Journal of Applied Sciences Research, 3(11): 1476-1478, 2007

Study on the Analysis of Trace Elements in *Aloe vera* and Its Biological Importance

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Abstract: The role of some inorganic elements like vanadium, zinc, sodium, potassium, magnesium, aluminium, iron, nickel, cadmium, copper, cobalt and manganese in the improvement of impaired glucose tolerance and their indirect role in the management of diabetes mellitus, hypoglycemic, wound healing and anti-inflammatory effects are being used, which contain both organic and inorganic constituents. In the present study, an attempt has been made to analyze the inorganic elements present in the *Aloe vera* leaf gel. The concentration of various elements K, Mg, Na and Zn in the sample was more than 200 µg. The concentration of other elements analyzed in the sample decrease in the order Fe >Al > V > Cu > Mn > Pb > Ni > Co > Cd.

Key words: *Aloe vera* leaf gel, Trace elements

INTRODUCTION

Mineral elements serve as structural components of tissues and as constituents of the body fluids and vital enzymes in major metabolic pathways and are essential for the function of all cells[3]. Their concentration in living tissues and the adult human requirement are somewhat lower than those of the bulk elements and they were not easily quantified by early analytical methods, hence the name "trace" elements [6]. Growing concern with environmental factors in human health over the last few years has aroused renewed interest in the trace elements [1]. Many herbs have been shown to have hypoglycemic action in animals and humans. However, the ultimate objective of their use is that they should interact directly with our body chemistry. They might be used in various forms like food and medicines, which contains both organic and inorganic constituents. Even trace elements play an important role in the formation of active constituents in medicinal plants. *Aloe vera* L. (*Aloe barbadensis* Miller) is an important medicinal plant belongs to the family Liliaceae. Aloe products have long been used in health foods and for medical and cosmetic purposes. These products range from aloe drinks to aloe gels, powders, capsules, creams, etc., for both internal and external uses for a wide variety of indications. Aloe gel contains phenolic anthraquinones, carbohydrate polymers and various other inorganic and organic compounds. Aloe has a wide range of medicinal applications such as wound healing effect, reduces blood sugar in diabetes, soothes burns, eases intestinal problems, reduces arthritic swelling, ulcer curative effect, stimulates immune response against cancer, etc. Keeping the above facts in view, the present study was carried out to analyze the trace metalion content of *Aloe vera* gel.

MATERIAL AND METHODS

The study was carried out at Department of Inorganic Chemistry, University of Madras, Guindy campus, Tamilnadu to analyze the trace metals in the *Aloe vera* sap. The matured *Aloe vera* leaves were collected from three different locations of Tamilnadu.

Preparation of Ash: Mature, healthy and fresh leaves of *Aloe vera* having a length of approx 1.5 – 2 ft were washed with fresh water. The leaves were cut transversely into pieces. The thick epidermis was selectively removed. The solid gel in the center of the leaf was homogenized. The dry- ashing method was adopted by placing the properly dried and ground plant sample (100 g) into a vitresil crucible overnight in an electric muffle furnace, maintaining the temperature between 410 ^{o}C and 440 ^{o}C, because loss of zinc might occur at >450 ^{o}C and loss of potassium occur at >480^{o}C. Also, ashing will destroy all of the organic materials present in the sample. The ash was removed from the crucible and allowed to dry in a desiccator. The yield of ash in gel powder was approx 3.25 g/ 100g.

Analysis of inorganic elements in Aloe vera leaf gel ash: Two grams of ash were digested with mixture of nitric acid, sulphuric and perchloric acid in the ratio of

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11:6:3, respectively for 24 hours for the removal of organic matters. The digested sample was made up to 100 ml and used for assay of trace elements through Atomic Absorption Spectroscopy (AAS- Varion 200AA) using suitable hollow-cathode lamps. Sodium and Potassium were estimated by a flame photometer.

RESULTS AND DISCUSSIONS

There were thirteen elements viz., lead, vanadium, manganese, cobalt, copper, cadmium, nickel, aluminium, zinc, iron, magnesium, sodium potassium and zinc were found in *A. vera* (Table 1). The highest concentration of magnesium, sodium and potassium were recorded in *A. vera* gel (more than 200 µg). The concentration of other elements analysed in the study decrease in the order Fe >Al > V > Cu > Mn > Pb > Ni > Co > Cd. The iron, aluminium and vanadium concentration in *A. vera* were18.59 to 21.36, 11.73 to 12.49 and 7.545 to 9.396 µg, respectively. The concentration of other trace elements ranged from 0.046 to 1.854 µg. The lowest concentration of cadmium (0.043 to 0.051 µg) was found in *A.vera*. This finding is concomitance with the earlier reports of[4].

Each element has their individual role in the structural and functional integrity of the living cells and organisms. The importance of the trace elements in living organisms was first shown over a century ago. Claunde Bernard and Mcmunn demonstrated the existence of a number of trace mental containing enzymes (metallo enzymes) of importance to the structural and functional integrity of the living cells. Growth concern with environmental factors in human health over the last few years has aroused renewed interest in the trace elements. Abnormalities in their metabolism have been demonstrated in many human diseases. In particular, diabetes mellitus as been shown to be associated with abnormalities in the metabolism of zinc, chromium, magnesium and manganese. Diabetes mellitus is a chronic metabolic disorder, which can alter the nutritional status of the individual. Studies in humans and animals have shown that optimal intakes of elements such as copper, zinc, sodium, magnesium, calcium, chromium and iodine can reduce individual risk factors. The role of inorganic elements like zinc, chromium, vanadium, iron, copper and manganese in the improvement of impaired glucose tolerance and their indirect role in management of diabetes mellitus are being increasingly recognized.

