5].

Cactus can absorb and contaminated with heavy metals during cultivation, during processing and from soils [5, 7]. Ones these essential and heavy metals entered in the biological cycle of plants ,vegetables and fruits through the roots and leaves of plants from different sources [2], they were accumulated excessively in different parts of plants [4, 9]. This is determinant in enzymatic metabolism, in plants and animal nutrition [5, 8]. They can also bind to functionality of essential S-H groups in enzymes and proteins. They can substitute functional elements in prosthetic group of enzymes resulting in an inactive catalysis [2, 5, 7].

Currently many nations including our country Ethiopia consumed cactus pear as fresh food. And they feed the leave and the pear to their cattle particularly in northern Ethiopia. But metal level of these plants is doubtful due to their quality since, they contains excess metal ions by absorbing from soil, water, air and other source [4, 6, 8]. Therefore this study is targeted to analyze metal level in cactus in around *Adigrat* town, northern Ethiopia.

MATERIALS AND METHODOLOGY

Study area

The present study is conducted in Adigrat University, in northern region of Ethiopia. *Adigrat* is a city and separate woreda that found in Tigray Region of Ethiopia. It is located in the eastern zone around 900 km far from Addis Ababa which is capital city of Ethiopia with longitude 14°16′N 39°27′E coordinates and latitude 14°16′N 39°27′E with an elevation of 2457 meters above sea level. *Adigrat* is endowed with cactus plant which is harvested once in a year. The largest pharmaceutical manufacturing plant in Ethiopia, '**Addis Pharmaceuticals Factory SC'**, is also located in Adigrat.

Equipment and instrument

Atomic absorption spectrometer was extensively used to analyze inorganic elements. This FAAS should be equipped with standard hollow cathode lamps and air-acetylene flame will be used for absorption measurement of different elements or for determination of trace elements and heavy metals such as Ca, Ni, and Mg in the cactus plant. Flame photometry consists of burner, Nebulizer and mixing chamber, simple color filters and Photo-detector was used for determination of Na and K. Other preliminary equipments like analytical balance, round bottom flasks, and refrigerator uses during entire laboratory work.

Chemical and Reagents

Reagents that are uses in the analysis are all analytical graded. HNO_3 and H_2O_2 were used for digestion of cactus samples. Stock standard solutions containing 1000 mg/L in 2% HNO_3, of the metals Ca, Na, K, Mg and Ni are used for preparation of standards solution. Distilled water was used for dilution of sample, and rinsing glassware and sample bottles.

Sample Collection

Plant samples; mature a healthy and fresh leaf of cactus was collected from two sites namely Kebele 04 and Kebele 05 in Adigrat town. The collected leaves were washed with fresh water and put in clean polyethylene plastic bags and was brought to the laboratory for further pre treatment.

Preparing stock solution

The plant sample was cut in to small pieces and their thick epidermis was removed. The solid gel will be dried at 80-100°C in electric oven and then the dried plant material was ground into powder form using pestle and mortar. Sample plant weighted into separate flask and was digested with 5ml HNO_3. The flask was covered with watch glasses and heated to boil on an electric hot plate at 80-100°C. After heating for one hour, the content of flasks was treated with additional 5ml HNO_3 followed by 2mlof 30% H_2O_2 and was heat for another hour. The watch glass was removed from the top of the flasks and heating was continued until the volume of the content was reduced to semi dried mass. Then the contents of flasks was cooled by diluting around $2NHNO_3$ and filtered through Whatman#42 paper into volumetric flasks that marked as stock sample solution for the determination of metal ions by FAAS.

Preparation of standard solution: Working standard solution of Na, Mg, K and Ni were prepared from stock standard solution (1000ppm) in 2N HNO_3 and calibration curves was plotted for each element using FAAS. The calibration curves was obtained statically by plotting concentration vs. absorbance by adopting least square method.

Determinations of elements

The sample solution that were prepared before was aspirated into FAAS and absorbance measurements was performed for each element using optimum instrumental conditions for different flame atomization modes. The chemical analysis for the determination of Ca, Mg and Ni were performed by using Absorption Spectroscopic standard method while the content of Na and K was estimated using flame photometry.

