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Determination of Some Essential Metals in Selected Medicinal Plants

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ABSTRACT

Medicinal plants are sources of different essential metals that have different biological activities including those useful in the treatment of human diseases. Among the indigenous medicinal plants used as phytomedicines for the treatment of many diseases in Kano State are *Annona squamosa, Psidium guajava, Anacardium occidentale, Ficussycomorus* and *Pomegranate.* The aim of this study was to determine the levels of essential metals present in the herb tissues (leaf and stem) samples obtained from Kwarin Gogau garden, airport road, Kano State. The plant samples were collected, pretreated and digested by wet digestion method and analyzed using Micro Plasma Atomic Emission Spectrophotometer (MPAES). The results obtained in this study showed that extracts of the medicinal herbs investigated contained essential metals. The mean concentrations range for essential metals were: Zn (0.109-0.658mg/kg), Cu (0.026-0.079 mg/kg), K (1.846 -11.669 mg/kg), Mn (0.039-1.269 mg/kg), Fe (0.019-0.107mg/kg), Ni (0.054-0.144 mg/kg). Comparing the results obtained with the permissible limits set by WHO for consumed medicinal herbs, it was concluded that the essential metals present in the herbs were below permissible limits. Also, there was no statistically significant difference between the plant tissues samples analyzed for Zn, Cu, K, Mn, Fe, and Ni (P>0.05).

Keywords: Essential metals**,** Garden, Medicinal plants, MPAES, Wet digestion

INTRODUCTION

The term of medicinal plants includes various types of plants used in herbalism and some of these plants have medicinal activities (Hunt I, 2000). Medicinal plants are considered as rich resources of ingredients which can be used in drug development and synthesis. The use of traditional medicine and medicinal plants in most developing countries, as a basis for the maintenance of good health, has been widely observed by UNESCO, (1996).

The use of herbs as medicine is the oldest form of health care known to humanity and has been used in all cultures throughout history (Barnes *et al.*, 2007). Herbal medicine or herbalism is the use of herbs or herbal products for their medicinal value. They may come from any part of the plant but are most commonly made from leaves, roots, bark, latex, seeds, and flowers. They are eaten, swallowed, drunk, inhaled, or applied to the skin. They have worldwide applications in the treatment of different types of diseases.

Heavy metals are those in their standard state and have a specific gravity of more than about 5gcm^{-3}. Some of the heavy metals are essential in very low concentrations for survival of all forms of life. Trace heavy metals are important in daily diets, because of their essential nutritious value and possible harmful effects (Mustafa *et al.*,2004). Heavy metals such as zinc (Zn), copper (Cu), potassium (K), manganese (Mn), iron (Fe) and nickel (Ni) are essential metals, since they play an important role in biological system. It is important to have quality medicinal herbs in order to protect consumers from contamination (WHO 1998; and 2005., Jabeen*et al.*,2010). Herbs which are contaminated can be toxic and produce undesirable side effects (Fuh*et al.*,2003*;* Bandaranayake *et al.*,2006). This contamination by heavy metals can lead to bioaccumulation of these toxic and disease-causing elements in the body of consumers.

The purpose of the current study was to determine essential metals concentration in some selected medicinal plants. The subject plants are thoroughly consumed by the general public and it is the utmost need to analyzed the concentrations in the leaves and stem in order to ascertain their toxicity level and compare the concentrations with WHO Standard. Plants used in traditional medicine are relatively safe, but some may have undesirable adverse effects which may be due to over dosage or certain factors such as heavy metals contamination and could lead lead to toxic effects.

Heavy metals are considered as one of the most significant environmental concerns because of their toxicity and accumulation in the tissues of living organisms which even at low levels can endanger human health.

MATERIALS AND METHODS

All the glassware used throughout the process of analytical work were washed with liquid detergentand rinsed with several changes of de-ionized water before drying in an oven at 105°C.

Chemicals of analytical grade purity and deionized water were used.

SAMPLING AND SAMPLE PRE-TREATMENT

Fresh leaves and stem of *Annona squamosa, Psidium guajava, Anacardium occidentale, Ficussycomorus*and *Pomegranate* were collected from KwarinGogaugarden, Airport road, Kano State and stored in separate polythene bags. The samples were labeled and transported to the laboratory where they were thoroughly washed with tap water and deionized water to remove surface contamination like soil, dust, and spray residue before the analysis.

