Inorganic Nutrients of *Saccharum bengalense*

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Summary: Keeping in view the medicinal importance of Saccharum bengalense inorganic nutrients like Na^+, K^+, Ca^{+2}, Mg^{+2}, Fe^{+3}, Al^{+3}, HCO_3^{-1}, Cl^{-1}, PO_4^{-3}, SO_4^{-2} and CO_3^{-2} were determined from its stem, flowers and adjacent soil. The levels of K^+, Mg^{+2}, Fe^{+3}, PO_4^{-3} and SO_4^{-2} were found higher in stem of the plant and Na^+, Ca^{+2}, $Cl^{-1}$and HCO_3^{-1} were found higher in flowers of the plant. This base line data generated will be helpful for the preparation of herbal medicine.

Introduction

Cholistan is one of the hottest, arid and sandy deserts in Pakistan. The temperature during summer is high ≤ 50° C and mostly mild in winter with no frost. The mean annual rainfall varies from less than 100 mm in the western part to 200 mm in the eastern part. Rain usually falls during monsoon, winter and spring and is highly variable both on temporal and spatial scales. Aridity is the most striking feature of Cholistan with wet dry years occurring in clusters. The desert was formed by deposition of aeolin sands or alluvium deposits. The alluvium deposits are composed of granites, schists, states and gneiss. The soil of Cholistan is generally saline, alkaline and gypsiferous [1 – 4].

Vegetation in Cholistan desert is typical of arid tract and consists of xerophytic species, which have adapted to extreme seasonal, temperature and moisture fluctuations and wide variety of edaphic conditions. Fortunately a wide range of nutritious and drought tolerant species of grasses, shrubs and trees occupy the region [3].

The common name of the plant is 'Kana' or 'Sarkanda' and is distributed from north and North West India to Pakistan and Afghanistan. Flowering and fruiting are perennial and mostly found from October to January. The plant is very large tufted grass and is of little account as a fodder plant because cattle and buffaloes eat the tender young leaves, only during the scarcity of fodder. A valuable fiber can be extracted from the upper leaf sheats of flowering culms. The stem is sweet, acrid; cooling aphrodisiacand is useful in burning sensations, thirst, erysipelas, blood troubles, urinary complaints, eye diseases and tridosha. The root smoke being considered beneficial and is burnt near women after delivery and burns scalds [3 – 7].

Results and Discussion

Plants possessing their antibiotics properties have been well known since old civilization of Romans, Egyptians and Arabs [8]. In deserts, the medicinal plants are used traditionally as such or with slight modifications by the 'Hakims' and the results are satisfactory and patients get cured. The plant barks, leaves, roots, juices, gums, fruits and seeds in heterogeneous ground mixture or in solution form are used in the treatment of several diseases. Systematic investigation of medicinal plants started in the various research centers in the sub-continent. Keeping in view the medicinal importance of Saccharum bengalense, inorganic nutrients were determined from its stem, flowers and adjacent soils [3].

Table 1 shows that the levels of sodium in stem (5 – 10 ppm) is lower than the flowers (10 – 40 ppm), with the average value of 10 ppm in their soils. But the level of potassium is higher in stem (40.8 – 70.9 ppm) compared to the level in flowers (0.4 – 10.4 ppm) of the plant and soil (10 – 35 ppm). The univalent cations of Na^+ and K^+ perform various electrochemical functions in the human body such as emulsion stabilization, charge neutralization and

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Table 1: Comparative levels of nutritive elements found in *Saccharum bengalense's* stem, flowers and adjoining soils.

Sample area	Sample type	pH	Moisture %	Organic contents %	Soluble salts %	Na^{+} (ppm)	K^{+} (ppm)	Ca^{+2} (ppm)	Mg^{+2} (ppm)	Fe^{+3} (ppm)	Cl^{-1} (ppm)	HCO_3^{-1} (ppm)	PO_4^{-2} (ppm)	SO_4^{-2} (ppm)
	Soil	7.78	7.14	4.48	15.38	10.05	35.00	6.00	1.2	860	17.8	410	0.13	100
A	Plant Stem	–	–	–	–	10	40.8	40	430	285	178	490	1.04	86
	Plant Flowers	–	–	–	–	10	0.4	32	31.2	218	199	820	0.35	20
	Soil	7.60	3.45	7.40	10.29	10.20	10.15	0.27	0.21	229	78.4	106	0.2	200
B	Plant Stem	–	–	–	–	5	70.9	80	140	569	157	710	1.0	154
	Plant Flowers	–	–	–	–	15	10.3	24	28.8	553	500	288	0.8	240
	Soil	7.30	13.63	3.93	14.50	10.00	10.00	0.14	1.26	172	71.2	600	0.25	250
C	Plant Stem	–	–	–	–	5	60.1	24	43	704	203	300	0.7	154
	Plant Flowers	–	–	–	–	40	10.4	120	48	540	311	600	0.35	48

(Average values, n = 4, Confidence interval at 95%)

supply of free energy during cell stimulation. In muscle contraction and nerve stimulation, Na^{+} enters the cell whereas K^{+} leaves it and the potential difference across the cell membrane changes temporarily. The metabolic energy adenosine triphosphate (ATP) is then needed to pump K^{+} back into cell and Na^{+} out of it for normal condition. Na^{+} and K^{+} stabilize oil in water emulsions and maintain the solubility of proteins, such as globulins, which are insoluble in pure water but soluble in dilute salt solutions [8 – 10].

