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Comparative account of heavy metal analysis of selected plant species by ICP-AES

Inam F, Deo SS, Kadam NS, Mahashabde RP *

Department of Chemistry, Institute of Science, Nagpur, India

ABSTRACT

The presence of some heavy metals in selected medicinal plants belonging to different families was investigated. The elemental analysis of root, fruit & even whole plant powders of Ocimum sanctum (OS), Ocimum kilimandsacharicum (OK), Garcinia mangostana (GM), Swertia chirayata (SC), and Andrographis paniculata (AP) was done by ICP-AES. The main purpose of this study was to document evidence of essential heavy metals in these medicinal plants which are extensively used in herbal products & standardized extracts.

Keywords: Medicinal plants, Essential heavy metals, ICP-AES

*Corresponding author
Email: rachana_mahashabde@rediffmail.com

INTRODUCTION

It has been found that some herbal products or extracts can have high level of heavy metals, which shows the need to study their level in important medicinal plants [1].

In ancient days, Indian medicinal system recommended most of the herbal drugs in the form of decoction (hot water extract), where the possibility of heavy metal toxicity is minimized or detoxified by other medicinal plants.

It has been reported that whatever is taken as food could cause metabolic disturbance subject to the allowed upper & lower limits of trace metals [2]. The deficiency & excess of essential micronutrients & trace toxic metals can cause serious effects on health [3, 4].

Some metals are also essential nutrients (Cu, Fe, Zn etc.) & only become toxic at higher concentrations, while others (Pb, Cd, Ni etc.) don't have beneficial properties.

This is an attempt to compile and document evidence of heavy metals viz. cadmium, cobalt, copper, iron, nickel, manganese, lead, zinc and aluminium in these medicinal plants by using IRIS Intrepid II XDL, ICP-AES [5] & highlight the need for research and development.

MATERIALS AND METHODS

Collection of plant material:-

The plants and whole plant powders of OS, OK, SC, AP & GM were collected from Shri Sail Medi farms, Nagpur. The plants were botanically identified and authenticated from the Department of Botany, Rashtrasant Tukadoji Maharaj, Nagpur university, Nagpur. The plants specimens were dried and herbarium sheets were made. The specimens of the plants is deposited in the Department for further references.

EXPERIMENTAL:-

Elemental analysis of plant powders:-

The plant samples were analyzed for various elements by using IRIS Intrepid II XDL, ICP-AES [5] manufactured by Thermo fisher Electrons Ltd, USA. The levels of cadmium, cobalt, copper, iron, nickel, manganese, lead, zinc and aluminium were measured in these plants. The results are included in [Table 2]

RESULTS AND DISCUSSION

[Table 1] summarizes Pharmacognostic features of the selected medicinal plants. As evident from table all the plants are very useful medicinally.

TABLE 1: PHARMACOGNOSTIC FEATURES OF THE MEDICINAL PLANTS

S.no.	Plant name/ Family	Common Name	Part used	Medicinal properties
1	Ocimum sanctum/ Lamiaceae	Tulsi	Whole plant	Antistress, analgesic, antipyretic, anti-inflammatory, antihypertensive, CNS depressant, radio protective activities etc
2	Ocimum kilimandsacharicum / Lamiaceae	Kapur tulsi	Whole plant	Antistress, analgesic, antipyretic, anti-inflammatory, antihypertensive, CNS depressant, radio protective activities etc
3	Garcinia mangostana/ Guttiferae	Mangosteen	Fruit	Anti-inflammatory, CNS depressant, anti-Alzheimer, anti- arthritis, anti-Parkinson's etc
4	Swertia chirayata/ Gentianaceae	Chirayita	Whole plant	Anti-inflammatory, anti-helmintic, astringent, antimalarial, CNS depressant etc
5	Andrographis paniculata/ Acanthaceae	Kalmegh	Whole plant	Anti-fertility, CNS depressant, anti-inflammatory, anti- HIV, anti-cancer activities, etc

TABLE 2: RESULTS OF ELEMENTAL ANALYSIS

S.no.	Metals	OS	OK	GM	SC	AP
1	Cd (ppm)	0.60	0.20	4.0	5.10	8.70
2	Co (ppm)	68	44	36	96	213
3	Cu (ppm)	84	127	172	63	22
4	Fe **%**	1.75	1.70	0.19	1.68	1.40
5	Ni (ppm)	11	10	29	21	13
6	Mn (ppm)	0.067	0.059	0.067	0.12	0.051
7	Pb (ppm)	207	Nd	Nd	8	6
8	Zn (ppm)	0.05	0.05	0.19	0.21	0.34
9	Al **%**	3.50	3.15	1.45	4.1	4.07

Trs – Traces; Nd- Not detected

The percentage of Cd, Co, Cu, Fe, Ni, Mn, Pb, Zn & Al [6-9] in these plants is appended in [Table 2].

