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Determination of Some Trace Elements and Macro Minerals in Grewia Mollis Plant Parts

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Abstract: *The study was carried out to determine the concentration of trace and micro elements in parts of Grewia mollis, a plant used as food and as medicine by the Bura and Tangale people of Borno and Gombe state Nigeria respectively. The leaves stem bark and root bark of the plant were usually pulverised and used in cooking and in medicinal preparation for the treatment of infection and other disease by the folklore among the Bura and Tangale people of Borno and Gombe state respectively. The elemental determination was carried out using ICP-OES and wet digestion method. The highest concentration of the trace elements was found with iron in the leaves of the plant and the least concentration of the trace elements was found in the leaves with cadmium and molybdenum which were zero. The highest concentration of the macro elements were seen with calcium in the root bark of the plant, while the least was sodium in the leaves of the plant. Majority of the trace elements were in the recommended limits set by WHO and some countries for edible and medicinal plants with few going above the recommended limits. Based on the result the plant Grewia mollis is rich in macro and micro element and can be used by the folk lore to supplement the requirements of these minerals with caution thereby improving the health status of the people.*

Keywords: *Grewia mollis trace elements, macro minerals and ICP-OES*

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INTRODUCTION

African plants constitute a rich untapped pool of natural products. Scientific investigations of medicinal plants have been initiated in many countries because of their contribution to health care.

In developing countries it was estimated that about 80 % of the population relies on plant based preparation used in their traditional medicinal system and as the basic need for human primary health care (WHO, 2000; Hamayun et al 2006).The global demand for herbal medicine is growing (Muregi et al 2003; Zowai et al 2003). Interest in medicinal plants reflects the recognition of the validity of many traditional claims regarding the value of natural products in health care (Hamayun et al, 2006).

Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in biosystems through contaminated water, soil, plants and irrigation water. Industrial discharge, fertilizers, fossil fuels, sewage sludge and municipality wastes are the major sources of heavy metal contamination in soils and subsequent uptake by crops (Pendias and Pendias, 1992).

Heavy metal contamination of the food items is one of the most important assessment parameters of food quality assurance (Marshall, 2004; Radwan and Salama, 2006; Wang et al., 2005; Khan et al., 2008). International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risk that these metals pose to the food chain and its contamination (Radwan and Salama, 2006).

Grewia mollis (Tiliceae) commonly known in Northern Nigeria as dragaza'a is a shrub or small tree that grows up to 10.5m tall, and grows in tropical areas (Burkill, 2000; Sharma, 2002 Katende et al, 1995). The fruit is edible and very sweet (Person, 1982). It is popularly used in folk medicine to treat malaria fever (Fowler, 2006). The mucilaginous bark and leaves are applied to ulcer cuts, sores and snake bites (Brink, 2007).

The bark and root preparation are taken to treat cough. Extracts of stem bark and leaves are drunk to treat fever. The decoction of the stem bark is taken to treat diarrhoea, and maceration is taken to ease child birth. The mucilage is credited with laxative properties while an infusion of the bark is used to treat colic (Lockett et al, 2000). The pounded leave mixed with water are taken against stomach problems and also given by constipated domestic animals (Ruffo et al, 2002). The decoction of the leaves is used in baths and drinks against rickets in children and difficult birth (Kokwaro, 1993).

A decoction of the roots is drunk in case of palpitation (Katenda et al, 1995). The sap from root shavings is placed under the eyelid to treat sore eyes, where as a liquid obtained by kneading the root bark in water is drunk to treat stomach ache, colic and poisoning by certain plants (Neuwinger, 2000). The paste of ground root is applied to rheumatic swellings and inflammation while the fruit is used as febrifuge and in treatment of malaria fever (Lockett et al, 2000; Fowler, 2006).

Some findings demonstrated that the mucilage obtained from the stem bark can serve as a good binder in paracetamol formulations (Martins et al 2008,; Muazu, et al 2009). A reports suggest that high concentration of stem bark in dietary may cause some adverse effects, especially liver injury (Wilson, 2010).

