Medicinal Status of *Colocacia esculenta* Linn and Its Relation with Soil

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Summary: Soil of *Colocacia esculenta* Linn was collected from the area of Musakhel Swat District and investigated for pH, micronutrients and macronutrients. pH was found in the range of 6.7 to 7.5 which is slightly acidic to neutral. Sodium, potassium and calcium were found in the range of 9.104-16.461 mg/ L, 7.443-19.107 mg/ L and 9.318-20.206 mg/ L respectively. When the calcium contents are low in the plant body then it could cause the rapid disintegration and disfiguring of growing tips of roots and shoots. The low level of calcium in the soil causes reduction in the translocation of carbohydrates, chlorosis, toxicity of meristematic tissues, expansion of cell, and decolourisation of roots. Magnesium was in the range of 12.216 to 16.133 mg/ L. At low quantity, magnesium could cause chlorosis and appearance of patches on the leaves and subsequently plant death. Iron was found in the range of 6.037 to 13.315 mg/ L. Copper was found from 1.789 to 4.268 mg/ L. The functions of copper in plants include catalysis for respiration, enzyme constitution, chlorophyll synthesis, and carbohydrate and protein metabolism. Zinc and cadmium were found in the range of 5.07 to 6.677 mg/ L and 1.428 to 4.316 mg/ L respectively, which is lower than the desirable level for a fertile soil. Therefore it may cause diseases like necrosis, wilting, red orange coloration of leaves and general reduction in growth. The tap root of *Colocacia esculenta* Linn, collected from Musakhel Swat District, was investigated for micronutrients and macronutrients. Sodium, calcium, magnesium, copper, zinc, cadmium, aluminium and iron were found in the range of 5.223 to 18.42 mg/ L, 18.123 to 22.43 mg/ L, 6.124 to 12.22 mg/ L, 3.041 to 6.342 mg/ L, 2.1 to 8.6 mg/ L, 0.120 to 0.432 mg/ L, 0.5421 to 3.512 mg/ L and 5.123 to 15.33 mg/ L, respectively.

Introduction

Colocacia esculenta Linn is a herbaceous perennial plant (0.5-2 m tall), with an underground starchy corm, which produces at its apex a whorl of large leaves with long robust petioles. *Colocacia esculenta* are grown mostly as a staple or subsistence crop throughout the tropics, subtropics, and in many warmer regions of the temperate zone. The maturation period varies according to the cultivar (6 to 18 months). *Colocacia esculenta* can be used as a source of power alcohol, medicinal plant (treatment of snake bites) and as a big source of essential nutrients [1-3] including macronutrients (K, Ca, Mg, P and S) and micronutrients (Fe, Mn, Zn, Cu, Mo, and Ni). Some essential elements are needed in large quantities and others in much smaller quantities. However, from a practical standpoint, three of the six essential macronutrients are most often "managed" by the addition of fertilizers to soils, while the others are most often found in sufficient quantities in most soils and no soil amendments are required for adequate supplies [1-6].

The macronutrients or micronutrients apply the law of the minimum: the most growth-limiting nutrient will limit growth, no matter how favourable the nutrient supply of other elements is. For example, a deficiency of Fe or Mn (most common in soils containing calcium carbonate) can severely limit plant growth in spite of adequate N, P, and K [1-6]. Deficiencies of nutrients in plants have various visual symptoms that usually similar regardless of the species. Visual symptoms usually involve changes in coloration following a specific pattern, such as from the leaf tip down the midrib towards the base of the leaf or from the leaf margin toward the midrib, or between the veins of the leaf. Such symptoms may appear in new leaves or old leaves, indicating the phloem mobility of the deficient nutrient and the ability of the plant to translocate existing stocks of the deficient nutrient. In many cases, internodal distances will shorten as well. Many nutrients deficiency symptoms are ambiguous unless they are well developed, and a visual diagnosis can be regarded as an educated guess until tissue samples are gathered and chemical analyses are used to compare elemental composition with healthy leaf tissue. In fact, many types of environmental and management damage can masquerade as visual

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nutrient deficiency symptoms [7]. In the present research work *Colocacia esculenta* Linn was used for the investigation of micro and macronutrients, its association with soil and its impacts on the plant and human body.

