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Quantitative Assessment of Mineral Composition of *Aloe vera* (L.) Burm.f. leaves by ICP-MS and CHNS Analyzer.

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Abstract: ***Aloe vera has spectacular medicinal properties and has long history for their therapeutic applications. The aim of this study is to analyze concentration of macro, micro and trace elements from Aloe vera leaves for understanding their nutritive and pharmaceutical values. The elemental analysis has been done by using ICP-MS and CHNS Analyzer. The concentration of basic elements like Carbon (36783 ppm), Hydrogen (7300 ppm) and Nitrogen (51140 ppm) has been found maximum. The concentration of Magnesium, Phosphorus, Potassium, Calcium, Barium, Boron, Sodium, Zinc, Mangenese and Aluminium was found 8031 ppm, 869.9 ppm, 4464.8 ppm, 558.3 ppm, 18.57 ppm, 21.5 ppm, 40.8 ppm, 63.8 ppm and 966 ppm respectively. Aluminium is a heavy metal and has been found quite high in Aloe vera leaves. The leaves of Aloe vera contain trace elements like Arsenic (0.31 ppm), Lead (1.02 ppm), Chromium (4.6 ppm), Copper (9.48 ppm), Selenium (43.13 ppm), Nickel (2.98 ppm), Molybdenum (0.96 ppm) and Ferrous (49.1 ppm). Tin is a toxic metal, the traces of which have been found to be 11.8 ppm. Some heavy and toxic metals like Mercury, Silver, Cadmium, Lithium, Beryllium and Bismuth have not been detected in Aloe vera leaves.***

Keywords: *Aloe vera*, Therapeutic, Pharmaceutical values, Concentration, Basic elements, Metals, Trace element.

1. Introduction

Mineral elements are essential for human life; they may be beneficial or harmful. The human body contains at least 60 detectable chemical elements. However, only about 25 of these are believed to participate in the healthy functioning of the human body (Nielsen F.H., 1999). Analysis of mineral elements is most important to understand the pharmacological and nutritional values of medicinal plants. Mineral elements play important role in biochemical and metabolic reactions in the living organism, which are mainly responsible for the formation of active organic constituents (Serfor-Armah et.al, 2001). The minerals have been categorized in to major, minor and trace elements on the basis of their availability in the plants. Their deficiency causes diseases whereas the excess presence may cause toxicity (Hashmi et.al, 2007). Medicinal plants contain vital elements which are widely used as a precursor for regulated pharmaceutical products. Medicinal values of the pharmaceutical products are due to the presence of secondary metabolites. Primary metabolites are the precursors of secondary metabolites. Secondary metabolites like flavonoids, alkaloids, lipids, polyphenols etc. play important role in the formulation of drugs (Pawar *et.al*, 2015). Polluted environment is accountable for the incidence of toxic metals in the medicinal plants. Environmental contamination due to metals exerts physiological stress that is clearly too severe for survival of most species by means of physiological acclimatization, rather than genetic adaptation (Tongue, 1998). Traditional herbal medicines are used for treatment of various illnesses, but sometimes they could turn out to be toxic because of the presence of some heavy metals and other impurities apart from the pharmacological effect. For example inorganic arsenic causes cancer (Uddin, 2011). Elemental analysis of medicinal plants is also helpful for knowing the quantity of heavy and toxic metals and quality of that medicinal plant.

Aloe vera (L.) Burm.f. is a xerophytic plant, it belongs to the family Liliaceae and in Maharashtra it is commonly known as Korphad. It is traditionally used for curing various diseases like stomach disorders, burns etc. because of their medicinal properties. *Aloe vera* shows several pharmacological activities including antiarthritis, antifungal (Rosca et al, 2007), antibacterial (Heggers et. al, 1979), hypoglycemic (Tanaka et.al, 2006), anti-inflammatory (Che et.al, 1991), anticancer (Furukawa et. al, 1991), wound healing (Fulton, 1990) and antiaging (West et. al, 2003) etc. Earlier researchers have reported presence of Al, B, Ba, Ca, Fe, Mg, Na, p and Si in *Aloe vera* gel. The pharmacological properties and toxicity of the medicinal plants depend on the presence of elements. Therefore quantitative assessment of elemental concentration is important and essential to understand their nutritive and pharmacological value. In view of this aspect, present investigation has been undertaken.