In recent years, several authors across the world, reported many studies on the importance of elemental constituents of herbal plants which enhanced the awareness about trace elements in these plants (Wong et al., 1993 in China; Sharma et al., 2009 in India; Sheded et al., 2006 in Egypt; Koe and Sari, 2009, Basgel and Erdemoglu, 2006). Therefore the present study was undertaken to determine the levels of heavy metals and macro minerals in different parts of Grewia mollis plant and compared the values with those recommended by WHO and other countries for edible or medicinal plants.

MATERIAL AND METHODS

COLLECTION OF PLANT MATERIAL

The *Grewia mollis* plant parts were collected in Hawul local Government Area of Borno State. The collection was done in September when the leaves were green. The infected parts were removed and the healthy fresh part was air dried under a shade and pulverized using motorized miller.

REAGENTS: All the solvents and reagents used for this work were of Analar grade. Distilled water was used as solvent for solution preparation and all glass wares were washed, cleaned and dried in an oven at 105^oC.

Analytical Procedure

The Wet digestion method was used to digest the sample, 1gm of the sample was transferred into the digestion tube. 5ml of nitric acid-perchloric acid mixture (2:1 by volume) was added and the content mixed. The tube was placed into the digestion block inside a fume cardboard and the temperature controlled of the digestor set at 150^oC and digested for 1hour 30minutes. The temperature was then increased to 230^oC and digested for 30minutes. The digestor temperature was then reduced back to 150^oC for 30minutes. The digestor was then switched off and the tube removed and about 30ml of distilled water added to the tube within few minutes. The concentrated digest was not allowed to cool to room temperature to prevent the formation of in soluble precipitate. More water was then added to the tube to make up to mark on the tube and the content mixed thoroughly.

The ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry) methods were used for the quantitative analysis of the elements in all samples. To determine the elemental levels, AOAC methods were used (AOAC 1996, 2003, 2012).

RESULTS

TABLE1: ELEMENTAL COMPOSITION OF GREWIA MOLLIS PLANT PARTS

S.NO.	ELEMENTS	SYMBOL	PLANT PARTS (ppm)		
			LEAVES	STEM BARK	ROOT BARK
1	MANGANESE	Mn	0.7811	1.1400	2.2990
2	CADMIUM	Cd	0.0000	0.0011	0.0043
3	COBALT	Co	0.0328	0.0130	0.0358
4	CHROMIUM	Cr	0.1840	0.1006	0.2025
5	COPPER	Cu	0.0894	0.3049	0.3409
6	IRON	Fe	35.2300	9.8600	22.7800
7	MOLYBDENUM	Mo	0.0000	0.0854	0.1001

8	NICKEL	Ni	0.1024	0.0867	0.1135
9	LEAD	Pb	0.1126	0.4945	0.5881
10	ZINC	Zn	0.7271	5.6770	5.0320
11	POTASSIUM	K	132.7000	239.4000	231.5000
12	MAGNESIUM	Mg	78.3500	191.9000	344.2000
13	SODIUM	Na	4.0530	16.3500	26.9900
14	CALCIUM	Ca	492.9000	1299.0000	2527.0000
15	PHOSPHORUS	P	18.9300	61.9000	101.3000