Results and Discussion

Soil of Colocacia esculenta Linn:

The soil of *Colocacia esculenta* , collected from Musakhel Swat District, was investigated for pH, micronutrients and macronutrients.

pH:

pH of *Colocacia esculenta* soil was found in the range of 6.7 to 7.5 (Table- 1), showing from slight acidic to neutral nature. The highest pH value was found for the soil of plot numbers 4 and 5 (7.5), while the lowest value was recorded for plot number 1 (6.7), which may be due to the presence of low lime content [8]. pH value of a soil is defined by the kinds of parent materials from which the soil is formed. Rainfall also affects the soil pH. Water passing through the soil leaches through basic nutrients, such as calcium and magnesium, from the soil and is replaced by acidic elements such as aluminium and iron. For this reason, soils formed under light rainfall conditions are more acidic than those formed under arid conditions. The soil pH may influence the nutrients absorption and plant growth through direct effect of hydrogen ion, indirectly through its influence on nutrients availability and the presence of toxic ions. In most soils, nutrient's availability is of great importance, for instance, several essential elements like Fe, Mn and Zn tend to become less available as the pH of the soil is raised from 5-8, while Mo is available at a higher pH level. At pH value below 5.0, aluminium, iron and manganese are often soluble in sufficient quantities essential to the growth of some plants. At very high pH values, the bicarbonate ion is sometimes present in sufficient quantities to interfere with the normal uptake of other ions and thus is detrimental to optimum growth of a plant and fertility of the soil [9].

Sodium:

The concentration of sodium in the samples of *Colocacia esculenta*, collected from different plots, was found in the range of 9.104 to 16.461 mg/ L. The highest value of sodium was recorded for the sample S-5 and the lowest, for S-1, as shown in Tables 2-6.

Table- 1: pH of soil, collected from area Musakhel Swat

Sample No.	Sample Code	pH	Average
	S-1A	6.6	
1	S-1B	6.7	6.7
	S-1C	6.9	
	S-2A	7.3	
2	S-2B	7.4	7.3
	S-2C	7.4	
	S-3A	7.4	
3	S-3B	7.4	7.4
	S-3C	7.4	
	S-4A	7.5	
4	S-4B	7.6	7.5
	S-4C	7.6	
	S-5A	7.5	
5	S-5B	7.6	7.5
	S-5C	7.5	

Potassium:

Potassium is necessary for photosynthesis, starch development, translocation of sugar and formation of chlorophyll and is present in soil at three levels i.e. 1-unavailable, 2-readily available and 3-slowly available. In most of the soils, potassium is unavailable. Comparatively high levels of potassium are consumed by soil growing plants. Potassium also plays a key function in the water balance, activation of some enzymes and carbohydrate transformation in the plant body. The exact mechanism that governs the potassium fixation and release is not clear but there are certain factors which influence the fixation of potassium, for example, soil colloids, wetting and drying and the presence of lime contents [9]. The concentration of potassium in the samples of *Colocacia esculenta* collected from different plots is found in the range of 7.443 to 19.107mg/ L. The highest value of potassium is recorded for the sample S-5 and the lowest for S-1, as shown in Tables 2-6.

Calcium:

The concentration of calcium in the soil of *Colocacia esculenta* collected from different plots, was found in the range of 9.318 to 20.206 mg/ L. The highest value of calcium was recorded for the

Table-2: Nutritional status of *Colocacia esculenta* and its Soil, collected from Plot 1 (500 meter away from GT road) at Village Aboha Swat District

Nutrients	Concentration (mg/ L)				S. D	Plant-1 (mg/ L)
	S-1A	S-1B	S-1C	Average		
Sodium	12.33	13.42	1.564	9.104	0.357	6.442
Potassium	8.425	7.452	6.452	7.443	0.804	5.223
Calcium	10.12	8.423	9.412	9.318	2.840	8.123
Magnesium	10.11	14.23	12.31	12.22	2.133	6.124
Iron	10.23	13.42	15.41	13.02	0.830	5.123
Copper	3.145	2.145	4.125	3.138	1.258	3.124
Zinc	4.123	6.142	7.152	5.805	0.457	2.134
Cadmium	2.134	1.452	1.023	1.536	0.608	-
Aluminum	3.124	3.412	5.123	3.886	0.231	1.234

Table-3: Nutritional Status of *Colocacia esculenta* and Its Soil, collected from Plot 2 (300 meter away from GT road) at Village Aboha Swat District

Nutrients	Concentration (mg/ L)				S. D	Plant-2 (mg/ L)
	S-2A	S-2B	S-2C	Average		
Sodium	10.43	12.12	10.64	11.06	0.320	8.342
Potassium	9.325	8.522	7.653	8.500	0.681	6.333
Calcium	14.52	12.22	10.43	12.39	1.672	9.323
Magnesium	12.21	13.23	14.32	13.25	0.860	8.246
Iron	9.235	10.49	11.22	10.32	0.813	15.33
Copper	4.226	3.228	5.334	4.262	0.854	6.342
Zinc	6.426	7.552	6.053	6.677	0.636	8.662
Cadmium	5.008	4.52	3.422	4.316	0.660	0.231
Silicon	6.442	8.322	9.523	8.095	1.270	-
Aluminum	2.004	2.011	2.103	2.039	0.044	2.836

S.D. = Standard deviation

Table-4: Nutritional status of *Colocacia esculenta* and its Soil, collected from Plot 3 (300 meter away from GT road) at Village Kota Swat District.

