Research Article

Analysis of Physico-Chemical and Qualitative Inorganic Elements in the Selected Herbal Plants

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ABSTRACT

Many herbal plants are isolated and analyzed for their medicinal properties and healing components in recent days. Since safety and effectiveness of plant products promote the pharmaceutical use of herbs for health problems, in the present investigation different parts of the selected plants were analyzed for their physico-chemical contents and inorganic trace elements. *Allium cepa, Aloe vera, Aristolochiabracteolata, Centellaasiatica, Ocimum sanctum, Piper betle,Sesbaniagrandiflora* and *Solanumtorvum* are the eight plants used for the present study. These plants are easily available and few of these plants are often used in our food in our daily life. Among the moisture, organic and inorganic content of the herbal plantsanalyzedmoisture content was high irrespective of the plant parts. The inorganic content in all the plant parts ranked, next to the organic content. Analysis on qualitative inorganic elements for acid radicals like sulphate, sulphide, chloride, phosphate, carbonate, nitrate, nitrite, fluoride and oxalate and basic radicals like lead, aluminium, iron, zinc, magnesium, mercury, calcium, sodium and potassium recorded variations. The elements analyzed in the present work could serve as an important factor in determining the quality of the plants. Hence, these plants could be used as better alternates against a variety of degenerative diseases.

Keywords: Inorganic elements, moisture, organic, phytochemicals, qualitative analysis and radicals

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INTRODUCTION

Indian Ayurvedic system is one of the noteworthy traditional systems, which mainly depends on the usage of medicinal plants and their parts for the treatment of animals and humans against various diseases. Plants have different chemicals in their roots, stem, leaves, flowers and fruits. Many plants have great nutritive value and some of them are also the major source of medicine which plays a vital role in the human history. Studies on the phyto-chemistry of plants have shown that aromatic and medicinal plants have a great source of diverse nutrient and non-nutrient molecules which act as antioxidants and antimicrobial agents [1 – 4].

Dry matter obtained after the removal of water content from the plant parts contains both organic and inorganic substances. When the dry matters of the plants are burned, ash is obtained. The nutritional and mineral components are also an important factor in determining the quality of herbs. Inorganic compounds play a vital role against a variety of degenerative diseases. Inorganic constituents like calcium, phosphorous, potassium and sodium are essential to lead a healthy life [5 – 7]. The inorganic compounds are essential in trace amounts to play an important role in nutrition, enzyme reaction and also in the metabolic processes [8].

Metals and trace elements have a decisive role to play in the patho-physiology of human diseases [9]. Metals and minerals present in biological system play a significant role in the metabolism [10]. The phytochemicals found in plant parts which are natural bioactive compounds are divided into primary and secondary constituents. The secondary metabolites which include, organic substances like alkaloids, terpenoids and phenolic compounds [11] are known to be responsible for the therapeutic potential of the herbal plants [12]. The phytochemicals also work as nutrients and fibers to activate the defense system against disease [13].

Medicinal herbs have been regarded as healthy sources of life by many people and now, the awareness is growing. In fact, most of us use certain medicinal herbs in our day to day lives, while cooking without even realizing their importance. Hence in the present work, few commonly used herbal plants were selected for analyzing their physico-chemical and inorganic contents.

Varieties of *Allium cepa* have been an important dietary resource and have also been of interest for medicinal purposes since ancient times [14]. *Aloe vera* has a long history as a multipurpose folk remedy [15]. *Aristolochiabracteolata* is also traditionally used for different ailments and is reported to exhibit anthelmintic effect [16]. *Centellaasiatica* is a slender and creeping herb, which is used as a brain tonic [17]. It is also known to exhibit neuroprotective activity enhancing learning and memory[18]. *Ocimum sanctum* is an aromatic herb, which is widely used in folk medicines for several ailments because of its high medicinal value [19]. *Piper betle* leaf extracts are used as traditional medicine to treat throat inflammation, alleviating cough and indigestion and as breath freshener and antiseptic for wounds [20]. *Sesbaniagrandiflora* is cultivated for its edible leaves which have cooling effect[21]. *Solanumtorvum* is intensively used worldwide in the traditional medicine as poison antidote and for the treatment of fever, wounds, toothdecay and arterial hypertension [22].