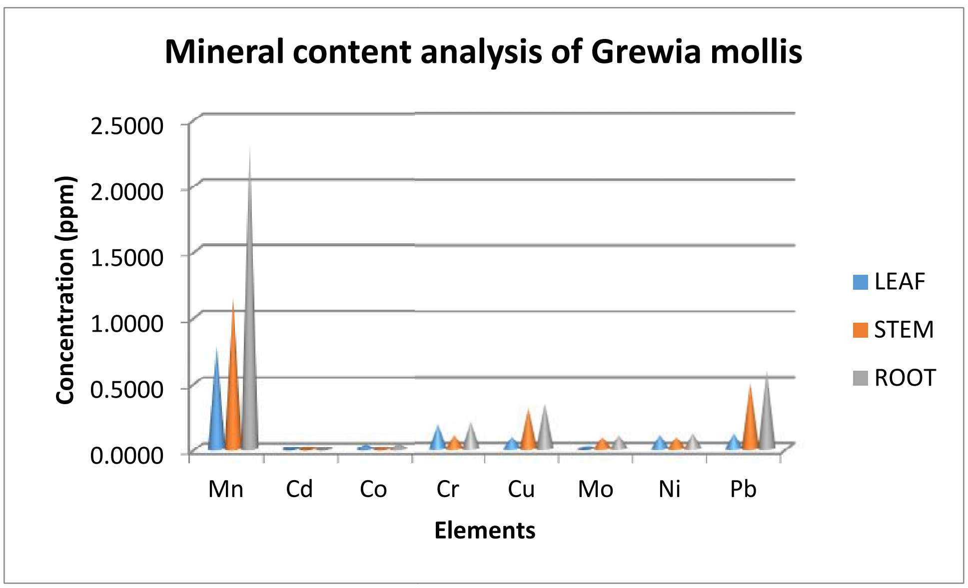

Fig. 1: Trace elements in various parts of Grewia mollis

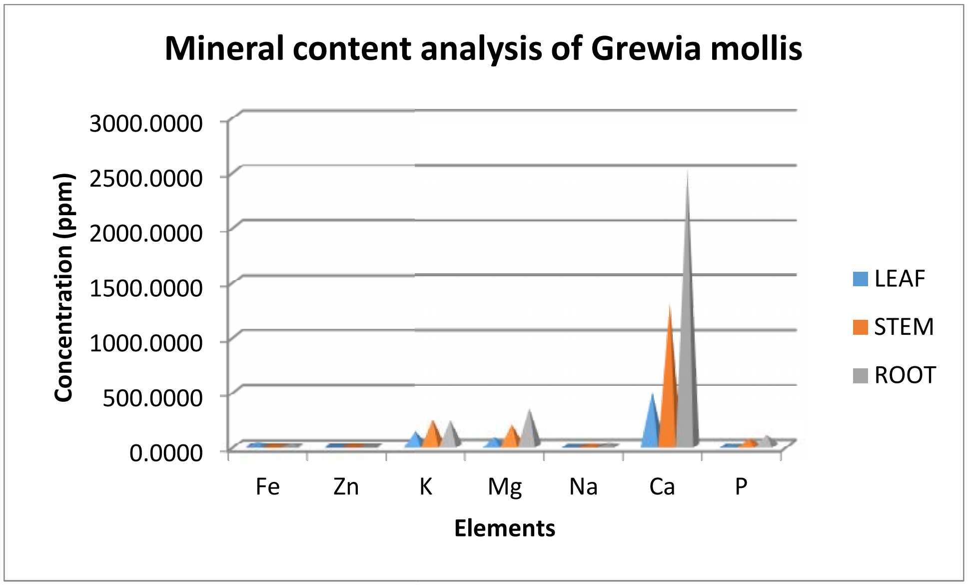

Fig.2: Trace elements in various parts of Grewia mollis

MANGANESE

The permissible limit set by FAO/WHO (1984) for Manganese was 2.00 ppm in edible plants (FAO/WHO, 1984). However, the permissible WHO (2005) limits for Mn in medicinal plants have not yet been set (WHO, 2005). In Egypt 446 ppm to 338 ppm limit have been set for manganese in medicinal plants (Egyptian Code (501), (2005). The manganese content of Grewia mollis showed that in the root bark is 2.2990 ppm, stem bar 1.1400ppm and the leaves 0.7811ppm (table 1) which are in the range set by the FAO/WHO (1984) with exception of the root which is above 2.00ppm.

