Investigation of Specific Elemental Distribution in *C. sativus* L., *S. melongena* L. and *M. charantia* L. by Atomic Absorption Spectrometry

[1] SULTAN ALAM*, [2]ILYAS AHMAD AND [3]FAZLULLAH KHAN BANGASH
[1]*Department of Chemistry, Govt. Post Graduate Jahanzeb College Saidu Sharif Swat, Pakistan.*
[2]*Department of Botany, Govt. Post Graduate Jahanzeb College Saidu Sharif Swat, Pakistan.*
[3]*Institute of Chemical Sciences University of Peshawar, Pakistan.*

(Received 31st May 2007, accepted in revised form 19th September 2008)

Summary: *C. sativus* L. *S. melongena* L. and *M. charantia* L. samples were collected from fruit market of Swat and investigated for specific elemental distribution by atomic absorption spectrometry. The results showed that the concentration of metals in all samples were high with skin as compared to without skin. The metals were found in concentration (mg/L) as; Sodium: *C. sativus* L. with skin (10.2) and without skin (9.5), in *S. melongena* L. with skin (15.2) and without skin was (8.4) and *M. charantia* L. with skin and seed (4.5) and without skin and seeds was (3.1). Calcium: *C. sativus* L. with skin (8.1) and without skin (6.0), in *S. melongena* L. with skin (18.4) and without skin was (11.2) and *M. charantia* L. with skin and seed (8.1) and without skin and seeds was (6.1). Magnesium: *C. sativus* L. with skin (7.4) and without skin (6.3), in *S. melongena* L. with skin (10.2) and without skin was (8.4) and *M. charantia* L. with skin and seed (4.5) and without skin and seeds was (3.2). Iron: *C. sativus* L. with skin (3.1) and without skin (2.1), in *S. melongena* L. with skin (4.2) and without skin was (1.2) and *M. charantia* L. with skin and seed (3.1) and without skin and seeds was (4.1). Other elements like nickel, copper, zinc, cobalt, cadmium and chromium were found in trace quantities.

Introduction

Metals have essential impacts on human health in many ways. Some metals such as Cu, Mn and Zn etc. are essential micronutrients with a human intake requirement up to few milligrams per day. However, micronutrients may become harmful if ingestion rates are too high. Their deficiencies, excesses or imbalances in the dietary sources can have deleterious influences on human health [1-6]. Metal concentrations in foodstuff depend on soil characteristics such as content of organic matter, pH and clay mineralogy, which can affect the availability of elements. Vegetables and animals can take up high amount of metals from contaminated soils as well as from contaminated water and polluted air. Besides environmental pollution, a matter of concern is the addition of chemical products as fertilizers, fungicides, insecticides and herbicides to crops. These products may contain several metals and their additions can increase the metal concentrations in soil and water. Furthermore, the physical and chemical forms in which they are dispersed can increase the metal availability for plants and so increase the metal concentrations in vegetables [3]. Research workers studied the metal concentrations in vegetables. *C. sativus* L. was used earlier for heavy metals like copper, cadmium determination in contaminated soil and then their acute toxicities were compared [7, 8]. The EC_{50} values (the concentration of metals in the soil that reduces the growth of shoots and roots by 50%) were derived using the Trimmed Spearman–Karber method. The basic purpose of this study was to know the nutritional status of *C. sativus* L., *S. melongena* L. and *M. charantia* L. This study was further extended to the role of nutrients in the human body and its impact on life.

Results and Discussion

Sodium

As sodium is the predominant cation in extracellular fluid and its concentration is under tight homeostatic control. Sodium is very efficiently reabsorbed by the kidney when intakes are low or losses are excessive. Sodium acts in consort with potassium, the chief cation of intracellular fluid to maintain proper body water distribution and blood pressure. The Estimated Minimum Requirement of healthy persons for sodium from the National Academy of Sciences is: 120 mg/day for infants to 500 mg/day for adults. High sodium intake of highly salted foods may also be related to asthma, urinary

*To whom all correspondence should be addressed.

calcium losses and to gastric cancer [4]. The concentration of sodium in *C. sativus* L. with skin was found as 10.21 mg/Kg and without skin 9.51 mg/Kg, in *S. melongena* L. with skin was noted as 15.2 mg/Kg and without skin was 8.4 mg/Kg and *M. charantia* L. with skin and seed was 4.5 mg/Kg and without skin and seeds was 3.1 mg/Kg as can be seen from Figs. 1-6. The result shows that the concentration of sodium in all samples is high with skin which is an indication of sodium accumulation in the bark and seed. The highest concentration of sodium was noted in the sample of *S. melongena* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin and seed.