There are many works on the phytochemical study of secondary metabolites in plants. However, studies related to inorganic elements or nutritional elements of plant parts are very scarce. Hence in the present investigation, the above mentioned plant parts are analyzed for its qualitative inorganic content.

MATERIALS AND METHODS

Selection of plant materials

The plant parts selected for this analysis are enlisted in (**Table1**).

Table1: List of plant parts selected for the study

S. No.	Scientific name	Family	Common name	Vernacular name in Tamil	Parts used
1	*Allium cepa*	Alliaceae	Small onion	Vengayam	Bulb(B)
2	*Aloe vera*	Asphodelaceae	Aloe	Kattalai	Leaf (L)
3	*Aristolochiabracteolata*	Aristolochiaceae	Worm killer	Aadutheendapalai	Leaf (L)
4	*Centellaasiatica*	Apiaceae	Indian Pennywort	Vallarai	Leaf (L)
5	*Ocimum sanctum*	Lamiaceae	Holy basil	Tulasi	Leaf (L)
6	*Piper betle*	Piperaceae	Betel leaf	Vetrilai	Leaf (L)
7	*Sesbania grandiflora*	Fabaceae	Agati	Akatthi	Leaf (L)
8	*Solanumtorvum*	Solanaceae	Devil's fig	Sundai	Fruit (F)

Collection and authentication of the plant materials

The plant materials selected were collected from the local markets of Chennai, Tamilnadu, India. They were identified morphologically and authenticated by Dr. A. Manoharan, Head of the department of plant biology and biotechnology, Presidency College, Chennai, India.

Physico-chemical analysis

Moisture content determination

To determine the moisture content fresh leaves of *A. bracteolata*, *C. asiatica, O. sanctum, P. betle, S. grandiflora*were washed and shade dried till they attain consistency in weight. The bulb of *A.cepa* and fruit of *S.torvum* are cut into pieces, while the*A. vera* leaf was cut open to remove the gel while the pieces of green skin of *A.vera*were shade dried till a constant weight is obtained. The moisture content was obtained from the differences in dry and wet weight of the samples and converted into percentage.

Determination of ash

The dried leaf materials were powered using electrical blender. Five grams of dry leaf powders were taken separately in pre-weighed crucibles and placed over a tripod stand and ignited slowly over Bunsen flame, till no fumes were evolved. The crucibles were then transferred to Muffle's furnace at a temperature of 550 – 600^{o}C for 5 – 6 hours, till the black carbon particles turns into white color. Then the crucibles were transferred to a desiccator for cooling and weighed to calculate the percentage of total ash. The ash obtained was used for further analysis.

The water and organic content of the plant parts were calculated by subtracting the total of dry weight from the weight of fresh leaves and dry inorganic weight.

For inorganic element analysis, the ash was dissolved in distilled water and used as aqueous ash. Inorganic acid and basic radicals present in the plant parts were analyzed[23].

RESULTS

Physico-chemical analysis

Physico-chemical analysis of the plant materials of the present investigation showed the moisture content to be a predominant component of all the plant parts. Moisture content of *A. vera* was reported to be the maximum (94%), while it is the leastin *S. grandiflora*. *A. bracteolata* leaves also recorded only 74% moisture content recording the dryness of the leaf. Interestingly the onion bulbs recorded the maximum water content. While in the *S. torvum*fruit is only 73%. The organic content of the plant materials also varied in accordance to their moisture content.

Even though plant material with high moisture content appears to record less organic content, they are rich in their organic resource. Except *S. grandiflora*, the other tested leaves of the present investigation relatively recorded 85-90 % organic contents. The organic content of *S.torvum* fruits is nearly 90%, while in onion bulb it is roughly 80%.