2. Material and Method

Collection and Identification

Aloe vera (L.) Burm.f. fresh plants have been collected from Kothrud, Pune and identified and authenticated from Botanical Survey of India (BSI), Pune. The specimen (VMK-9) has been deposited in the herbarium of Botanical Survey of India, Pune, Maharashtra (India).

The matured *Aloe vera* leaves were shade dried and powdered by using mechanical grinder.

Digestion process of Plant Samples

Dry plant powder samples were digested by using Mars protein analyzer digester. Dry powder (0.5g) of *Aloe* leaves was taken in the tube; 5ml acidifying water was added followed by 1 ml hydrogen peroxide solution and 4 ml nitric acid. One blank sample was also kept in the digester. Then

the program of the digester was created in three steps by setting the method as follows:

Table 1: Programme settings for the Mars digester instrument

Parameters	First step	Second step	Third step
Ramp	5º	10º	10º
Temperature	60º	150º	190º
Power	800	1200	1600
Hold time	5	5	20

Preparation of plant sample solution:
The sample after digestion was removed from the digester. Then it was poured into 25 ml volumetric flask and the level was adjusted by adding acidifying water and used for the ICP –MS analysis.

Preparation of standard solution:
The standard solution of 10 ppm was prepared from 1000 ppm multi element standard solution of Fluka make.

Sample analysis
The prepared sample solution and standard solution were introduced in ICP-MS to determine elemental content. The linearity of standard solution was kept as 0.1 ppb, 0.5 ppb, 1 ppb, 5 ppb, 10 ppb, 50 ppb and 100 ppb. Then freshly prepared 5% acidifying water was introduced in ICP-MS followed by standard solutions of different linearity. Again freshly prepared 5% acidifying water was introduced followed by blank sample. Then the plant sample solution was introduced followed by blank sample. The data analysis was done by using ICP-MS TOP Batch Analysis software.

Estimation of Carbon , Hydrogen, Nitrogen and Sulphur by CHNS Analyzer

Carbon, Hydrogen, Nitrogen, and Sulphur are the basic elements of living nature. Their quantitative determination is most necessary for physiological aspects. The CHNS(O) Analyzer is used for determining the percentages of Carbon, Hydrogen, Nitrogen and Sulphur as well as Oxygen in case of organic compounds, based on the principle of "Dumas method" which involves the complete and instantaneous oxidation of the sample by "flash combustion". After combustion, the products are separated by a chromatographic column and detected with the help of a thermal conductivity detector (T.C.D.), which gives an output signal proportional to the concentration of the individual components of the mixture.

The CHNS(O) analyzer (Make: Thermo Finnigan, Italy; Model: FLASH EA 1112 series) was used to determine the percentages of Carbon (C), Hydrogen (H), Nitrogen (N) and Sulphur (S) present in the *Aloe vera* Leaves. The test was carried out at Sophisticated Analytical Instrument Facility (SAIF), IIT Bombay.

3. Results and Discussion

The elemental composition of *Aloe vera* Leaves by CHNS Analyzer is given in the Table No. 2 and by ICP-MS in the Table No. 3. The maximum concentrations of Carbon, Hydrogen and Nitrogen have been found in *Aloe vera* leaves i.e 367830 ppm, 51140 ppm and 7300 ppm respectively but sulphur has not been detected (Table No. 1 and Fig. No.1).