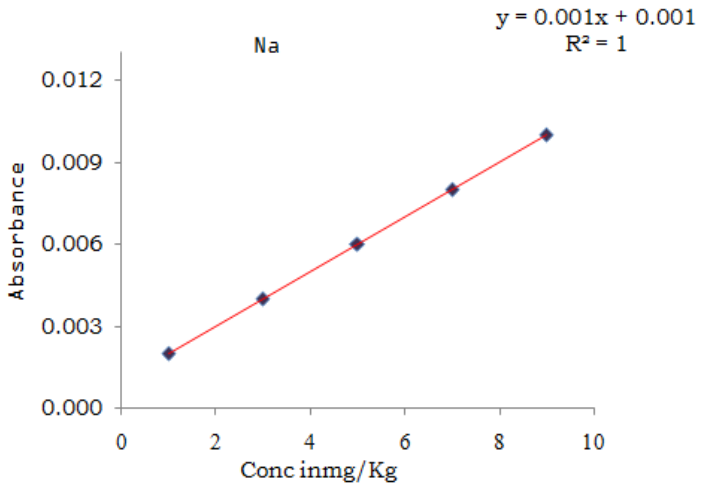
Data Analysis

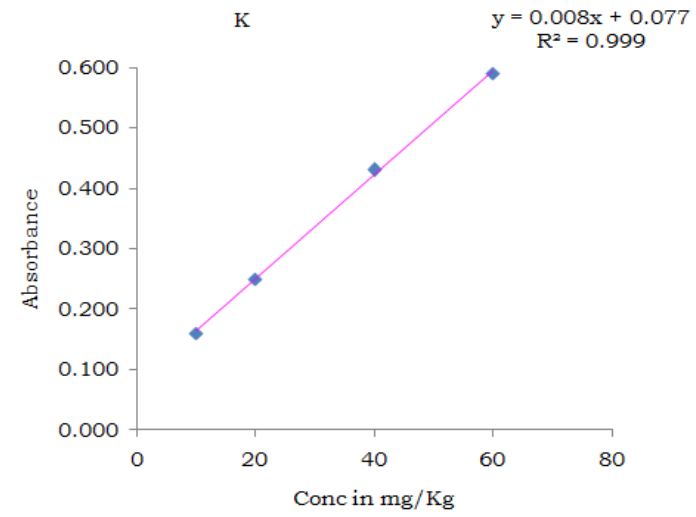
All determinations were done in triplicate and results were reported as mean values ± standard deviation Microsoft Excel 2007.