The leaves with high organic content recorded lesser percentage of inorganic material and vice versa. Accordingly *S. grandiflora* leaves and onion bulbs recorded highest percentage of inorganic content in the present investigation (**Table 2**).

Table 2: Physico-chemical analysis of the selected plant parts

S.No.	Plants used	Moisture content in percentage (%)	Organic content in percentage (%)	Inorganic content in percentage (%)
1	*Allium cepa*	91	77.8	22.2
2	*Aloe vera*	94	87.8	12.2
3	*Aristolochiabracteolata*	74	89.9	10.1
4	*Centellaasiatica*	88	89.1	10.9
5	*Ocimum sanctum*	80	85.5	14.5
6	*Piper betle*	83	85.6	14.4
7	*Sesbania grandiflora*	60	74.3	25.7
8	*Solanumtorvum*	73	88.6	11.4

Qualitative analysis of the inorganic elements

The results of the elemental analysis of inorganic elements in the selected plant parts as acid and basic radicals were recorded in tables 3 and 4. The acid radical sulphate is present in all the plant parts selected, except the leaves of *A.bracteolata*. Sulphide is absent in all plant parts except *S.grandiflora*. Chloride is present in *A. vera*, *A. bracteolata*, *C.asiatica*, *O. sanctum* and *S.torvum*, while it is absent in others. Phosphate is present in all plants except*A. bracteolata.* Presence of carbonate was recorded in all plant parts while it is absent in *C. asiatica.* Nitrate was detected only in *A.cepa*, *S.grandiflora* and *S.torvum*, whereas it is absent in the other five plants selected. Nitrate was reported in all plants except *S. torvum.* Fluoride and oxalate are present in *A. vera*, *C. asiatica*, *O. sanctum*, *P. betle*, *S. grandiflora*, while they were not detected in *A. cepa*, *A. bracteolata* and *S. torvum* (**Table 3**).

Table 3: Elemental analysis of inorganic acid radicals

S.No.	Name of the plants	Acid Radicals								
		Sulphate	Sulphide	Chloride	Phosphate	Carbonate	Nitrate	Nitrite	Flouride	Oxalate
1	*A. cepa*	+	-	-	+	+	+	+	-	-
2	*A. vera*	+	-	+	+	+	-	+	+	+
3	*A. bracteolata*	-	-	+	-	+	-	+	-	-
4	*C. asiatica*	+	-	+	+	-	-	+	+	+
5	*O. sanctum*	+	-	+	+	+	-	+	+	+
6	*P. betle*	+	-	-	+	+	-	+	+	+
7	*S. grandiflora*	+	+	-	+	+	+	+	+	+
8	*S. torvum*	+	-	+	+	+	+	-	-	-

Analysis of inorganic basic radicals showed the absence of lead and mercury in all the plant parts analysed. Iron, calcium and sodium were reported in all the plant parts selected. Aluminium, zinc and magnesium are present in most of the plants except in *A. bracteolata* and *S. torvum*. Potassium is not detected only in the leaves of *C. asiatica*(**Table 4**).

Table 4: Elemental analysis of inorganic basic radicals

S. No.	Name of the plants	Basic Radicals								
		Lead	Aluminium	Iron	Zinc	Magnesium	Mercury	Calcium	Sodium	Potassium
1	*A. cepa*	-	+	+	+	+	-	+	+	+
2	*A. vera*	-	+	+	+	+	-	+	+	+
3	*A. bracteolata*	-	-	+	-	-	-	+	+	+
4	*C. asiatica*	-	+	+	+	+	-	+	+	-
5	*O. sanctum*	-	+	+	+	+	-	+	+	+
6	*P. betle*	-	+	+	+	+	-	+	+	+
7	*S. grandiflora*	-	+	+	+	+	-	+	+	+
8	*S. torvum*	-	-	+	-	-	-	+	+	+

DISCUSSION

Phytochemical and proximate analyses of plants are used to assess their potential nutritive and medicinal benefits. In plants, the inorganic elements are available only in trace amounts which may usefully influence various functions. These elements are used extensively in chemotherapy and are essential in human and animal health [24 - 26]. Some of the chemical compounds and elements found in the extracts have been known to exert pharmacological effects, while others are capable of protecting the active ingredients in the herb from decomposing either chemically or physiologically [27].