Nutrients	Concentration (mg /L)				S. D	Plant-3 (mg/ L)
	S-3A	S-3B	S-3C	Average		
Sodium	14.03	15.02	16.02	15.02	0.812	9.042
Potassium	10.855	10.02	9.443	10.106	0.580	7.233
Calcium	12.82	12.99	11.78	12.53	0.534	10.02
Magnesium	14.21	14.33	15.45	14.66	0.550	9.559
Iron	5.775	6.048	8.082	6.635	1.029	9.038
Copper	2.115	1.208	2.044	1.789	0.411	3.041
Zinc	3.412	6.665	5.985	5.354	1.402	6.421
Cadmium	4.028	3.51	2.12	3.219	0.805	0.432
Silicon	4.471	5.302	6.503	5.425	0.832	-
Aluminum	1.234	3.452	4.562	3.082	1.382	3.421

Table- 5: Nutritional status of *Colocacia esculenta* and its Soil, collected from Plot 4 (300 meter away from GT road) at Village Nawakalay Swat District.

Nutrients	Concentration (mg/ L)				S. D	Plant-4 (mg/ L)
	S-4A	S-4B	S-4C	Average		
Sodium	10.03	11.22	13.22	11.49	1.315	10.11
Potassium	16.23	14.56	12.84	14.54	1.388	10.45
Calcium	18.45	17.85	18.42	18.24	0.284	13.42
Magnesium	16.48	15.74	14.52	15.58	0.810	10.23
Iron	6.485	8.421	9.452	8.119	1.228	7.412
Copper	3.145	4.012	3.018	3.391	0.442	4.012
Zinc	4.123	7.152	6.412	5.895	1.280	7.852
Cadmium	3.142	4.000	1.023	2.721	1.251	0.120
Silicon	2.314	3.142	3.752	3.069	0.589	-
Aluminum	0.982	0.7521	0.854	0.862	0.093	0.5421

S.D. = Standard deviation

Table-6: Nutritional status of *Colocacia esculenta* and its Soil, collected from Plot 5 (300 meter away from GT road) at Village Barikot Swat District.

Nutrients	Concentration (mg/ L) S-5A	S-5B	S-5C	Average	S. D	Plant-5 (mg/ L)
Sodium	15.42	16.42	17.54	16.46	1.134	12.33
Potassium	19.45	18.42	19.45	19.11	0.487	18.42
Calcium	20.42	19.85	20.35	20.21	0.266	22.43
Magnesium	17.42	14.56	16.42	16.13	1.185	12.22
Iron	5.552	6.663	5.896	6.037	0.462	6.421
Copper	2.415	3.145	2.145	2.568	0.178	3.178
Zinc	3.145	4.523	7.542	5.070	1.835	2.123
Cadmium	1.231	2.000	1.055	1.428	0.410	0.169
Silicon	0.314	0.512	0.541	0.455	0.129	-
Aluminum	2.314	3.415	4.523	3.417	0.901	3.512

S.D. = Standard deviation

sample S-5 and the lowest for S-1, as shown in Tables 2-6 .Low calcium contents in the plant body could cause rapid disintegration and disfiguring of growing tips of roots and shoots. The low levels of calcium in the soil increase the concentration of magnesium up to abnormal range, reduce the translocation of carbohydrates, chlorosis, toxicity of meristematic tissues, expansion of cell, and deco lour roots [10].

Magnesium:

The concentration of magnesium in the sample of soil of *Colocacia esculenta,* collected from different plots was found in the range of 12.216 to 16.133 mg/ L. The highest value of magnesium was recorded for the sample S-5 and the lowest for S-1, as shown in Tables 2-6. At a low quantity, it can cause chlorosis and appearance of patches on the leaves which can lead to plant death [11].

Iron:

The concentration of iron in the sample of soil of *Colocacia esculenta,* collected from different plots, was found in the range of 6.037 to 13.02 mg/ L. The highest value of iron was recorded for the sample S-1 and the lowest, for S-5, as shown in Tables 2-6. Typically the soil contains total 1-5 % iron. The reddish and yellowish colors of soil indicate the presence of iron oxides and iron hydroxides. Ferric iron compounds have a low solubility in soils solution, thus decreasing the ferric iron contents in the soil. The concentration of iron in the soil decreases with the increase in pH of the soil, with a minimum around pH 7.4 - 8.5. Such situations mostly occur in the case of calcareous soils. Iron deficiencies occur most frequently in cool and wet soil, where microbial activity and root growth are limited. As the soil warms, microbial activity and root proliferation increase, allowing plants to absorb more iron. If microbial activity is sufficient to decrease the oxygen supply in acid soil, some ferric iron oxide and hydroxide will be transferred to more soluble ferrous forms. On the other hand, in alkaline soil high microbial respiration may produce sufficient carbon dioxide to react with water to form carbonate ions. Plants absorbed carbonate ions immobilize iron within plants, resulting in deficiency. Iron deficiency is expressed as yellow leaves due to low levels of chlorophyll (chlorosis), which first appears in the younger upper leaves in interveinal tissues. Severe iron deficiencies may cause leaves to turn completely yellow or almost white, and then brown as leaves die. Iron deficiencies are found mainly in plants cultivated on calcareous (high pH) soils. Slight acidic to neutral Ph (6.25-7.55pH) indicates the iron concentration is sufficient [9].