The plant stem (24 – 80 ppm) and flowers (24 – 120 ppm) has high level of calcium than the soil (0.14 – 6 ppm) in which Saccharum bengalense is planted. Calcium plays an important as factor IV in blood cloting mechanisim. Calcium alongwith thromboplastin is required for conversion of prothrombin to thrombin, which activates fibrinogen to form the fibrin network [9].

The level of magnesium in plant stem (43 – 430 ppm) and flower (28.8 – 48 ppm) is high than its level in soil (0.21 – 1.26 ppm). Magnesium is essential activator for all enzymes, which transfer phosphate from adenosine triphosphate to adenosine diphosphate. These reactions are fundamental and widespread and thus influence all basic life processes such as glycolytic cycle. The physical stability of DNA, chromosomes and ribosomes also depends on magnesium. Therefore, a certain amount of magnesium is required during cell duplication process. Normally there is no Mg^{+2} deficiency in the body. However, renal failure and alcoholism may lead to magnesium deficiency, which may cause gross muscular tremor, hallucination, depression and spasmophilia. Excess amount of magnesium is also harmful as it blocks neuromuscular transmission [11–13].

The soil has high level of iron (172– 860 ppm) with the random levels in plant stem (285–704 ppm) and flowers (218–553 ppm). Normally the human body contains 4 – 6 grams of Fe of which nearly 1 g is stored in the liver and spleen. Iron in the body is present mainly as a component of haemoglobin and myoglobin and is responsible for oxygen transport and cellular respiration. It is also present in the intracellular cytochrome enzyme system, which is involved in energy production. During pregnancy iron reserves are depleted which have to be compensated by higher intake of iron. The daily requirement of iron is 10 – 20 mg and its deficiency causes hemolytic anemia, stomatities, listlessness, palpitation, exertion and reduced physical activity. The excessive intake of iron above 50 mg/day accumulates in the liver as haemosidrin and causes haemachromatosis, which is characterized by gray, skin pigmentation, hepatic enlargement, pancreatic infiltration with diabetes and myocardial diseases resulting in heart failure [14 – 19].

Concentration of chloride studied in Saccharum bengalense was higher in stem (157 – 203 ppm) and flowers (199 – 500 ppm) with the lower concentration in soil (17.8 – 78 ppm). The bicarbonates are also found higher in stem (300 – 710 ppm) and flower (288 – 820 ppm) than the adjoining soil (106 – 600 ppm). Chloride is absorbed from the soils as chloride ion (Cl^{-1}) and probably remains in this form in the plant without becoming a structural part of organic molecules. Chloride is essential in water balance, osmotic pressure regulation as well as acid base equilibrium. Mostly it may be required for cell division in leaves and roots [16 – 19].

Phosphate ions are observed higher in stem (0.7 – 1.04 ppm) and flowers (0.35 – 0.8 ppm) of the plant then its level in the adjoining soil (0.1 – 0.25 ppm). Phosphorus is involved in carbohydrate, protein, fat and muscle energy metabolism and in the transport of fatty acids within the cell. The metabolic energy is stored and transferred through high-energy bonds of phosphate esters such as adenosine

triphosate (ATTP) and adenosine diphosphate (ADP) [9].

The sulphate ions are found lower in the stem (86 – 154 ppm) and flowers (20 – 240 ppm) of the plant than its level in the soil (100 – 250 ppm). Sulpher also forms high-energy bonds similar to phosphate bonds. In pantheine residue of acetyl coenzyme-A and in the derivative of lipoic acid (thioctic acid) the sulfur bond is equivalent in energy to phosphate bonds of ATTP. Heavy elements like Hg or As combine with sulphahydryl (-SH) group to block the binding sites which causes inactivation of -SH group enzymes. The tendency of – SH group to bind heavy metals is important and is used in detoxification mechanism by employing these as chelating agents for the removal of heavy metals. For example, the detoxification agent "Birthish anti-Leiwisite" acts by binding the arsenic atom of the chlorovinylarsine poison gas leiwisite similarly; B-pencillamine acts as detoxification agent in the treatment of lead poisoning [9].

Experimental

Materials

During this study, 4 samples from each study area of the plant and soils were collected in the month of November 2001 and January 2002 (Table 2). The samples were then analysed for different cations and anions like Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+3}, Al^{+3}, PO_4^{-2}, SO_4^{-2}, HCO_3^{-1} and Cl^{-1}, using different laboratory methods.

Chemical Reagents

All the reagents and chemicals used were of analytical reagent grade. All solutions of the standards and samples were prepared in freshly prepared deionised water.