Table 2: Elemental Analysis of *Aloe vera* Leaves By CHNS Analyser

Elements	ppm
Carbon	367830
Hydrogen	51140
Nitrogen	7300
Sulphur	0

Figure 1: Chromatogram of *Aloe vera* Leaves by CHNS Analyser

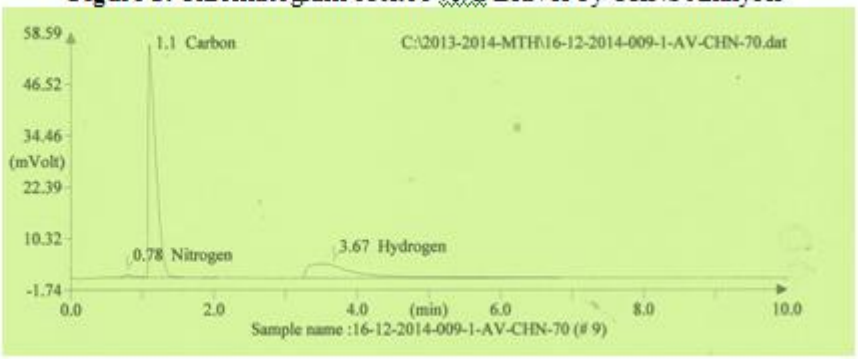
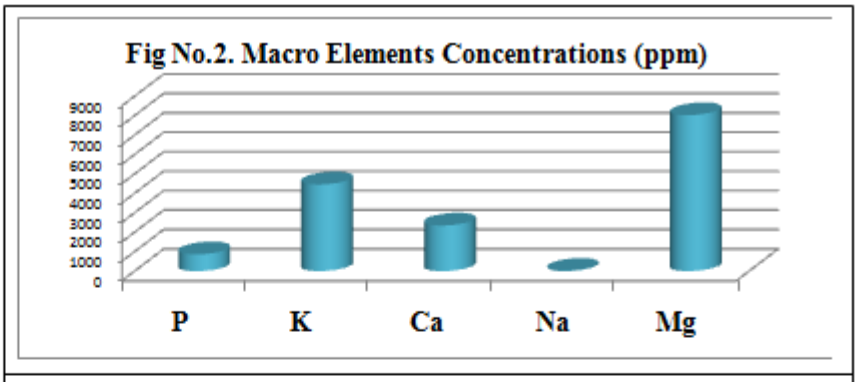
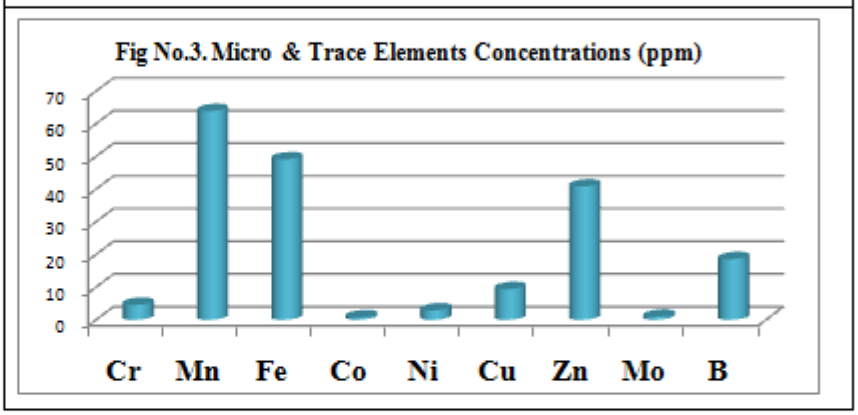
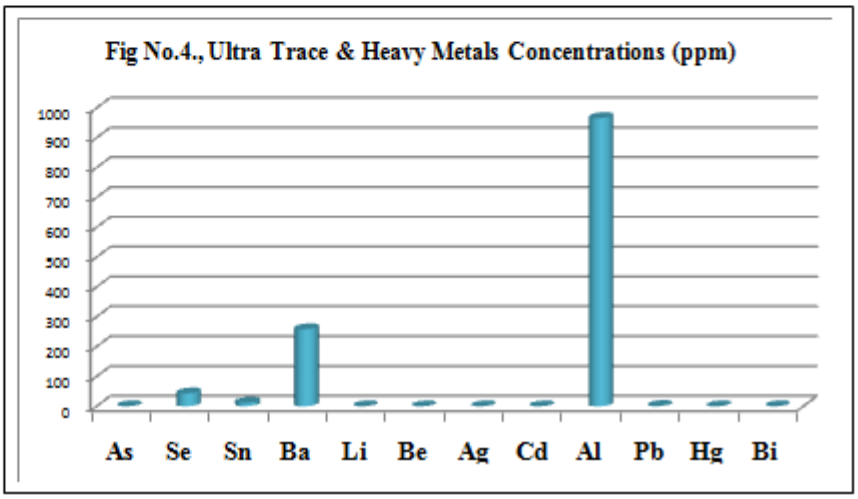