Potassium

The problems associated with potassium are anxiety, blistering skin, confusion, constipation, decreased blood sugar, depression, deterioration of memory, digestion upset, dry skin, gas, granulation of the eyelids, heart deterioration, improper fat digestion, lack of sleep, muscular weakness, nausea, nervous system deterioration, skin eruptions and warts [5]. Potassium in *C. sativus* L. with skin was found as 9.5 mg/Kg and without skin 8.0 mg/Kg, in *S. melongena* L. with skin was noted as 16.4 mg/Kg and without skin was 10.1 mg/Kg and *M. charantia* L. with skin and seed was 6.3 mg/Kg and without skin and seeds was 5.2 mg/Kg as can be seen from Figs. 1-6. The highest concentration of potassium was noted in the sample of *S. melongena* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin and seed.

Calcium

Calcium is one of the most important elements in the diet because it is a structural component of bones, teeth and is essential for many metabolic activities. Acute deficiency symptoms are avoided because of the large skeletal stores. Prolonged bone resorption from chronic dietary deficiency results in osteoporosis. Requirements are therefore high during childhood, adolescence, pregnancy and breastfeeding. Recommended daily intake varies accordingly: 500 mg for infants 0 to 12 months, 800 mg for 1 to 10 years children, 1200 mg for 11 to 24 years ages [6]. The concentration of calcium in *C. sativus* L. with skin was found as 8.1 mg/Kg and without skin 6.0 mg/Kg, in *S. melongena* L. with skin was noted as 18.4 mg/Kg and without skin was 11.2 mg/Kg and *M. charantia* L. with skin and seed was 8.124 mg/Kg and without skin and seeds was 6.124 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of calcium in all samples is high with skin. The highest concentration of calcium was noted in the sample of *S. melongena* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin.

Magnesium

Magnesium deficiency results in fatigue, confusion, irritability, weakness, hypertension, heart disturbance, loss of appetite, insomnia, nausea, vomiting, diarrhea, problems with nerve conduction, and problems with muscle contraction. The DRIs, according to age and sex are: 30 mg for infants of 0-6 months, and 75 mg for 7-12 months, 80 mg for 1 to 3 years, 130 mg for 4 to 8 years, 240 mg for 9 to 13 years, 410 mg for 14 to 30 years males, 400 mg for males >30 years, 420 mg for 14 to 30 years females [8]. Magnesium in *C. sativus* L. with skin was found as 7.4 mg/Kg and without skin 6.3 mg/Kg , in *S. melongena* L. with skin was noted as 10.2 mg/Kg and without skin was 8.4 mg/Kg and *M. charantia* L. with skin and seed was 4.5 mg/Kg and without skin and seeds was 3.2 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of magnesium in all samples is high with skin. 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.

Chromium

The estimated safe and adequate daily dietary intake of chromium for adults is 50 to 200 μg [9]. The concentration of chromium in *C. sativus* L. with skin was found as 0.124 mg/Kg and without skin 0 mg/Kg, in *S. melongena* L. with skin was noted as 0 mg/Kg and without skin was 0 mg/Kg and *M. charantia* L. with skin and seed was 0.133 mg/Kg and without skin and seeds was 0.102 mg/Kg as can be seen from Figs. 1-6. The highest concentration of chromium was noted in the sample of *M. charantia* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin and seed.

Copper

The estimated safe and adequate intake range for copper is 1.5 to 3.0 mg/day. Copper is

Table-1: Investigation of specific elemental distribution in the samples of *C. sativus* L., *S. melongena* L. and *M. charantia* L. collected from fruit market swat.