As evident from this table maximum amount of Cadmium was found in AP followed by SC, GM, OS, and OK in decreasing order of its presence. High amount of Cobalt was found in AP followed by SC, OS, OK, and GM in decreasing order of its presence. Copper was found maximum in OK, GM & OS whereas SC and AP showed comparatively less amount. Iron was found in high % in OS, OK & SC followed by AP and GM in decreasing order of its presence. Nickel was found maximum in GM, followed by SC, AP, OS, and OK in decreasing order of its presence. Manganese was found least in AP followed by OK, OS, GM and SC in the increasing order of its presence.

Lead was found in the following increasing order of its presence in AP, SC & OS whereas not detected in OK & GM. Zinc was found maximum in AP and found in other plants in the following increasing order of its presence OS, OK, GM, SC. Aluminium was found in these plants in the following increasing order of its presence GM, OK, OS, AP and SC.

Cadmium (Cd) [10-11]**:-**While it is definitely believed to not be essential for plant and animal life processes, some believe cadmium is a trace element with some necessary role in life processes. Although its need and use are not currently understood. It is thought to be involved with the metabolism. Its status as an essential trace element remains unclear.

Cobalt (Co):- Cobalt is element that is necessary for good human health. While cobalt has no specific function by itself, it forms the core of vitamin B-12. Without cobalt, Vitamin B-12 could not exist. The body uses this vitamin for numerous purposes. B-12 is necessary for the normal formation of all cells, especially red blood cells. Vitamin B-12 also helps vitamin C perform its functions, and is necessary for the proper digestion of the food that we eat. Additionally, vitamin B-12 prevents nerve damage by contributing to the formation of the protective sheath that insulates nerve cells.
A deficiency of vitamin B-12 can cause our red blood cells to form improperly. This can prevent our red blood cells from carrying enough oxygen from our lungs to the different parts of our bodies, thus causing a condition called anemia.

Copper (Cu) - A micronutrient:-Copper is an element that is very important for our good health. Actually, that may be understating the true importance of this element. Copper is critically important for dozens of body functions. To begin with, copper is a major component of the oxygen carrying part of blood cells. Copper also helps protect our cells from being damaged by certain chemicals in our bodies. Copper, along with vitamin C, is important for keeping blood vessels and skin elastic and flexible. This important element is also required by the brain to form chemicals that keep us awake and alert. Copper also helps your body produce chemicals that regulate blood pressure, pulse, and healing. Current research is looking into other ways copper can affect human health, from protecting against cancer and heart disease, to boosting the immune system. General symptoms of not getting enough copper in your diet include anemia (a condition in which your blood can't supply enough oxygen to your body), arthritis (painful swelling of the joints), and many other medical problems. Copper can be found in dried beans, almonds, broccoli, garlic, soybeans, peas, whole-wheat products, and seafood. Unfortunately, many people do not get enough copper in their diets. Also, eating food rich in fructose (sugars in fruit, and cornstarch) and taking mega-doses of vitamin C for long periods of time can keep your body from absorbing the copper in your food. This lack of copper intake by your body can cause the medical problems mentioned above, or it can even affect your life span.

Iron (Fe) - A micronutrient: - The element iron has many functions in the body. This element is used by the body to make tendons and ligaments. Certain chemicals in our brain are controlled by the presence or absence of iron. It is also important for maintaining a healthy immune system and for digesting certain things in the food that we eat. In fact, it plays a vitally important part of how our body obtains energy from our food.

The iron we obtain from our diet is an essential part of hemoglobin - the part of our blood that carries oxygen. Iron is essential for blood to work efficiently. If we don't get enough iron in our diets, our blood won't carry enough oxygen to our bodies and we can feel tired, have decreased alertness and attention span and our muscles may not function properly. This type of iron deficiency is not uncommon among athletes, especially long distance runners. This is frequently the cause of fatigue among these athletes. If the lack of iron in our bodies is severe, we can get "iron deficiency anemia", which essentially means that our blood won't carry enough oxygen to our bodies so we can function normally. Iron deficiency anemia is probably the most common nutritional disease in the world, affecting at least five hundred million people. Fortunately, it is easy to get enough iron in your food, if you eat a balanced diet. Many foods contain iron, and eating a wide range of foods can help most people meet their needs for this important element.

Nickel (Ni):- Nickel is known to be an essential trace element for several species of animals. Experimental research shows that when chickens and rats are fed a diet that lacks nickel, they develop liver problems. If they are fed a normal diet, the symptoms do not appear. Animals are not the only ones that need this element to function properly. Bacteria use nickel to make special chemicals called enzymes. These enzymes are necessary for bacteria to function properly.