Sample Preparation/Digestion

The samples were air dried for few days in the laboratory and then in oven at the temperature of 105°C to remove moisture in order to prevent food decay and microbial activity. The dried samples were subsequently ground in a clean mortar and pestle to tiny particle size and directly stored in fresh plastic containers for further analysis.

Wet acid digestion was carried out using standard methods reported by AOAC(1990).One (1.0) g of each dried sample was weighed and added to 10cm^3 of concentrated HNO_3 in a 50 cm^3 beaker and placed on the electric hot plate for 1 hr to get semi dried sample. Furthermore, 10 cm^3 of concentrated HNO_3 and 4cm^3 of H_2O_2 were added the mixture was kept on hot plate and heated vigorously. Addition of HNO_3 and H_2O_2 was continued untill colorless solution was obtained. Finally, the volume reduced to 2-3cm^3. The solution was then cooled and filtered with Whatman filter paper. The filtrate was transferred into 25cm^3 sample bottles and made up to mark with deionized water before analysis using Micro Plasma Atomic Emission Spectrophotometer (MPAES). Blank sample was also prepared by digesting the same proportion of the reagents used in the sample digestion under the same experimental condition without the sample.

RESULTS AND DISCUSSIONS

The results for the determination of some essential metals in selected medicinal plants are presented in Figures1-6:

ZINC (Zn)

The concentrations of zinc in all the plant sample tissues analyzed varied from 0.109± 0.021 and 0.658 ± 0.823 mg/kg with the least concentration found in *Anacardium occidentale* 0.226 mg/kg and highest concentration in *Psidium guajava*. 0.868mg/kg (Fig 1).

The WHO permissible limit set for zinc in herbal medicine is 50 mg/kg while its daily intake is 11mg/day (Khan *et al*., 2008). The resulst revealed the concentrations of zinc were below the permissible limit. Statistical analysis showed there was no significant difference between the plant tissues analyzed (P>0.05). In another research work carried out by Suliman(2000) on determination of Zinc in Sudanese medicinal plants and reported 0.98 mg/kg of zinc concentration which is below the permissible limits higher than the results obtained in this work. Zinc is an essential trace element necessary for proper growth, blood clotting and DNA synthesis, however high zinc intake beyond the permissible limits produce toxic effects in the immune system (Orisakwe*et al*., 2012).

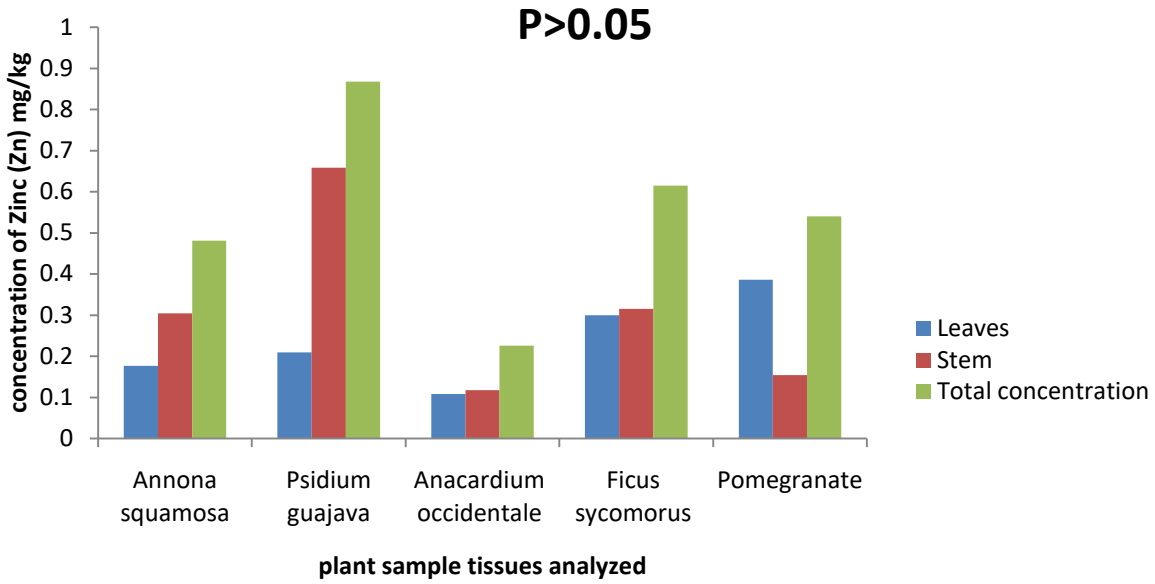

Figure 1: Concentration of zinc (Zn) in the plant sample tissues analyzed

COPPER (Cu)