Copper:

The concentration of copper in the sample of soil of *Colocacia esculenta,* collected from different plots, was found in the range of 1.789 to 4.262 mg/ L. The highest value of copper was recorded for the sample S-2 and the lowest for S-3, as shown in Tables 2-6 .The suitable value for agricultural soil ranges from 1 to 50 mg/ L [12]. The functions of copper in plants include catalysis for respiration, enzyme constitution, chlorophyll synthesis, carbohydrate and protein metabolism [12]. Deficiency symptoms of Cu are dieback of stems and twigs, yellowing of leaves, stunted growth, and pale green leaves that wither easily. Cereal crops are especially susceptible to low Cu levels, with curled leaves at tillering, head and stem bending, shrivelled grain, and delayed maturity. Copper deficiencies are mainly reported on organic soils (peats and mucks), and on sandy soils which are low in organic matter. Copper uptake decreases with increases in soil pH and increased P and Fe availability in soils. Some crops that are sensitive to copper deficiency are alfalfa, barley, corn, oats, wheat and some vegetable crops. While at a greater concentration it may cause stunting and reduce branching. The concentration of copper in the soil sample of the study area is within the permissible limit and thus causes no harm to plant body.

Zinc:

The major sources of zinc through which it enter in to the soil are zinc sulphides, zinc oxide and zinc silicates. Soil Zn availability is diminished by high soil phosphorous levels and soil pH greater than 6.5. Deep sandy soils have inherently low Zn supplies. The required level of Zn in soil is 10-300 mg/ L [13]. The functions of zinc in plants are the formation of growth hormones, promotion of protein synthesis, and seed and grain maturation and production [14]. The zinc level in the soil sample of *Colocacia esculenta* was found in the range of 5.07 to 6.677 mg/ L. The highest value of zinc was recorded for the sample S-2 and the lowest, for S-5, as shown in Tables 2-6. Zinc deficiency symptoms are short internodes (rosetting), a decrease in leaf size, chlorotic bands along the midribs of corn, mottled leaves of dry beans, and narrow yellow leaves in the new growth of citrus and delayed maturity. Zinc deficiency is mainly found on in plants cultivated sandy soils that are low in organic matter. It occurs more often during cold, wet spring weather and is related to reduced root growth and activity. Uptake of Zn decreases with increased soil pH, and is adversely affected by high levels of available P and Fe in soils. On the other hand at a greater concentration, it reduces the amount of iron and interferes with magnesium [14]. As the soils of the study area have low concentration of zinc than the recommended value thus it may cause the above mentioned effect on the plant body.

Cadmium:

Cadmium is the heavy metal of greatest concern in agricultural soils. The amount of cadmium in the soil sample of *Colocacia esculenta* was noted in the range of 1.428 to 4.316 mg/ L. The Highest value of cadmium was recorded for the sample S-2 and the lowest for S-5, as shown in Tables 2-6, which is higher than the desirable level for a fertile soil. Therefore, it may cause diseases like necrosis, wilting, red orange coloration of leaves and general reduction in growth (0.1-1.0 mg/ L). Cadmium is loosely held by soil constituents and is readily available to plants. Thus, increased concentrations in soil result in increased concentrations in crops. Cadmium accumulation in plant materials varies with crop type and plant part. In general, broadleaf plants accumulate more cadmium than grasses, and plant leaves and stems accumulate more than seeds [14].

Nutrients in the Tap Root of Colocacia esculenta.

The tap root of *Colocacia esculenta* was collected from Musakhel Swat District and investigated for both micro and macronutrients.

Sodium:

Sodium was found in a concentration range of 6.442 to 12.33 mg/ L, as shown in Tables 2-6 and Fig. 1-5. Sodium acts in consort with potassium, the chief cation of intracellular fluid, to maintain proper body water distribution and blood pressure. Sodium is also important in maintaining the proper acid-base balance and in the transmission of nerve impulses. Persons who experience pronounced losses of sodium through diarrhoea, heavy perspiration or inability of the kidney to reabsorb it may experience decreased blood volume and a fall in blood pressure that could result in shock. The estimated minimum requirement of sodium for healthy persons (EMRHP) according to the National Academy of Sciences ranges from 120 mg/ day for infants to 500 mg/ day for adults and children > 10 years. Recommendations for the maximum amount of sodium that can be incorporated into a healthy diet range from 2,400 to 3,000 mg/ day or 6 to 7.5 grams of table salt/ day. A substantial portion of