Nutrients	Concentration (mg/Kg)					
	Cucumis sativus L		*S. melongena L*		*M. charantia Linn*	
	with skin	without skin	with skin	without skin	with skin	without skin
Sodium	10.2 ± 0.01	9.51 ± 0.02	15.2 ± 0.012	8.45 ± 0.012	4.52 ± 0.04	3.1 ± 1.01
Potassium	9.52 ± 0.02	8.04 ± 0.05	16.5 ± 0.014	10.1 ± 0.01	6.32 ± 0.02	5.2 ± 1.03
Calcium	8.12 ± 0.03	6.01 ± 0.11	18.4 ± 0.011	11.2 ± 0.012	8.12 ± 1.02	6.1 ± 1.23
Magnesium	7.45 ± 0.012	6.32 ± 0.22	10.2 ± 0.02	8.42 ± 0.014	4.52 ± 1.23	3.3 ± 0.01
Iron	3.14 ± 0.07	2.13 ± 0.02	4.2 ± 0.03	1.23 ± 0.01	3.12 ± 1.01	4.1 ± 0.05
Copper	0.89 ± 0.01	0.64 ± 0.08	0.87 ± 0.06	0.41 ± 0.02	0.51 ± 0.02	0.41 ± 0.02
Zinc	0.42 ± 0.06	0.32 ± 0.011	0.41 ± 0.08	0.21 ± 0.11	0.35 ± 0.09	0.25 ± 0.03
Cadmium	0.12 ± 0.01	0.21 ± 0.031	0.85 ± 0.01	0.45 ± 0.07	0.23 ± 0.07	0.1 ± 0.01

± Standard deviation

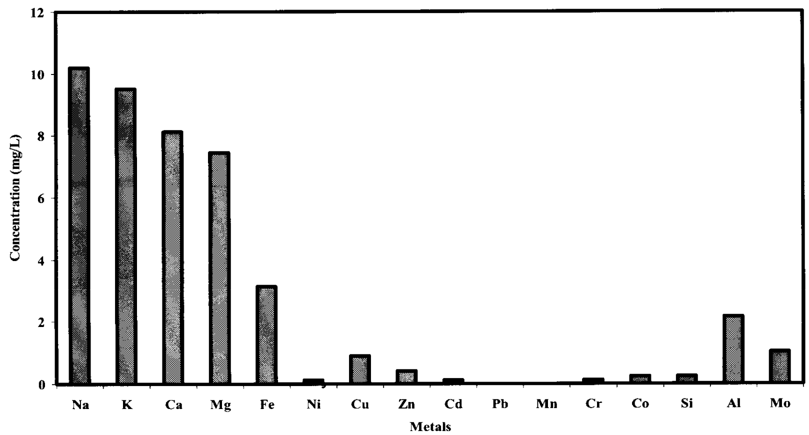

Fig. 1: Investigation of specific elemental distribution in *C. sativus* L. with skin.

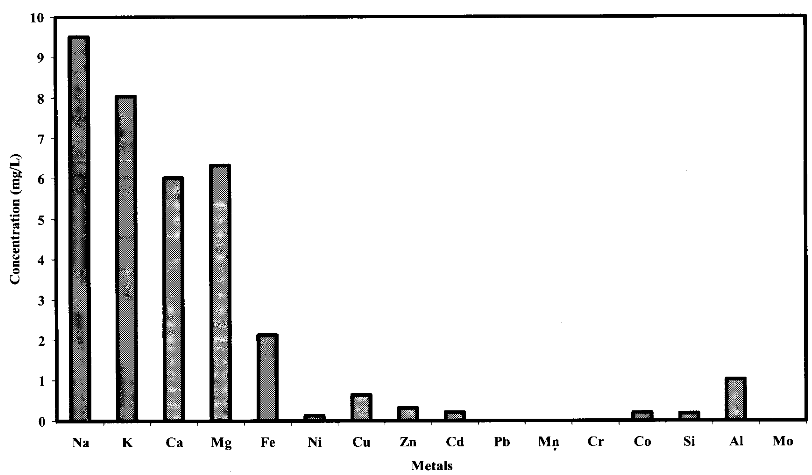

Fig. 2: Investigation Specific elemental distribution in *C. sativus* L. without skin.