Plant Sample Preparation

The plants were cleaned visually to remove the dust particles and dried at 150°C to a constant weight. The dried plants were grinded to fine powder and then used for dry ashing. The pre-cleaned silica crucible was heated at 600°C to a constant weight. The powdered plant material in the crucible was heated in a muffle furnace at 600°C until there was no evolution of smoke. The crucible containing plant ash was cooled at room temperature and moistened with deionised water to keep it overnight. The undissolved particles were filtered and make up the volume to 1000 ml. This solution was used as sample solution [2-3].

Soil Sample Preparation

20 grams of dried soil was taken in a 500 ml beaker, stirred it with 100 ml deionised water for 30 minutes and filtered through 'Whatman 42' filter paper. The volume of the filtrate was made up to 1000 ml and is used for quantitative estimation of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+3}, Al^{+3}, PO_4^{-3}, SO_4^{-2}, HCO_3^{-1} and Cl^{-1} [2-3].

Methods

Sodium and potassium were determined by flame photometer model 'Corning – 40'. Calcium and magnesium were determined by complexometric titration. Iron was determined by oxidation-reduction titration. Phosphates were determined by colorimetric method using 'ammonium dihydrogen phosphate' as standard solution and 'molybodate' as complexing agent. Sulphates were estimated gravimetrically. Bicarbonates were determined by titrimetric method and chlorides were determined by argentometric titration [20, 21].

Conclusion

It is concluded that the levels of nutritive elements like K^{+}, Ca^{+2}, Mg^{+2}, HCO_3^{-1} and PO_4^{-3} are found higher in the Saccharum bengalense than the soil in which the plant is being growing and the levels Na^{+}, Fe^{+3} and SO_4^{-2} were found lesser in the plant even when the adjoining soil has their higher concentration. This data will help in establishing baseline levels on the use of this plant as medicine.

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Table 2: Plant sampling location of Cholistan desert.

Sample code	Sampling Areas.
A	Plant and soil samples collected from Bahawalpur near Satluj river.
B	Plant and soil samples collected from the desert area of Bahawalpur Airport.
C	Plant and soil samples collected near Chak No. 12 B. C.

References

1. I. Ahmad, M. Arshad and H. Bibi, *Online Journal of Biological Sciences,* **1**, 768 (2001).
2. F. Chouhan, M. H. S. Wattoo, S. A. Tirmizi, F. Z. Memon, Aziz-ur-Rahman and M. Tufail. *The Nucleus*, **39**, 195 (2002).
3. S. Kanwal, *M. Sc. Thesis, Chemistry department, Islamia University, Bahawalpur, Pakistan,* (2002).
4. M. Arshad and A. R. Rao, *Urumqi China.* 156 (1995).
5. Atta-ur-Rahman, S. M. Hakim and Viqar uddin Ahmad, *Pakistan Encyclopedia Planta Medica,* Hamdard Foundation Pakistan and H. E. J. Research Institute of Chemistry-Karachi, Pakistan (1986).
6. H. M. Said, *Medicinal Herbal,* Hamdard Foundation Karachi-Pakistan (1996).
7. M. M. Bhandari, *Flora of Indian Desert.* Scientific Publishers, Jodhpur, India (1978).
8. C. Orvig and M. J. Abrams, *Chemical Reviews,* **99**, 2201 (1999).
9. S. J. Khurshid and I. H. Qureshi, *The Nucleus*, **21**, 3 (1984).
10. M. A. Gretbtzoff, E. Schoffenials, *Comparative Biochemistry,* Academic press, New York, Vol **2**, 519 (1970).
11. E. J. Underwood, *Trace elements in human and animal nutrition*, Academic Press, New York (1977).
12. M. N. Huges, *The inorganic chemistry of biological processes*, Willey, New York (1972).
13. L. S. Goodman and A. Gilman. *Pharmacological basis of Theurapeutics,* 4th Ed. 811, Macmillian, New York (1971).
14. S. Garnick, O. G. Lamb, *Trace elements*, Bently and Beatties eds, p: 365, Acad. Press, New York (1958).
15. Recommended Dietary Allowance (RDA), 8th. Ed. National Academy of Sciences, Washington D C (1965).
16. D. C. Adrian, *Trace Elements in the Terrestrial Environment.* Springer, New York (1986).
17. J. B. Herry, and B. E. Statland. *Chemical Pathology and Clinical Chemistry.* W. B. Saunders Company, Philadelphia (1979).
18. E. J. Hewitt and T. A. Smith. *Plant Mineral Nutrition.* The Eng. Univ. Press Ltd. London (1974).
19. Kabata A. Pendias and H. Pendias. *Trace Elements in Soils and Plants.* CRC Press, Inc. Florida (1986).
20. J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, *Vogel's text book of quantitative inorganic analysis*, The English language book society and Longman, New York, p: 325 – 6, 335 – 8 (1978).
21. V. Harold, *Practical clinical biochemistry,* 4th ed. Vazirani for Anrold Heineman Pvt. Ltd. P:526 (1970).