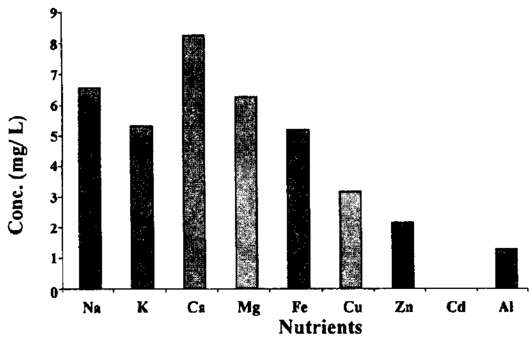

Fig. 1: Nutritional status of *Colocacia esculenta* collected from Village Aboha Swat District (Plot 1).

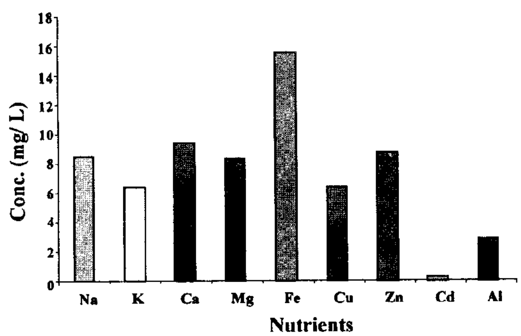

Fig. 2: Nutritional status of *Colocacia esculenta* collected from village Aboha Swat District (Plot 2).

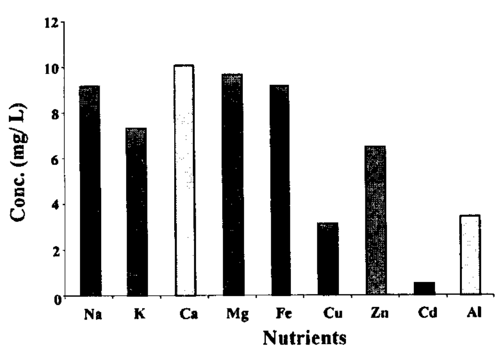

Fig. 3: Nutritional status of *Colocacia esculenta* collected from village Kota Swat District.

sodium in foods is hidden in the sense that it occurs in foods that are moderate in sodium content but are not thought of as salty foods and are consumed regularly, e.g., processed grain and cereal products.

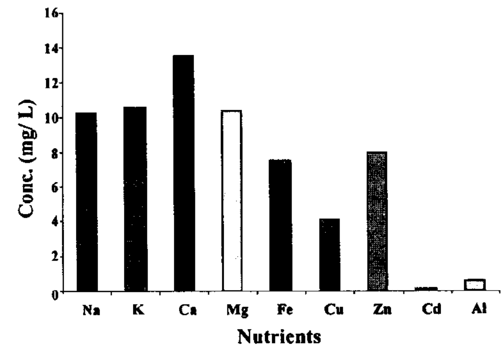

Fig. 4: Nutritional status of *Colocacia esculenta* collected from village Nawakalay Swat District.

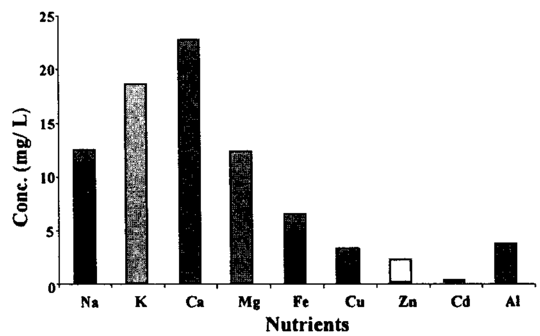

Fig. 5: Nutritional status of *Colocacia esculenta* collected from village Barikot Swat District.

The highest amounts of salt are found in table salt and soy sauce, followed by foods in brine such as pickles, olives and sauerkraut. Salty or smoked meats and fish, salted snack foods, bouillon cubes, bottled sauces, processed cheeses, and canned and instant soups also contain significant levels of sodium. Acute toxicity results in oedema and hypertension and can cause death in an infant because of limited excretory ability of the immature kidney. However, sodium is generally non-toxic for healthy adult individuals because it is excreted readily in the urine. High salt intakes have been correlated with hypertension, asthma, urinary calcium losses and to gastric cancer [15].