found in nuts as from 0.2 to 0.5 mg/28 g and in the legumes as 0.2 mg [10]. Copper in excess deposits in the brain and liver, causing damage to the kidneys; inhibit urine production, anemia and hair loss in women [9]. Copper level in *C. sativus* L. with skin was found as 0.89 mg/Kg and without skin was 0.6 mg/Kg, in *S. melongena* L. with skin was noted as 0.874 mg/Kg and without skin was found in the concentration of 0.41 mg/Kg and *M. charantia* L. with skin and seed was 0.51 mg/Kg and without skin and seeds was 0.41mg/Kg as can be seen from Figs. 1-6. The highest concentration of copper was noted in the sample of *C. sativus* L. with skin while the lowest concentration was noted in *S. melongena* L. without skin.

Iron

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 and older, and women over 50 years; 12 mg for 11-18 year-old males; 15 mg for 11-50 year-old females, including nursing mothers [9]. Iron is an essential nutrient that carries oxygen and forms part of the oxygen-carrying proteins, hemoglobin in red blood cells and is also a necessary component of various enzymes. The concentration of iron in *C. sativus* L. with skin was found as 3.1 mg/Kg and without skin 2.1 mg/Kg, in *S. melongena* L. with skin was noted as 4.2 mg/Kg and without skin was 1.2 mg/Kg and *M. charantia* L. with skin and seed was 3.1 mg/Kg and without skin and seeds was 4.12 mg/Kg as can be seen from Figs. 1-6.

Manganese

Estimated safe and adequate dietary intakes for Mn each day are 2.0-5.0 mg for adults. For children, ESADDIs are 1.0-1.5 mg for ages 1-3 years; 1.5- 2.0 mg for ages 4-6 years, 2.0-3.0 mg for ages 7-10 years, and 2.0-5.0 for ages 11-14 years. Symptoms

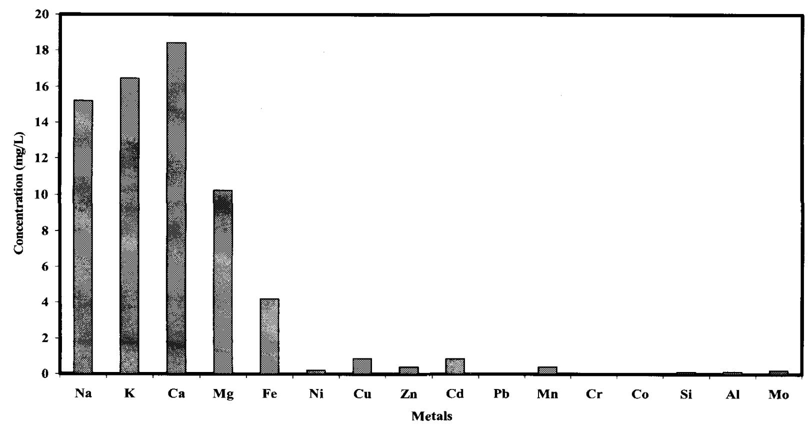

Fig. 3: Investigation of specific elemental distribution in *S. melongena* L. with skin.