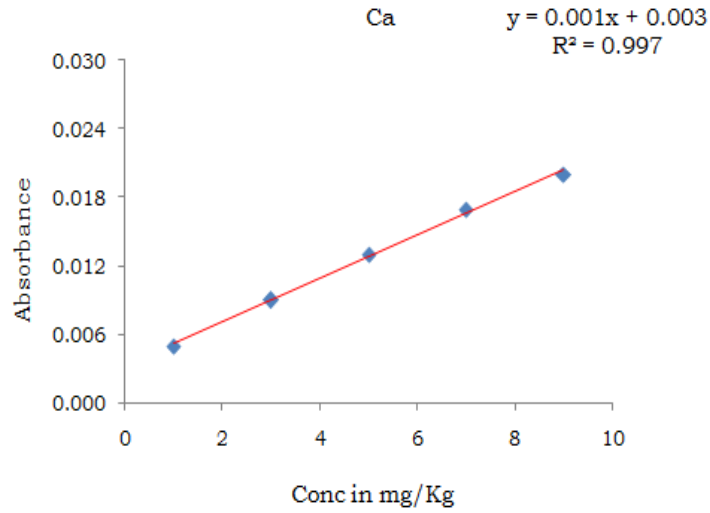
RESULT AND DISCUSSION

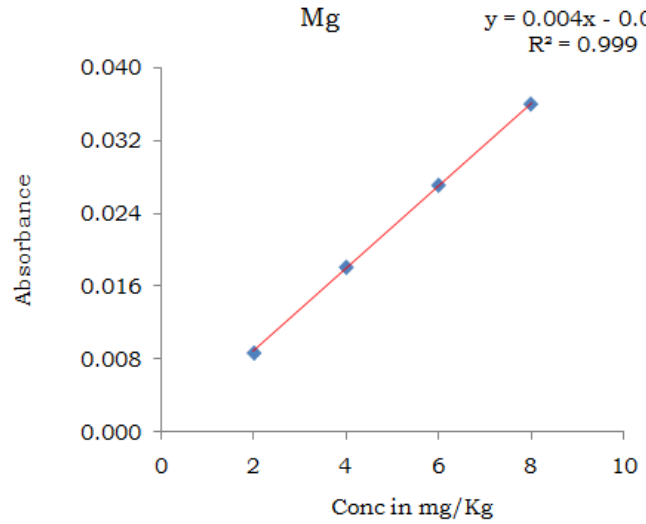
Calibration curve of standards

Working standards and correlation coefficients of the calibration curves is important for determinations of metals levels in plant sample using FAAS. The calibration curves were plotted as a function of absorbance vs. concentration of the standard solution. In this study five calibration curves were plotted for the metals Ca, Cu, Na, K, and Fe along with their correlation coefficient as shown in Fig.3.




K
y = 0.008x + 0.077
R² = 0.999
Absorbance
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
20
40
60
80
Conc in mg/Kg


Ca
y = 0.001x + 0.003
R² = 0.997
Absorbance
0.030
0.024
0.018
0.012
0.006
0.000
0
2
4
6
8
10
Conc in mg/Kg


Mg
y = 0.004x - 0.000
R² = 0.999
Absorbance
0.040
0.032
0.024
0.016
0.008
0.000
0
2
4
6
8
10
Conc in mg/Kg

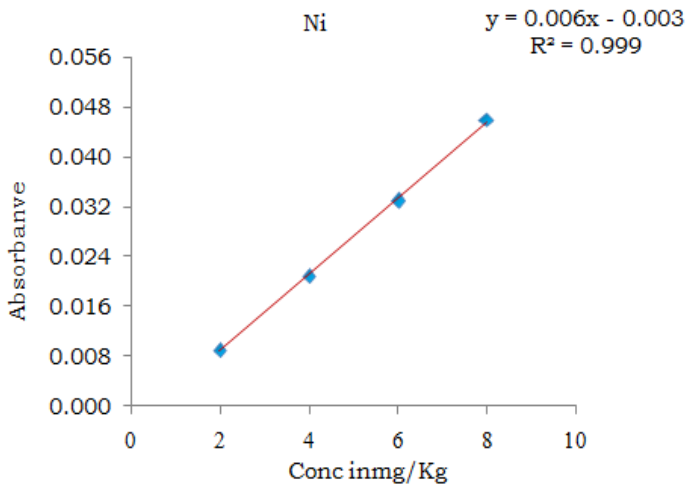


Fig.3. the calibration graphs of metal standard solution.

Determination of Metal Level in cactus Samples

The concentrations of five metals (Ca, Mg, Na, Ni and K) in the cactus samples were determined by FAAS and flame photometry. The average concentrations (mean ± SD) of metals in cactus samples from two areas (kebele 04 and kebele 05 in Adigrat Town) are shown (Table 1).

The result reveals that cactus sample contains the metal levels in the order of: K (23.88 mg/ Kg), Ca (17.440mg/Kg), (Mg 7.890 mg/Kg), Na (2.335 mg/Kg) and Ni (2.033 mg/Kg). The highest levels of K, Ca in the cactus are probably due to the fact that inorganic elements such as N, P, K, Mg and Ca are highly mobile in the plant tissue and trans-located from old plant tissue to new plant tissue [1, 10]. The other probable reason for higher concentration of K and Ca is due to the present of fertilized soil with manure and organic residues which is rich in K and Ca [1,6,10]. As the result, these metals are highly in plant material. In general, the concentrations of the analyzed metals in cactus sample are decreased in the order of: K (23.88 mg/ Kg) > Ca (17.440mg/Kg) > (Mg 7.890 mg/Kg) > Na (2.335 mg/Kg) > Ni (2.033 mg/Kg).