Potassium:

Potassium is the most essential cation of cells. Most of the total body potassium is found in the muscle tissue. The best potassium sources are fruits, vegetables, juices, meats and cereals. Total potassium can be considered a measure of lean body mass, muscle mass and cell mass. Hypokalemia (low serum K^{+1}) is the result of excessive loss of K^{+1} in the urine, usually a result of use of diuretic agents to treat hypertension. Hypokalemia may result in cardiac failure. The estimated minimum requirement of potassium for adolescents and adults is 2000 mg or 50 mEq/ day. The usual dietary intake for adults is about 100 mEq/ day. Potassium in *Colocacia esculenta* samples were found in the range of 5.223 to 18.42 mg/ L, as shown in Tables 2-6 and Figs. 1-5. For hypertension patients using diuretic medications, it is often recommended to supplement their diet with orange juice, bananas and vegetables, which contain high amounts of potassium. Increased potassium intake helps maintain normal plasma levels. Urinary excretion protects against the accumulation of high levels of potassium. However, acute hypokalemia can be lethal by causing cardiac arrest [16].

Calcium:

Calcium is the most common mineral in the human body. Adequate intakes of calcium are an important determinant of bone health and risk of fracture or osteoporosis. About 99 % of total body calcium is in the skeleton/teeth and 1 % in the blood and soft tissues. Calcium has four major biological functions: 1) structural as stores in the skeleton, 2) electrophysiological - carries charge during an action potential across membranes, 3) intracellular regulator, and 4) as a cofactor for extra-cellular enzymes and regulatory proteins. Calcium is present in variable amounts in all foods and water. Acute deficiency symptoms are avoided because of the large skeletal stores. Prolonged bone resorption from chronic dietary deficiency results in osteoporosis either by inadequate accumulation of bone mass during growth or increased rate of bone loss at menopause. Dietary calcium deficiency also has been associated with increased risk of hypertension, preeclampsia, and colon cancer. Calcium in *Colocacia esculenta* samples was found in the range of 8.123 to 22.43 mg/ L, as shown in Tables 2-6 and Figs. 1-5. The dietary recommendations set by the 1997 National Academy of Science panel on calcium and related nutrients are: 210 mg/ L for 0-6 month olds, 270 mg/ L for 6-12 month olds, 500 mg/ L for 1-3 year olds, 800 mg/ L for 4-8 year olds, 1300 mg/ L for individuals aged 9-18 years, 1000 mg/ L for individuals aged 19-50 years, and 1200 mg/ L for individuals over the age of 51 years. The recommended upper level of calcium is 2.5 g/ day. Symptoms of calcium toxicity are largely anecdotal [16].

Magnesium:

Magnesium is the fourth most abundant cation in the body, with 60 % in the bone and 40 % distributed equally between muscle and non-muscular soft tissue. Good dietary sources of magnesium include legumes, whole grain cereals, nuts and dark green vegetables. Magnesium has an important role in at least 300 fundamental enzymatic reactions, including the transfer of phosphate groups and the hydrolysis of phosphate and pyrophosphate. In addition, it functions in the activation of amino acids, synthesis and degradation of DNA and has a key role in neurotransmission and immune function. Magnesium acts as a calcium antagonist and interacts with nutrients, such as potassium, vitamin B6, and boron. Symptomatic deficiency is often observed in the presence of a predisposing disease state such as malabsorption, chronic alcoholism, renal dysfunction and hyperparathyroidism. Clinical manifestations of deficiency are related to its role as a cofactor in enzymatic reactions and in regulating neurotransmitters. Hypertension, arrhythmias, neuromuscular manifestations, and personality changes occur during deficiency. Accepted clinical uses of magnesium include the treatment of tachycardia and electrolyte depletion. It is also used for the management of premature labour, and for the prophylaxis and treatment of seizures in toxaemia of pregnancy and hypomagnesaemia associated with such conditions as alcoholism, Crohn's disease and hyperthyroidism. Magnesium is an active ingredient in antacids and laxatives. As can be seen from Tables 2-6 and Figs. 1-5, magnesium in *Colocacia esculenta* samples was found in the range of 6.124 to 12.22 mg/ L. The Dietary Reference Intakes (DRI), according to age and sex, are as follows: Infants 0-6 months, 30 mg and 7-12 months, 75 mg; ages 1-3 years, 80 mg; 4-8 years, 130 mg; 9-13 years, 240 mg; males 14-18 years, 410 mg; males 19-30 years, 400 mg; males > 30 years, 420 mg; females 14-18 years, 360 mg; females 19-30 years, 310 mg; and females > 30 years, 320 mg. Magnesium deficiency has been shown to be involved throughout the development of atherosclerosis, including oxidation of cholesterol and lipoproteins and calcification [17].