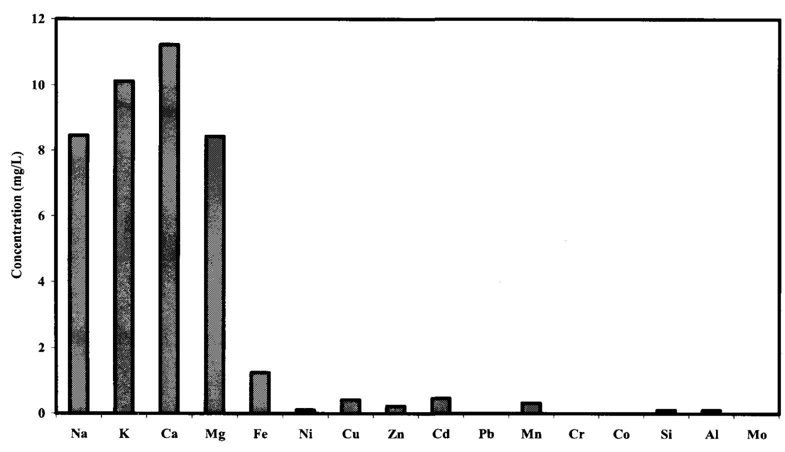

Fig. 4: Investigation of specific elemental distribution in *S. melongena* L. without skin.

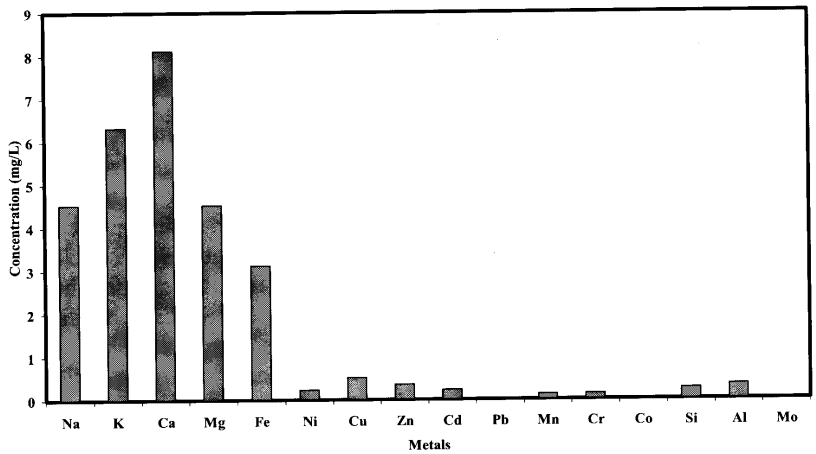

Fig. 5: Investigation of specific elemental distribution in *M. charantia* L. with skin.

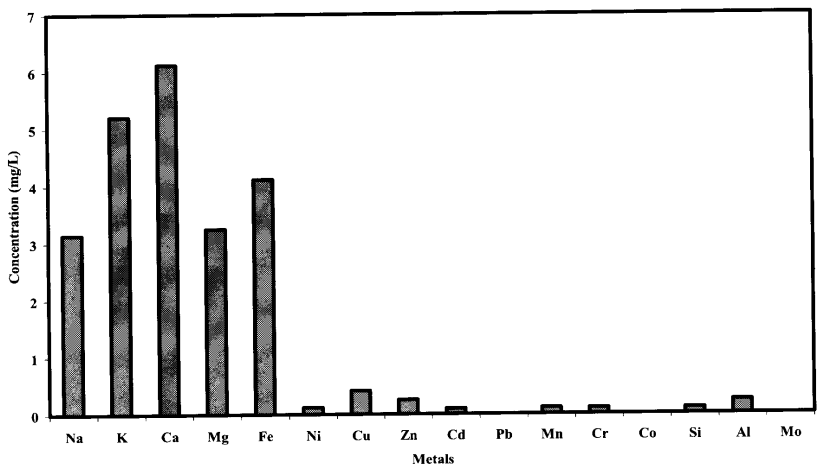

Fig. 6: Investigation of specific elemental distribution in *M. charantia* L. without skin.

of toxicity are the development of a schizophrenia with nervous disorders resembling Parkinson's disease [11]. Manganese is an essential trace mineral that is concentrated primarily in the bone, liver, pancreas, and brain. Manganese also activates numerous enzymes, particularly glycosyltransferases which are involved with the formation of cartilage in bone and skin. The manganese was not detected in *C. sativus* L. with skin and without skin, in *S. melongena* L. with skin was noted as 0.41 mg/Kg and without skin was 0.31 mg/Kg and *M. charantia* L. with skin and seed was 0.12 mg/Kg and without skin and seeds was 0.11 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of manganese in all samples is high with skin which is an indication of manganese accumulation in the bark and seed except *C. sativus* L. The highest concentration of manganese was noted in the sample of *S. melongena* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin.