Magnesium is one of the major minerals, which is related to the carbohydrate and fat metabolism. Diabetes mellitus is one of the chronic diseases most frequently associated with magnesium deficiency. Definite lowering of serum magnesium has been shown

Table 1: Metal Ion Concentration in *Aloe vera*

Metals	Place-1 (in µg)	Place-2(in µg)	Place-3(in µg)
Lead	0.77	0.621	0.865
Vanadium	9.396	7.545	8.687
Manganese	0.92	0.976	0.698
Cobalt	0.109	0.116	0.091
Copper	1.854	1.733	2.009
Cadmium	0.046	0.051	0.043
Nickel	0.303	0.291	0.326
Zinc	>200	>200	>200
Iron	21.36	18.59	20.05
Aluminium	11.73	13.27	12.49
Magnesium	>200	>200	>200
Sodium	>200	>200	>200
Potassium	>200	>200	>200

Place-1: Chennai, Tamilnadu, India
Place-2: Perambalur, Tamilnadu, India
Place-3: Coimbatore, Tamilnadu, India

in patients of long-term treatment with insulin and those recovering from ketoacidosis. The possible mechanisms of hypomagnesia are (a) increased loss of magnesium in urine due to the osmotic action of glycosuria and (b) depression of the net tubular re-absorption of magnesium due to hyperglycemia. Hypomagnesaemia has been postulated as a possible risk factor in the development and progression of diabetic retinopathy. A specific renal tubular defect may exist in diabetes mellitus, which may act together with osmotic diuresis to result in large magnesium urinary losses. Magnesium may also play a role in the release of insulin. The use of magnesium supplementation should be considered in situations where its deficit may have detrimental effect, such as acute myocardial infarction and arrhythmias, in patients on diuretics and in diabetic ketoacidosis.

Zinc is versatile, which has been well known to be an important trace element in diabetes as a cofactor for insulin, although their real mechanisms in carbohydrate metabolism are not clear. Its role in the normal growth of animals was demonstrated in rats and mice. Abnormal zinc metabolism has been suggested to play a role in the pathogenesis of diabetes and /or its complications. Patients with diabetes mellitus tend to have low serum zinc and increased urinary excretion. Zinc has numerous targets to modulate insulin activity, including its antioxidant capacity. Zinc enhances the effectiveness of insulin [2]. High intake of Zinc inhibits copper absorption by inducing metallothionein production. Zinc has a relatively low order of toxicity compared with most other trace elements. Long term zinc intakes higher than requirement could; however interact with metabolism of other trace elements.

Normal potassium concentration is necessary for optimal insulin secretion[7]. Potassium deficiency results more often from excessive losses than from deficient intakes. Deficiencies arise in abnormal conditions such a diabetic acidosis. Potassium depletion can result in reduced glucose tolerance. Sodium and Potassium ions play an important role in the disease related to renal disorder [5]. Vanadium, a group of V B elements was reported to elicit glucose lowering and cardio-protective effect in streptozotocin induced diabetic rats by Heyliger. Numerous investigations have demonstrated the beneficial effect of vanadium salts on diabetes in STZ diabetic rats, in rodents with genetically determined diabetes and in human subjects [8]. In 1970s the vanadate ion was shown to act as an efficient inhibitor of Na^+, K^+ - ATPase as well as of other related phosphohydrates. In 1980 vanadium was reported to mimic the metabolic effects of insulin in rat adipocytes. Subsequent studies revealed that vanadium therapy was shown to normalize blood glucose levels in STZ induced rats and to cure many hyperglycemia related deficiencies. Previous studies conducted in our laboratories have also supports the insulin mimic properties of vanadium.

Iron has several vital functions in the body, which mainly involved in oxidation-reduction reactions (ETC), hemoglobin-oxygen transport and also a co-factor for numerous other enzymes. Studies in experimental animals have clearly shown that iron deficiency has several negative effects on important functions of the body. However, excessive intake of iron may cause tissue damage, especially in liver. High dietary iron can inhibit Zn absorption, while iron and zinc added to a meal seems not to affect zinc absorption. However, pharmacological doses of iron could adversely affect zinc utilization. Manganese cannot be stored, but function as a key constituent of metallo-enzymes activator. In experimental animals, pancreatectomy and diabetes have been correlated with decreased manganese levels in blood. Further, manganese supplements have reversed the impaired glucose utilization induced by manganese deficiency in guinea pigs. Manganese may act like insulin in increasing the transport of glucose into adipose tissue either by enhancing an existing low level of insulin. Manganese requirement are low, and many plant foods contain significant amounts of this trace mineral. Deficiencies are therefore unlikely.

The primary function of copper in the body is to serve as constituents of many biologically important enzymes, thus enzymes, which contain copper in the active site, catalyze the oxidation of ferrous iron to ferric iron. Copper is required for absorption and transport of iron, and it plays a key role in hemoglobin synthesis. High plasma copper concentrations are found in people with diabetes mellitus. Enzymes that do not contain a trace element as an integral part but are activated by metals such as copper, iron respond to in vitro addition of several transition elements with a dose dependent activation. Thus the presence of essential trace elements in *Aloe vera* may readily account for the most of the therapeutic efficiencies. The identified above compounds may lay a direct or an indirect role in insulin secretion or action in a synergistic manner. The trace elements present in aloe vera have a significant role in anti-diabetic activity[4]. Further, the data obtained on individual element concentration in *Aloe vera* will be useful in deciding the dosage of herbal drugs prepared from these variety for the management of diabetes related metabolic disorders.

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