Copper:

Copper is a trace element that is essential for humans due to its being a part of enzymes. Copper is involved in the absorption, storage and metabolism of iron. The symptoms of copper deficiency are similar to iron deficiency that leads to anaemia. Copper may be absorbed both by the stomach and the small intestinal mucosa, with most absorbed by the small intestine. Copper is found in the blood bound to proteins. The average level of copper stored in the body is 50 to 120 mg mostly found in the liver. Excess dietary copper can also lead to high copper levels in the kidney. However, under normal situations, not much copper is excreted through urine. Most copper is excreted via bile that is released into the gastrointestinal tract, with minimal copper reabsorbed by intestinal cells. The uptake of copper and elimination through the bile allows copper to be conserved and tightly regulated. A lifetime marginal diet copper in humans is thought to lead to heart diseases. Copper deficiency has been observed in premature babies and infants suffering from malnutrition. The estimated safe and adequate intake for copper is 1.5 - 3.0 mg/ day. As can be seen from Tables 2-6 and Figs. 1-5, copper in *Colocacia esculenta* samples was found in the range of 3.041 to 6.342 mg/ L. Copper is found in foods such as nuts [0.2 to 0.5 mg/ 28 g , shellfish (1.0 to 3.7 mg/ serving), organ meats (3.8 mg/ serving of beef liver) and legumes (0.2 mg/ serving). Copper absorption may be decreased by the excess dietary iron or zinc. Conversely, excess copper consumption may cause iron deficiency, liver damage, weakness and nausea [9].

Iron:

Iron (Fe) is an essential nutrient that carries oxygen and forms part of the oxygen-carrying proteins, haemoglobin, in red blood cells. It is also a necessary component of various enzymes. Body iron is concentrated in the storage forms, ferritin and haemosiderin, in bone marrow, liver and spleen. Body iron stores can usually be estimated from the amount of ferritin protein in serum. Red meat, poultry, fish, vegetables, legumes and nuts are rich sources of iron. Severe iron deficiency results in anaemia, pale, red blood cells that have a low haemoglobin concentration. Iron deficiency anaemia in pregnancy increases the risk of premature and low birth weight babies. In young children, iron deficiency is associated with behavioural abnormalities and reduced cognitive performance that may not be fully reversible by iron replacement. In adults, severe iron deficiency, anaemia impairs physical work capacity. The Recommended Dietary Allowance (RDA) for iron is 6 mg for infants through 6 months of age; 10 mg for older infants and children through 10 years old, men 18 years, women over 50 years; 12 mg for 11-18 year-old males; 15 mg for 11-50 year-old females, including nursing mothers; and 30 mg during pregnancy [18]. Tables 2-6 and Figs. 1-5 show the iron in *Colocacia esculenta* samples in the range of 5.123 to 15.33 mg/ L.

Zinc:

The concentration of zinc in the samples was found in the range of 2.1 to 8.6 mg/ L., as shown in Tables 2-6 and Figs. 1-5. Zinc has structural, catalytic (enzymatic) and regulatory roles. About 1 % of the human genome codes for zinc finger proteins, where zinc provides a structural role for regulatory functions. Over 60 enzymes require zinc for activity, including the RNA polymerases. Zinc is actively taken up by synaptic vesicles, supporting in neuronal activity and memory. Zinc metabolism is altered during disease and physical stress through hormones, cytokines and toxins. Chronic zinc deficiency in humans results in reduced growth (dwarfism) and sexual development which are reversible by raising zinc intake. The Recommended Dietary Allowances (RDAs) are: infants, 5 mg/ day; children < 10 years, 10 mg/ day; males > 10 years, 15 mg/ day; females > 10 years, 12 mg/ day; pregnancy, 15 mg/ day; and lactation, 0-6 mo., 19 mg/ day; 7-12 mo., 16 mg/ day. Zinc is highly abundant in red and white meat and shellfish. Foods of plant origin except the embryo portion of grains, e.g., wheat germ, are low in zinc. Zinc from human milk is more absorbable than that from infant formulas or cow's milk. Acute zinc toxicity is characterized by gastric distress, dizziness and nausea. Symptoms of chronic toxicity include gastric problems [19].

Aluminium:

The typical dietary intake of aluminium varies widely from 3 to 100 mg/ day. Significant

Table-7: Conditions specification for atomic absorption spectrophotometer

Element	Wavelength (nm)	Slit width (nm)	Lamp Current (mA)	Flame
Calcium (Ca)	422.7	0.7	10	Air-Acetylene
Magnesium (Mg)	285.2	0.7	6	Air-Acetylene
Iron (Fe)	248.8	0.2	30	Air-Acetylene
Zinc (Zn)	213.9	0.7	15	Air-Acetylene
Copper (Cu)	324.8	0.7	15	Air-Acetylene
Cadmium (Cd)	228.8	0.7	4	Air-Acetylene