Table 3: Elemental Analysis Aloe vera Leaves by ICP-Ms

Elements	Concentrations (ppm)
Macro Elements	
P	869.9
K	4464.8
Ca	2352
Na	21.5
Mg	8031
Micro and Trace Elements	
Cr	4.6
Mn	63.89
Fe	49.1
Co	0.75
Ni	2.9
Cu	9.4
Zn	40.8
Mo	0.96
B	18.57
Ultra Trace and Heavy Metals	
As	0.3
Se	43.1
Sn	11.8
Ba	258.3
Li	0
Be	0
Ag	0
Cd	0
Al	966
Pb	1.02
Hg	0
Bi	0







Carbon, Hydrogen and Nitrogen are the basic element and most important in living organisms. Nitrogen is an essential building blocks of amino acids and nucleic acids. All organic compounds are mostly containing hydrocarbons. Whereas the concentration of Magnesium, Phosphorus, Potassium, Calcium, Barium, Boron, Sodium, Zinc, Manganese and Aluminium was found 8031 ppm, 869.9 ppm, 4464.8 ppm, 558.3 ppm, 18.57 ppm, 21.5 ppm, 40.8 ppm, 63.8 ppm and 966 ppm respectively (Fig No.1, 2 & 3). Concentration of Aluminium was found to be quite high in *Aloe vera* leaves. Magnesium element is abundantly present in the human being, which is distributed in bones (60%), skeletal muscles and soft tissues (30-40 %) and extracellular fluids (1%). Mg plays crucial role in lipid membrane stabilization, replication and metabolic processes (Hartwig (2001), (Yang et al. (2006), (Selmer et al. (2006), (Klein et al. (2004), (Beaven et al. (1990), (Payandeh et al. (2013).

Rajendran et al (2007) analysed trace elements in *Aloe vera* by AAS, which showed that concentrations of Potassium, Magnesium, Sodium and Zinc were more than 200 µg and has also been recorded average concentrations of Lead, Manganese, Cobalt, Copper, Cadmium, Nickel, Iron and Aluminium as 0.7 µg, 0.8 µg, 0.1 µg, 1.8 µg, 0.04 µg, 0.3 µg, 20 µg and 11 µg respectively. Manganese is essential for metabolism, reproduction, immunological system and growth of connective tissues in animal. But high level of Mn is toxic to the body, which causes neurodegenerative disorders (Avila et al, 2013). Phosphorus, Potassium, Sodium and Calcium are macro elements present in high amount in leaves of *Aloe vera*. Potassium and Sodium both are essential and they play crucial role in the cellular homeostasis (Pohl et. al, 2013). Calcium is main component in bone and helpful for regulating skeletal and cardiac muscles contractions (Toyoshima et. al, 2000). Zinc is most important and plays a role in the structure of proteins as well as in enzymatic catalyst (Auld, 2001). *Aloe vera* leaves showed satisfactory concentration of Zinc i.e. 63.8 ppm.

Zinc and Potassium are effective to enhance the concentration of insulin and prevent diabetes (Conlston (1980) & Underwood (1986).