Manganese is essential for the development of normal bone structure, reproduction, metabolism of amino acids, lipids, carbohydrates and functioning of the central nervous system. Its deficiency causes reproductive failure in both male and female. The kidney and liver are the main storage places for the manganese in the body (Hussain et al, 2009). Manganese deficiency has been reported in animals but rare in humans. Its deficiency also results in tissue damage and impairs CNS functions. Excess of manganese causes pneumonia, affects reproductive system, which may lead to infertility, adverse effects primarily is on the lungs and on the brain. Manganese is within permissible limit in the Grewia mollis plant parts therefore eating the plant parts will not have adverse effect. Excess of manganese is toxic to the body (Islam, 2016).

CADMIUM

The amount of cadmium content in the root bark, stem bark and leaves of Grewia mollis were 0.0358ppm, 0.0011ppm and 0 ppm respectively which was well below the permissible limit set by (WHO) for cadmium in edible plant of 0.21 ppm and for medicinal plants is 0.3ppm (WHO, 2005).

Cadmium is a toxic metal having functions neither in human body nor plants (Aleksandra et al, 2014; Hussain & Khan, 2010). Accumulation of cadmium in kidney leads to high blood pressure and renal diseases. Its accumulation also leads to damaging of the nerve cells, inhibition of release of acetylcholine and activation of choline esterase enzyme, resulting in a tendency for hyperactivity of the nervous system (Schumacher et al., 1991). Cadmium causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and immune system have been reported (Ali and Deokule, 2009; Heyes, 1997).

COBALT

The result for the elemental analysis of Grewia mollis parts for cobalt showed that the root bark has 0.0358ppm, stem bark 0.0130ppm and leaves 0.0328ppm which are all below the permissible limit of cobalt in plants which is 0.2 ppm set by WHO, 2005. Excess of cobalt causes cardiomyopathy, hyperglycemia, memory loss, allergic dermatitis (Elbetieha et al, 2008). Deficiency of cobalt causes pernicious anaemia, severe fatigue, and hyperthyroidism. Cobalt is a part of vitamin B12 which is essential for human health.

CHROMIUM

The concentration of chromium in the leaves of Grewia mollis is 0.1840ppm, stem brk 0.1006ppm and the root bark 0.2025ppm which is above the permissible limit set by FAO/ WHO (1984) in edible plant for chromium which is 0.02 ppm. Chromium plays an important role in synthesis of fatty acids and cholesterol. Excess of chromium causes asthma, shortness of breath, liver and kidney damage, allergic reactions (Katz and Salem, 1992).

Chromium regulates carbohydrate, nucleic acid and lipoprotein metabolism. It enhances the insulin's action and thus plays a role in glucose metabolism.(Kaplan et al 2003). Chromium deficiency leads to disturbance of glucose and lipids metabolism in humans and animals (Islam, 2016). It is highly toxic, carcinogenic and is lethal at high dosage. It is required by the human body in very trace amount. Chronic exposure to chromium may results in liver, kidney and lung damage (Zayed anaTerry, 2003).

On comparison, of the metal limit in the studied medicinal plant with those proposed by FAO/WHO (1984) it is found that all the plant parts accumulate chromium above this recommeded limit. However, for medicinal plants the WHO (2005) limits has not yet been established for chromium but the, permissible limits for chromium set by Canada, were 2.00ppm in raw medicinal plant material and 0.02 mg/day in finished herbal products (WHO, 2005).

COPPER

The highest concentration of copper was found in the root bark 0.3409ppm, followed by the stem bark (0.3049ppm) and the least was seen in the leaves 0.0894ppm. The permissible limit set by FAO/WHO for copper in edible plants was 3.00 ppm (FAO/WHO, 1984). However, for medicinal plants, the WHO limits have not yet been established for Cu. Permissible limits for Cu set by China and Singapore for medicinal plants were 20 ppm and 150 ppm, respectively (WHO, 2005) and India 17.6ppm to 57.3ppm (Reddy and Reddy, 1997).