Nickel

The toxic effects of nickel includes change in glucose tolerance, blood pressure, response to stress, growth rate, bone development and resistance to infection [12]. Nickel has great affinity for cellular structures such as chromosomes and ion channels, but its influence on them at normal tissue concentrations is not known. It is difficult to induce a deficiency because the requirement is low and nickel comes from a variety of sources. The concentration of nickel in *C. sativus* L. with skin was found as 0.12 mg/Kg and without skin 0.13 mg/Kg, in *S. melongena* L. with skin was noted as 0.22 mg/Kg and without skin was 0.11 mg/Kg and *M. charantia* L. with skin and seed was 0.23 mg/Kg and without skin and seeds was 0.12 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of nickel in all samples is high with skin which is an indication of nickel accumulation in the bark and seed. Highest concentration of nickel was noted in the sample of *M. charantia* L. with skin while the lowest concentration was noted in *S. melongena* L. without skin.

Zinc

Human body contains of 1.52 g of Zn, making it nearly as abundant as iron. It is highly concentrated in specialized areas of the brain, pancreas and adrenal gland, but is present in all cells, particularly in the nucleus. Chronic zinc deficiency in human 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. Acute zinc toxicity is characterized by gastric distress, dizziness and nausea. Symptoms of chronic toxicity include gastric problems, decreased serum ceruloplasmin activity and hypocupremia, decreased lymphocyte stimulation to PHA and reduced HDL cholesterol [13]. Zinc in *C. sativus* L. with skin was found as 0.42 mg/Kg and without skin 0.32 mg/Kg, in *S. melongena* L. with skin was noted as 0.41 mg/Kg and without skin was 0.21 mg/Kg and *M. charantia* L. with skin and seed was 0.35 mg/Kg and without skin and seeds was 0.25 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of zinc in all samples is high with skin which is an indication of zinc accumulation in the bark and seed. The highest concentration of zinc was noted in the sample of *C. sativus* L. with skin while the lowest concentration was noted in *S. melongena* L. without skin.

Cadmium

Prolonged accumulation of cadmium in the body stains the teeth. It can cause damage to the nervous system, decrease the detoxicative power of the organism, causes high blood pressure and atherosclerosis; damage the immune system; most importantly the antibody production, decrease fertility, cause anaemia, emphysema, and cancer. Children who are exposed to large concentrations of cadmium in their environment often have learning disabilities. Symptoms: alopecia, anemia, arthritis, cancer, lung disease, cerebral hemorrhage, cirrhosis of the liver, enlarged heart, diabetes, emphysema, hypoglycemia, hypertension, impotence, infertility, kidney disease, learning disorders, migraines, inflammation, renal disease, osteoporosis, schizophrenia, strokes, vascular disease, high cholesterol, and growth is impaired, cardiovascular disease [10]. Cadmium in *C. sativus* L. with skin was found as 0.12 mg/Kg and without skin 0.21 mg/Kg, in *S. melongena* L. with skin was noted as 0.85 mg/Kg and without skin was 0.45 mg/Kg and *M. charantia* L. with skin and seed was 0.23 mg/Kg and without skin and seeds was 0.10 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of cadmium in all samples is high with skin which is an indication of cadmium accumulation in the bark and seed except *C. sativus* L. without skin. The highest concentration of zinc was noted in the sample of *S. melongena* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin.