Present analysis shows that the leaves of *Aloe vera* contain trace elements like Arsenic (0.31 ppm), Lead (1.02 ppm), Chromium (4.6 ppm), Copper (9.48 ppm), Selenium (43.13 ppm), Nickel (2.98 ppm), Molybdenum (0.96 ppm) and Ferrous (49.1 ppm). Tin is a toxic metal, the traces of which have been found to be 11.8 ppm. Some heavy and toxic metals like Mercury, Silver, Cadmium, Lithium, Beryllium and Bismuth have not been detected in *Aloe vera* leaves. Selenium, Molybdenum, Manganese, Chromium, Boron, Arsenic and Nickel are used in ultratrace amount for the health benefit of animals (Nielsen, 1984; 1998). Sharma et al. (2011) revealed that *Aloe vera* can be used as a good treatment option for waste water and polluted soil because it absorbs trace elements from the soil. From this point of view in present study, concentrations of some heavy metals like Aluminium, Tin, Lead and Arsenic have been found quite high helping to decrease soil and water pollution.

4. Conclusion

The result showed basic and macro elements like C, H, N, Ca, K, P and Mg which were found in maximum concentrations in *Aloe vera* leaves. Trace elements such as Ar, Pb, Cr, Co, Se, Ni, Mo and Fe have been recorded in sufficient concentration which are necessary to human health and concentrations ranged from 0.32 – 258.3 ppm. Tin is a toxic metal, the traces of which have been found to be 11.8 ppm. Hg, Cd, Li, Ag, Bi and Be are heavy and toxic metals which have not been detected in *Aloe vera* leaves. In present study traces of some heavy metals like Aluminium, Tin, Lead and Arsenic also detected because *Aloe vera* has heavy metal absorbance ability and used in polluted soil for treatment purpose. One more importance of this study is that *Aloe vera* proves the biological role and heavy metal absorbance ability. The elements play vital role in formulation and medicinal properties of any herbal drugs. The *Aloe vera* leaves showed adequate amount of elemental concentrations hence prove their medicinal and nutritional properties.