Copper is an essential redox -active transition element that plays a vital role in various metabolic processes. Being toxic, its quantity in plants should be very low. It is essential to the human body since it forms a component in many enzyme systems, such as cytochrome oxidase, lysyl oxidase and an iron-oxidizing enzyme in the blood. The observation of anaemia in copper deficiency is probably related to its role in facilitating iron absorption and in the incorporation of iron in haemoglobin. Copper is needed for neurotransmitter synthesis (Osuocha et al, 2016; Amin et al, 2003). However, copper deficiency in humans is a rare occurrence. Copper could be toxic depending on the dose and duration of exposure (Obi et al., 2006). The results in the present study indicate that concentration of copper was almost in the permissible limit for all the plant parts.

IRON

The maximum tolerable level of iron for cattle was suggested as 1000ppm by National Research Council (1984). The permissible limit set by FAO/WHO (1984) in edible plants was 20ppm. However, for medicinal plants the WHO (2005) limits not yet been established for iron but in Egypt it ranges between 261 ppm to 1239 ppm limit is set for the iron in medicinal plants

In the roots Grewia mollis the concentration of Iron was found to be 22.7800 ppm, in the stem its concentration was found to be 9.8600 ppm and maximum of 35.2300ppm in the leaves. After comparison of the metal limit in the studied plant with those proposed by FAO/WHO (1984) of 20.00ppm it is found that the root and the leaves accumulate iron above this limit.

Iron plays an important role in oxygen and electron transfer in human body and is necessary for the synthesis of haemoglobin Wani et al 2010; Kaya and Incekara, 2003). Iron is a component of numerous proteins and enzymes. Iron deficiency results in anaemia, adverse pregnancy outcomes, developmental delays and impaired physical work performance (Lynch and Baynes, 1996). Deficiency of iron causes anaemia, poor resistance to infection, weakness. Iron is essential components of many proteins and enzymes in the human body.

Molybdenum

The concentration of molybdenum in the leaves of Grewia mollis is below detection with the machine, while the concentration in the stem bark was 0.0854ppm and the root bark concentration was 0.1001ppm. The variations of Molybdenum concentrations in foodstuffs, especially in plants, are greatly dependent on species and soil properties and rangs between 0.1-0.5mg/kg (Kabata-pedias and Mukharjee, 2007).

In most instances toxic amounts of molybdenum in forage consumed by ruminants have resulted from naturally occurring excess molybdenum in the soil or irrigation water" (Johnson, 1966). Molybdenum (Mo) is an essential trace metal. In humans, a low order of toxicity of Mo compounds has been observed. Possible reasons for this low degree of Mo toxicity are the facts that this metal is a necessary trace element in the body, functioning in conjunction with some flavoprotein enzymes (xanthine oxidase, aldehyde oxidase, sulphite oxidase), and it is rapidly eliminated in the urine (ePA 1998).

NICKIEL

Excess of nickiel causes allergic dermatitis known as nickel itch, which usually occurs when skin is moist. Nickel is carcinogenic can cause cancer of different organs such as nose, prostate, lungs. Nickel is required for production of insulin. It is component of several enzymes i.e., carbon monoxide dehydrogenase, urease, hepatic microsomal enzymes etc. The health benefits of nickel are healthy skin, bone structure. It is essential for Iron metabolism but is toxic at higher concentration. Nickiel toxicity in human is of rare occurrence because of it's low absorption (Aparna and Pooja, 2016). The chronic exposure has been related to increased risk of lung cancer, cardiovascular disease, neurological deficit, developmental deficits in childhood and high blood pressure.(Jaya and Amit, 2016).

The permissible limit set by FAO/WHO (1984) in edible plants was 1.63 ppm. The concentration of Ni in the parts of Grewia mollis showed that the leaves was 0.1024 ppm, while in the stem bark it was found to be 0.0867ppm and in root it was 0.1135ppm.