Water content of the plant differs and depends on the part of the plant where it is stored, nature of the soil and the climatic conditions. Fruits and vegetables store maximum water content than any other parts of plant. Water melon (92%), tomato

(94%) and cucumber (96%) are the classical examples for high water content [28]. However, *A.vera* recorded 94% water content unusual to a leaf in the present investigation. This is in accordance to the reports on *A. vera* leaves[8]. High water content of *A. vera* leaf is attributed to the equator climate and drought survival [28].

In plants the majority of sulphur is assimilated in the reduced form [29]. Sulphur is an essential component of vitamins, biotin and co-enzyme [30 – 32]. Chlorides are essential for waterbalance, osmotic pressure regulation as well as acid base equilibrium [30, 32]. Phosphorous, as phosphate is an integral component of plant cells which maintains blood sugar level, normal heart contraction [33], bone growth and kidney function when consumed by humans [34]. The carbonate, as bicarbonate ions plays a key role in the regulation of pH and acid balance in different parts of human body [35]. Most plants obtain the nitrogen they need as inorganic nitrate from the soil [36]. Nitrogen plays an important role in the digestion of food and growth [37]. With respect to the effects of fluoride on human health, the beneficial effects of fluoride in the prevention of dental caries have been assessed[38]. Oxalates in plants provide them structural support, protection against herbivores and maintenance of tissue ion balance [39 – 41].

Lead is neither essential nor beneficial to animals. However, the role of the inorganic basic radicals in animals andplants are varied. The effects of lead in plants vary because plants differ in the uptake from soil and sensitivity to lead [42]. Aluminium is not essential for the growth of plants or animals. Visual diagnosis of aluminium toxicity in plants is unreliable [43]. Iron plays a vital role in the formation of hemoglobin, normal functioning of the central nervous system [44, 45]and transfer of oxygen from lungs to the tissue[46]. Zinc is essential for the production of insulin a hormone and carbonic anhydrase, an enzyme in the body [47]. Magnesium plays an important role in the formation and functioning of bones and muscles and prevents high blood pressures and depressions[48]. Mercury is a toxic metal, which is not reported in plants generally [49]. Calcium, magnesium and potassium are essential for making good of worn out cells, building of red blood cells and maintaining body mechanisms [50]. Sodium and potassium take part in ionic balance of human body and help in the formation of gastric juice in stomach [51].

It is well established that soil texture governs most of the soil properties[52], including the amounts of nutrients available forms [53].The variations of the elements present in the selected plant parts of the present study may be due to the topography, soil-water-plant exchange complex and evapotranspiration of the environment [54]. The difference in the moisture content of the plant parts in the present study may be due to the difference in climatic and storage conditions as suggested earlier [55]. The inorganic residue (ash) remaining after the removal of water and organic matter, provides a measure of total amounts of mineral within the sample [56].

CONCLUSION

Nowadays, there is an increasing interest in the natural remedies, with a basic approach towards nature, due to people's awareness towards the potency and side effect of the synthetic drugs. Hence, it is necessary to analyze the herbal and phytochemicals for achieving sustainable and environmental friendly pharmaceutical products. To ensure the safety and efficacy of herbal medicines used, standardization and the development of the processing aspects of phyto-medicines are very important. Hence, the present study has provided supportive scientific evidence, in which the chemical elements present in the selected plant parts may be pharmacologically important. However, the currently available herbal products are not adequate to meet the demand. Therefore, there is a need to expand the research in much more variety of plants in future.

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