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References

[1] Auld DS. 2001 Zinc coordination sphere in biochemical zinc sites. *BioMetals* 14,271–313.
[2] Avila DS, Puntel RL, Aschner M. (2013) Manganese in health and disease. In *Interrelations between essential metal ions and human diseases* (eds Sigel A, Sigel H, Sigel RKO), pp.199–227.
[3] Beaven GH, Parmar J, Nash GB,Bennett BM, Gratzer WB. (1990) Effect of magnesium ions on red cell membrane properties. *J. Membr. Biol*. 118, 251–257.
[4] Che Q.M., Akao T, Hattori M, Kobashi K and Namba (1991), Isolation of human intestinal bacteria capable of transforming Barbaloin to Aloe-Emodin Anthrone, *Planta Medica*, 57 (1), 15-19.
[5] Coulston L; P. Dandona. *Dibetes*, 1980, 29, 665-667.
[6] Fulton J. (1990), The stimulation of post dermal abarasion wound healing with stabilized *Aloe vera* gel . Polythene Oxide Dressing, *Journal of Dermatologic Surgery and Oncology*, 16 (5), 460 – 467.
[7] Furukawa F, Nishikawa A, Chihara T, Shimpo K and Beppu H, (1991), Inactivation of Enveloped viruses by Anthraquinons extracted from plants, Antimicrobial agents and Chemotherapy, 35 (12), 2463-2466.
[8] Hartwig A.(2001) Role of magnesium in genomic stability. *Mutat. Res*. 475, 113–121.
[9] Hashmi DR, Ismail S, Shaikh GH, (2007), Assessment of level of trace metals in commonly edible vegetative locally available in the markets of Karachi city, *Pak. J. Botany,* 39 (3), 747 – 751.
[10] Heggers J.P., Pineless G.R. and Robson M.C. (1979), Dermaide *Aloe vera* gel: Comparision of the antimicrobial effect, *The American Journal of Medical Technology*, 41, 293-294.
[11] Klein DJ,Moore PB, Steitz TA. (2004) The contribution of metal ions to the structural stability of the large ribosomal subunit. RNA 10, 1366–1379.
[12] Nielsen FH. (1984) Fluoride, vanadium, nickel, arsenic, and silicon in total parenteral nutrition. *Bull. N.Y.Acad. Med*. 60, 177–195.
[13] Nielsen FH. (1998) Ultratrace elements in nutrition: current knowledge and speculation. *J. Trace Elem. Exp. Med.* 11, 251–274.
[14] Nielsen FH. 1999 Ultratrace minerals. In *Modern nutrition in health and disease*, 9th edn(eds Shils ME, Olsen JA, Shike M, Ross AC), pp. 283–303.
[15] Pawar S.G and Kamble V.M. (2015), Evaluation of chlorophyll content and chlorophyll stability index of some antiallergenic medicinal plants. *Asian Journal of Multidisciplinary Studies,* 3 (1), 17-20.
[16] Payandeh J, Pfoh R, Pai EF. (2013) The structure and regulation of magnesium selective ion channels. *Biochim. Biophys. Acta* 1828, 2778–2792.
[17] Pohl HR, Wheeler JS, Murray HE. (2013) Sodium and potassium in health and disease. In*Interrelations between essential metal ions and human diseases* (eds Sigel A, Sigel H,Sigel RKO), pp. 29–47.
[18] Rajendran A; V Narayananand; I Gnanavel. (2007), Study on the analysis of trace elements in Aloe vera and its Biological Importance, *Journal of Applied Science Research*, 3(11), 1476-1478.
[19] Rosca-Casiana, Parvu M, Vlase L. and Tamas (2007), Antifungal activity of *Aloe vera* leaves, *Filoterapia,* 78 (3), 163-166.
[20] Selmer M, Dunham CM, th FV, Weixlbaumer A, Petry S, Kelley AC, Weir JR,Ramakrishnan V. (2006) Structu re of the 70S ribosome complexed with mRNA and tRNA.Science 313, 1935–1942.
[21] Serfor Armah Y., Nyarko B.J.B., Akaho E.H.K, Kyere A.W.K., Osae S., Oppong- Boachie, K, Osae, EK.J.

2001, Activation analysis of some essential elements in five medicinal plants used in Ghana. *J. Radioanal, Nucl. Chem.*, 250 (1), 173-176.

[22] Sharma D, Rai S, Arora S, Gupta P, Sharma R and Chopra A (2011), Study of trace elements in Aloe vera L (Aloe barbadensis Miller) viz. Liliacea and its biological and environmental importance., *Journal of Chemical and Pharmaceutical Research*, 3 (3), 64-68.

[23] Tanaka et al (2006), Identification of five phytosterols from Aloe vera gel as antidiabetic compounds, *Biological and Pharmaceutical Bulletin*, 29 (7), 1418-1422.

[24] Tonguc O (1998), Determination of heavy metal level in some moss species around thermic power station, *Turkey Journal of Biology*, 28, 171-180.

[25] Toyoshima C, Nakasako M, Nomura H, Ogawa H. (2000) Crystal structure of the calcium pump of sarcoplasmic reticulum at 2.6 *Å resolution. Nature* 405, 647–655.

[26] Uddin R, Saffoon N, Alam M, (2011), Arsenic the poison and poisoned groundwater of Bengladesh, *International Current Pharmaceutical Journal*, 1 (1), 12-17.

[27] Underwood MK; MJ Rosentha; S Hong. (1986) Trace elements in human and animal nutrition, *Academic, New York*.

[28] West D., Zhu Y., (2003), Evaluation of Aloe vera gel cloves in treatment of dry skin associated with occupational exposure, *American Journal of Infection*,31 (1), 40-42.

[29] Yang W, Lee JY, Nowotny M.(2006) Making and breaking nucleic acids: two-Mg^{2+}-ion catalysis and substrate specificity. *Mol. Cell* 22, 5–13