Table-8: Sampling from the study area

Sample No.	Sample Code	Location	Date of collection	Source of Irrigation	Distance of field from the GT road
1	S-1A to S-1C P-1	Aboha	16th Dec. 2006	River Swat	500 m
2	S-2A to S-2C P-2	Aboha	16th Dec. 2006	River Swat	300 m
3	S-3A to S-3C P-3	Kota	17th Dec. 2006	River Swat	300 m
4	S-4A to S-4C P-4	Nawakalay	17th Dec. 2006	River Swat	300 m
5	S-5A to S-5C P-5	Barikot	17th Dec. 2006	River Swat including municipal sewage	300 m

sources of aluminium include baked goods prepared with chemical leavening agents (i.e., baking powder), processed cheese, grains, vegetables, herbs and tea. Aluminium toxicity is apparently not a concern for healthy individuals. Ingestion of high dietary aluminium most likely does not cause Alzheimer's disease, but may exacerbate this disease. Moreover, high intakes of aluminium through such sources as buffered analgesics and antacids by susceptible individuals (i.e., those with impaired kidney function including the elderly and low-birth-weight infants) may lead to pathological changes [20]. The concentration of aluminium in the samples was found in the range of 0.5421 to 3.512 mg/ L, as shown in Tables 2-6 and Figs. 1-5.

Cadmium:

The concentration of cadmium in the samples was found in the range of 0.120 to 0.432 mg/ L, as shown in Tables 2-6 and Figs. 1-5. The typical dietary intake of cadmium is 10 to 20 μg/ day. Significant sources of cadmium include shellfish, grains (especially those grown on high cadmium soils) and leafy vegetables. Cadmium has a long half-life in the body and thus high intakes can lead to accumulation resulting in damage in some organs, especially the kidney. The Reference Dose (RfD) (safe daily intake over a lifetime) for cadmium is 0.5 μg per kg body weight [20].

Experimental

Identification:

The medicinal plants were identified by the literature.

Primary Processing:

Five samples of *Colocacia esculenta* and its soil were collected from different localities of Musakhel Swat. Each sample is further composed of four samples in which one sample is plant (tap root of *Colocacia esculenta*) while the remaining three samples of soil of concerned field (Table- 8). The samples were then delivered quickly in order to prevent microbial fermentation and thermal degradation. The materials were stored under refrigeration in jars. All samples were inspected during the primary-processing stages by removing foreign matter by hand (damaged materials, soil, stones etc.).

Drying:

The plant tap root was used in dry form (air dried ovens at 100 °C), the moisture content of the material was kept low in order to reduce damage from mould and other microbial infestation.

Procedure:

Digestion of Colocacia esculenta Linn Tap Root

The dried tap root was ground to powder form by means of grinder and then one gram of sample was taken in a conical flask and treated with 4 cm^3 nitric acid and covered with watch glass. The flask was heated on an electric hot flat for one hour. After the completion of heating time the contents of the flask was cooled and added with 4 cm^3 of nitric acid again and then heated again for an hour. After one hour of heating, the watch glass was removed from the conical flask and the heating was continued until the volume of the contents was reduced to semi-dried mass. The contents of the flask were cooled, diluted to 25 cm^3 with double distilled water, and then filtered through ordinary filter paper. The sample was then stored in bottles for the determination of nutrients through atomic absorption spectrometer (A-Analyst 700-PerkinElmer USA) and flame photometer (Na,K).

Nutrients in the Soil of Colocacia esculenta Linn:

Digestion of Soil

Soil samples were taken from a depth of 0-15 cm of the agriculture fields (Table- 8), dried at 105 °C. The dried soil sample was screened and the particle size was reduced by means of pestle and mortar and then one gram of soil sample was taken in a conical flask, treated with 4 cm^3 nitric acid and covered with watch glass. The flask was heated on an electric hot flat for one hour. After the completion of heating time, the contents of the flask were cooled, added with 4 cm^3 of nitric acid and 2 cm^3 of H_2O_2 (30 %) and then heated again for an hour. After an hour of heating, the watch glass was removed from the conical flask and the heating was continued until the volume of the contents was reduced to semi-dried mass. The contents of the flask were cooled, diluted to 100 cm^3 with double distilled water and then filtered through ordinary filter paper. The sample was then stored in bottles for the determination of nutrients through atomic absorption spectrometer (A-Analyst 700-PerkinElmer USA) and flame photometer (Na,K). pH of the soil samples was measured by pH meter (Hanna HI 8418).

Conclusions

1. pH of the soil was found in the range of 6.7 to 7.5 showing from a slight acidic to neutral nature. The highest pH value was found for the soil of plot numbers 4 and 5 (7.5), while the lowest value was recorded for plot number 1 (6.7) which may be due to the presence of low lime content.
2. The highest value of potassium, calcium, magnesium was recorded for the soil sample S-5 and the lowest, for S-1
3. The highest copper content in soil was in S-2 and the lowest in S-3 and for zinc and cadmium, the highest was for the sample S-2 and the lowest, for S-5.
4. In the sample of *Colocacia esculenta*, the nutrients were found in concentrations enough to fulfil its nutritional values.
5. The soil of the study area is rich in nutrients which leach into the plant body and are thus accumulated.

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