On comparing the metal limit in the Grewia mollis plant with those proposed by FAO/WHO (1984) it was found that all plant parts concentrations falls within the permissible limit therefore its consumption will not lead to any negative effect by the nickel. However, for medicinal plants the WHO (2005) limits have not yet been established for Nickiel. Nickiel toxicity in human is not a very common occurrence because its absorption by the body is very low (Onianwa et al., 2000). Nickel is highly mobile element and its accumulation mostly takes place in leaves but in the Grewia mollis is not so.

LEAD

Lead is non essential heavy metal toxic to plants, animals and humans, and there is no evidence of its biological role in the human body. Lead causes both acute and chronic poisoning, and also has adverse effects on kidney, liver, vascular and immune system (Heyes1997; Khan et al, 2011) It causes a rise in blood pressure, miscarriages, subtle abortion, and decline in fertility of men through sperm damage and diminishing abilities of children and disruption of nervous systems (Jabeen et al 2018).

Lead has no beneficial effects in humans. The permissible limit set by FAO/WHO (1984) for lead in edible plants was 0.43 ppm. The maximum concentration of lead was found in the root bark (0.5881ppm) followed by the stem bark (0.4945ppm) and the least in the leaves (0.1126ppm). However, for medicinal plants the limit was 10ppm set by China, Malaysia, Thailand and WHO (Jabeen, et al., 2010). The extent of contamination of lead depends on the traffic densities and environmental pollution (Nasralla and Ali, 1985 ; Sovljanski et al., 1990).

Lead causes both acute and chronic poisoning, and also poses adverse effects on kidney, liver, vascular and immune system (Heyes, 1997). Hadi and Bano (2009) reported P. hysterophorus for the remediation of lead contaminated soil as it is good accumulator of lead.

ZINC

Zinc is one of the most important mineral in the body (Okwulehie and Ogoke, 2013). The permissible limit set by FAO/WHO (1984) for zinc is 27.4 ppm while the trace element analysis of Grewia mollis plant for zinc showed that the concentration zinc in the root bark is 5.0320ppm, stem 5.6770ppm and leaves 0.7271ppm which is within the limit set by FAO/WHO (1984). About 100-300 enzymes contain zinc. Zinc is known to govern the contractibility of muscles and helps to avoid prostrate problems. Zinc acts as a co-factor for enzymes in the body. It also takes part in synthesis of DNA, proteins and in insulin biosynthesis, storage, secretion Diwan et al, 2006). Zn is an important trace element and one of the several important micronutrients that is essential for proper functioning of the body. High concentration of zinc is neurotoxin.

POTASSIUM

Potassium helps in the proper function of brain and nerves, so it helps in prevention of stroke. It regulates acid-base and water balance in the blood and tissues. It is required for bone and in prevention of osteoporosis (He and Mac, 2008). High potassium in diet lowered blood pressure in individuals with raised blood pressure. Potassium is essential in protein bio-synthesis by ribosomes.

Potassium is also an essential macro-element for a human. It is important because it is involved in muscle contraction, in lipids metabolism, in proteins synthesis, maintaining the fluid and electrolyte balance in the body and is responsible in the nerve impulses sending (Mogos, 1997). Potassium remains one of the major electrolytes in the blood. Potassium is of great importance for many regulation systems in the body. The minimum daily intake of Potassium is 3.5g (Baysal, 2002). The maximum concentration of potassium in Grewia mollis parts was found in the stem bark 239.4000ppm followed by the root bark 231.5000ppm and the least in the leaves 132.7000ppm. The use of the Grewia mollis as a food can supply the daily requirement of potassium by man by the plant

MAGNESIUM

The concentration of magnesium in Grewia mollis was 78.3500ppm in the leaves, 191.900ppm in the stem bark and 344.200ppm in the root bark, which was far below the permissible level of 200pm set by FAO/WHO (1984) with the exception of the root bark which is higher.