Though many scientists suspect that nickel is necessary for good human health, it has not been proven. People with certain liver and kidney diseases are known to have low levels of nickel in their bodies. Also, excess nickel in the body is associated with a high incidence of heart disease, thyroid disease and cancer. In both of these cases, the significance of the amount of nickel in the body is unknown. Some scientists think that nickel affects hormones, cell membranes and chemicals called enzymes. Whatever the case, nickel certainly appears to affect human health, even though we do not know exactly how.

Good sources of nickel include chocolate, nuts, fruits and vegetables. Meats are typically low in this interesting element.

Manganese (Mn) - A micronutrient: - Manganese is actually an extremely important element that the body uses for a variety of things. For instance, we use it to make chemicals that help us digest the food that we eat. Manganese also supports the immune system, regulates blood sugar levels, and is involved in the production of energy and cell reproduction. This important element is also important for bone growth. Additionally, manganese works with vitamin K to support blood clotting. Working with the B-complex vitamins, manganese helps to control the effects of stress while contributing to ones sense of well being.

Though it is extremely rare in humans, it is suspected that not getting enough manganese can cause poor bone formation, affect fertility and the ability for blood to clot. Birth defects can possibly even result when an expecting mother doesn't get enough of this very important element. Some researchers are also looking into a link between poor manganese

intake and higher skin cancer rates. The fact that manganese is so important to humans, yet deficiencies in humans are so rare, may indicate that humans have evolved ways to make sure that we don't ever run out of this element in our bodies.

As is the case with most, if not all, elements, we can easily get enough manganese from a good balanced diet. Foods high in manganese include avocados, berries, nuts and seeds, egg yolks, whole grains, green leafy vegetables and legumes (such as peanuts, peas and beans).

Lead (Pb):- Lead is a nonessential trace element having functions neither in humans nor plants. They induce toxic effects in humans at low doses. Symptoms of lead poisoning are colic, anemia, headache, brain damage, nervous disorders etc. Lead is a nonessential trace element having functions neither in humans nor plants. They induce toxic effects in humans at low doses. Symptoms of lead poisoning are colic, anemia, headache, brain damage, nervous disorders etc.

Zinc (Zn) - A micronutrient: - Zinc has been recognized as an essential trace element for plants, animals and humans for more than 70 years. Though the average adult body only contains between 2-3 grams of zinc (a paperclip weighs about one gram), this element has some very important functions. Zinc is involved in well over one hundred different reactions in the body. Some of these reactions help our bodies construct and maintain DNA, the molecule that controls how every single part of our bodies is made and works. Zinc is also needed for the growth and repair of tissues throughout our bodies. This extremely important element is used to form connective tissue like ligaments and tendons. Teeth, bones, nails, skin and hair could not grow without zinc. Zinc is widely considered by doctors to be one of the most important elements to a healthy immune system. This unique element is essential for the creation, release and use of hormones in the body. It helps developing foetus grow correctly and our brains to work right. Additionally, our senses of sight, taste and smell depend on this element.

Not getting enough zinc can have serious effects on our health. Some of the symptoms of zinc deficiency include hair loss, mental apathy and damage to reproductive organs. Decreased growth rate and impaired mental capacity are other symptoms. Additionally, you can lose most of your senses of taste and smell, develop mental disorders .Many factors affect how well our bodies absorb zinc in the food we eat, and at times it can be difficult to get enough zinc even from a well balanced diet. Good sources of zinc include whole wheat bread, seafood and other animal meats.

Several other sources (US Geological Survey, United Nations FAO) list additional elements as having a role in plant and/or animal life processes. But no description of that "role" was discovered. Those elements are: Strontium, Lithium, Barium, Rubidium, Cesium, and Platinum (for plants).

Aluminum (Al):- Until recently, aluminum was thought to be useless to life processes. It is now thought to be involved in the action of a small number of enzymes. For a technical

explanation: "it may be involved in the action of enzymes such a succinic dehydrogenase and d-aminolevulinate dehydrase (involved in porphyrin synthesis)." Even if this element is necessary for some life function, the amount necessary is greatly exceeded by our incidental intake through our drinking water, food, deodorants and some antacids. Aluminum is relatively benign, and it is used in food additives and indigestion pills. It has been linked to Alzheimer's disease and the body has a hard time ridding itself of excess aluminum. Aluminum is somewhat more toxic to plants.

CONCLUSION

This study revealed that investigated medicinal plants are good source of essential heavy metals. Medicinal herbs are easily contaminated during growth, development and processing. After collection and transformation into dosage form, the heavy metals confined in plants finally enter the human body and may disturb the normal functions. It is important to have good quality control practices for herbal products & standardized extracts screening in order to protect consumers from toxicity.

ACKNOWLEDGMENTS

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