Table 1.The distribution pattern of metals in cactus samples in two Kebeles (mg/Kg).

Metals	Kebele 05	Kebele04	Their Mean
	mean± SD	mean± SD	mean± SD
Na	3.000±0.600	1.000±0.004	2.335±0.003
K	21.220±0.166	25.360±0..071	23.88±0.174
Ca	18.100±0.0165	16.670±0.018	17.440±0.018
Ni	2.177±0.016	1.742±0.016	2.033±0.016
Mg	7.820±0.011	8. 044±0.012	7.890±0.012

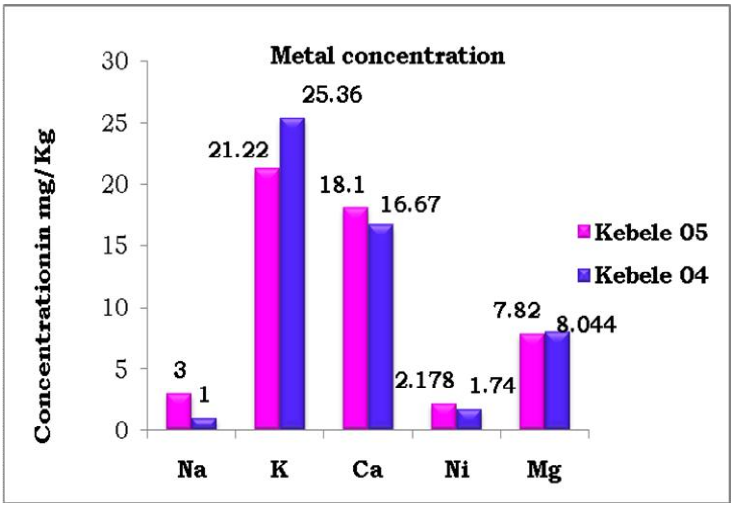


Fig.4. Concentration of metals in cactus sample in two Kebeles

Comparisons of Metal Levels Sample between two Kebeles

In this study the uptake of metals by plants was varied in concentration of the metals in the two sampling sites, to which the plants were taken. As shown in (Table. and Fig.4.), the concentration of metals are varied depending on sampling areas. The results showed that the metals viz K, Na, Ca are present in high concentration in all sampling sites (Table1). But comparative differences are scrutinized between sampling sites.

The level of macro-element (K) varied from (21.220-25.360mg/Kg), which is highest in Kelebele 04 (25.360 mg/Kg) and lowest in Kelebele 05 (21.220 mg/Kg). The level of Ca is highest in Kelebele 05 (18.100mg/Kg) and lowest in Kelebele 04 (16.670 mg/Kg). The level of Na is higher in Kelebele 05 (3.000 mg/Kg) and lower in Kelebele 04 (1.000 mg/Kg). The highest and the lowest concentration of Ni were found in Kelebele 05 (2.177mg/Kg) and Kelebele 04 (1.742mg/Kg), respectively. This study reveals that the levels of metal ions greatly rely on their sample site, and the highest metal concentration except K was obtained from Kebele 05 in cactus sample as shown Fig4 and table 1.

CONCLUSION

Cactus is a medicinal plant that has grown in warm climate with a number of nutrients and bioactive compounds that play useful role in the treatment of various diseases. It has the capability to absorb metal ions from soil that play a vital role in bio and physiological activities in plant and in animal in trace quantity. But excessive uptake of these metals by plants from soil is leading a serious effect for plants and animals. Inlight of these, this study is designed to evaluate the level of metals (Ca, Na, K, k and Ni) in cactus leaves in northern

region of Ethiopia using FAAS and FP. The results reveal that the mean values in cactus samples are decreased in the order of: K (23.88 mg/ Kg) > Ca (17.440mg/Kg) > (Mg 7.890 mg/Kg) > Na (2.335 mg/Kg) > Ni (2.033 mg/Kg). The data acquired from this study perhaps helpful for researches that may be conducted on agronomy and physiology of the plant, nutrient requirement and soil-plant nutrient balance of plant. It is also helpful for toxicological studies look upon human health as well as with respect to quality of plant products.

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