Magnesium is important to all the cells in humans. It is present in many enzymes involved in proteins, lipids, and carbohydrate metabolism. In plants, Magnesium is present in chlorophylls. Magnesium is required in the plasma and extracellular fluid, where it helps maintain osmotic equilibrium. It is required in many enzyme-catalyzed reactions, especially those in which nucleotides participate where the reactive species is the magnesium salt, e.g., Mg ATP. It can also prevent some heart disorders and lower blood pressure. Lack of Magnesium is associated with abnormal irritability of muscle and convulsions and excess Magnesium with depression of the central nervous system (Prasad, 1981).

Magnesium deficiency in humans caused muscle spasms and has been associated with a high blood pressure, many cardiovascular diseases, diabetes, and osteoporosis. The necessary daily intake is 350 mg/day for men and 300 mg/day for women (Mogos, 1997). Intracellular Magnesium deficiency is correlated with the impaired function of many enzymes utilizing high energy phosphate bonds, as in the case of glucose metabolism (Stef, et al., 2010).

SODIUM

The concentration of sodium was found to be maximum (26.9900ppm) in root bark followed by stem bark (16.3500ppm) and leaves (4.0530ppm).

Sodium is essential to all living organisms. Like Potassium, it is also one of the major electrolytes in the blood. Without sodium the body cannot be hydrated, it would dry off. At the point when some vital processes are taking place, sodium is not needed, too much of sodium will cause the cell to break down (Gbolahan, 2001). Sodium is of great importance for the regulation of many systems in the body. The minimum daily intake of sodium is 2.4 g (Baysal, 2002). Sodium deficiency cause loss of body weight and nerve disorder (Lokhande et al, 2010).

CALCIUM

The highest content of calcium in the Grewia mollis was found in the root bark (2527.000ppm) and the least in the leaves (492.900ppm). High concentration of calcium is important because of its role in bones, teeth, muscles system and heart functions. Calcium deficiency can lead to low bone mass (osteopemia), bone fractures, numbness and tingling in the fingers and abnormal heart rhythms.

Calcium is necessary for normal functioning of cardiac muscles, regulation of cell permeability, blood coagulation. Excess of calcium in blood results to calcification of several internal organs. Deficiency of calcium causes diseases like rickets, osteoporosis (Susan, 2008).

Phosphorous:

The highest concentration of phosphorus was found in the root bark 101.300ppm, followed by the stem bark 61.9000ppm and the leaves 18.9300ppm. Phosphorus is one of the key elements necessary for the growth of plants and animals. Phosphates are formed from this element. It is an essential nutrient for all life forms and plays a role in deoxyribonucleic acid (DNA), ribonucleic acid (RNA), adenosine diphosphate (ADP), and adenosine triphosphate (ATP). It is required for these necessary components of life to occur.

Phosphorous maintain blood sugar level, normal heart contraction is dependent on phosphorous (Linder, 1991) also important for normal cell growth and repair, needed for bone growth, kidney function, and cell growth. It plays an important role in maintaining the body's acid-alkaline balance (Johns & Duquette, 1991).

CONCLUSION

The elemental analysis of Grewia mollis shows that it is rich in biologically important elements, which have therapeutic values hence, it could serve as a supplement of macro and micro elements in the body. The elements Calcium, potassium, magnesium, phosphorous, sodium and iron are rich in the plant, therefore it is expected that the consumption of the plant will help in proper functioning and maintains the human health. The result on the trace elements of the plant is of great importance to understand the pharmacological action of the plant. The result obtained from the study of the trace elements in the Grewia mollis will be useful in deciding the quantity to be used for preparation of food or the dosage to be used in medicinal preparation. The use of the Grewia mollis both for food and medicinal purpose can be justify from the study because there will be effect of poisoning from trace elements therefore its use as food or medicine is well justified.

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