Silicon

Dietary silicon intake of human varies greatly with the amount and proportions of foods of animal (silicon-low) and plant (silicon-high) origin consumed and the amounts of refined and processed foods in the diet. The silicon content of drinking water, and beverages made thereof, shows geographical variation; silicon is high in hard water and low in soft water areas. The richest sources of silicon are unrefined grains of high fiber content and cereal products. The daily average intakes of silicon apparently range from about 20 to 50 mg/day [14]. The concentration of silicon in *C. sativus* L. with skin was found as 0.24 mg/Kg and without skin 0.18 mg/Kg, in *S. melongena* L. with skin was noted as 0.12 mg/Kg and without skin was 0.11 mg/Kg and *M. charantia* L. with skin and seed was 0.25 mg/Kg and without skin and seeds was 0.11 mg/Kg as can be seen from Figs. 1-6. The results show that the concentration of Silicon in all samples is high with skin which is an indication of silicon accumulation in the bark and seed. The highest concentration of silicon was noted in the sample of *M. charantia* L. with skin while the lowest concentration was noted in *M. charantia* L. without skin.

Molybdenum

Molybdenum is an essential nutrient for animals and human. Tissue content of molybdenum is low, with the highest concentrations in the liver, kidney, adrenal gland and bone. The estimated safe and adequate dietary intakes of molybdenum (μg/day) are: 15-30 at age 0-6 months, 20-40 for 6-12 months, 25-50 for 1-3 years, 30-75 for 4-6 years, 50-150 for 7-10 years, and 75-250 for adolescents and adults. This range is based on the usual dietary intake about 75 to 240 µg/day by adults. Rich sources of molybdenum include legumes, cereal products, and leafy vegetables. The amount in foods depends on the soil molybdenum content. Molybdenum is very well absorbed, but its bioavailability may be affected by some food components. Molybdenum toxicity is much more likely than deficiency. Toxicity is common in cattle grazing in pastures with high molybdenum soil. A high incidence of gout has been reported in humans with intakes of 10-15 mg/day [14]. The concentration of molybdenum in *C. sativus* L. with skin was found as 1.0 mg/Kg and was not detected in without skin sample, in *S. melongena* L. with skin was noted as 0.2 mg/Kg but was not detected in without skin sample and in *M. charantia* L. with skin and without skin was not found as can be seen from Figs. 1-6.

Cobalt

Cobalt is an essential element, required for good health in animals and human and therefore, it is important that foodstuffs contain adequate quantities of cobalt. The amount of cobalt absorbed from food or water depends on many things including state of health, the amount of food or drink received, and the number of days, weeks, or years of consumption of foods or drinks containing cobalt. If there is not have enough iron in the body, it may absorb more cobalt from the foods you eat. Once cobalt enters your body, it is distributed into all tissues, but mainly into the liver, kidney, and bones. After cobalt is breathed in or eaten, some of it leaves the body quickly in the feces. The rest is absorbed into the blood and then into the tissues throughout the body. The absorbed cobalt leaves the body slowly, mainly in the urine. Studies have shown that cobalt does not readily enter the body through normal skin, but it can if the skin has been cut [15]. Cobalt was found only in *C. sativus* L. with skin was found as 0.25 mg/Kg and without skin 0.2 mg/Kg as can be seen from Figs. 1-6.

Experimental

Primary Processing

C. sativus L., *S. melongena* L. and *M. charantia* L. were collected from fruit market Swat and delivered quickly in order to prevent microbial fermentation and thermal degradation. The materials were stored refrigerated, in jars and then inspected during the primary-processing stages by removing foreign matter by hand (damaged materials, soil, stones).

Drying

C. sativus L., *S. melongena* L. and *M. charantia* L. were used in dry form (ovens dried), the moisture content of the material was kept low in order to reduce damage from mould and other microbial infection.

Procedure

Digestion

The dried *C. sativus* L., *S. melongena* L. and *M. charantia* L. were ground to powder form by means of grinder next one gram of sample was taken in conical flask and treated with 4 cm^3 nitric acid of analytical grade(Merck) 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 and then added 4 cm^3 of nitric acid again and then heated again for an hour. After one hour 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 and then diluted to 25 cm^3 with double distilled water and then filtered through ordinary filter paper. The sample was then stored in bottles for determination of nutrients through atomic absorption spectrometer (A-Analyst 700-Perkin Elmer USA).

Conclusion

Adequate level of macro and micronutrients were measured in *C. sativus* L, *S. melongena* L. and *M. charantia* L. with skin and the lowest in without skin samples thus fulfill the nutritional status for consumers.

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