The range of copper concentration in all the plant tissues analyzed were between 0.026±0.006 to 0.079±0.015 mg/kg. With *Pomegrante* having the least concentration of 0.087±0.013 mg/kg.and *Annona squamosa* with highest concentration of 0.146±0.035 mg/kg(Figure 2).Statistically no significant difference between the plant samples tissues analyzed(P>0.05).

The recommended permissible limit WHO (2006) safe for copper in medicinal plants is 20 to 150mg/kg, but in this study, the concentrations were below the permissible limit. Maobe*et al.*, (2012) conducted a research at south west Kenya on profile of heavy metals on selected medicinal plants and reported 3.05mg/kg to 14.4mg/kg which is also within the WHO (2006) limits higher than the results obtained in this work. Copper is an essential metal to human life in small quantity it is a keycomponent in redox enzyme, hemocyanin and cellular metabolism, but in high doses it can cause anemia, liver and kidney damage. People with Wilson's disease are at greater risk for health effects from over exposure to copper (WHO 2005).

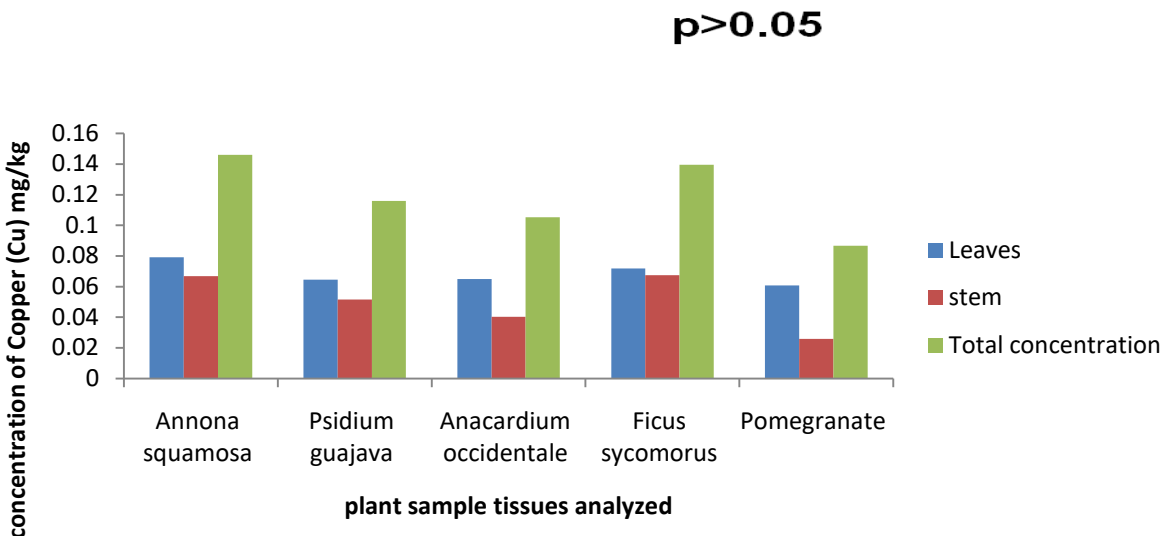

Figure 2: Concentration of Copper (Cu) in the plant sample tissues analyzed

POTASSIUM(K)

Potassium mean concentrations varied from 1.846 mg/kg to 11.669 mg/kg. Among all the plant samples analyzed *Anacardium occidentale*has the lowest concentrations of 4.35mg/kg while*Ficussycomorus*has the highest concentrations of 20.12mg/kg.(Figure 3). (P>0.05) that means there is no statistically significant difference between the plant sample tissues analyzed.

Similar research conducted by Ducu*et al*.,(2010) on determination of macro elements contents of some medicinal plants from Lasi, Romania and reported 1.945 mg/kg of potassium which is below the recommended amount (WHO 2006), and lower than the results obtained in this work.

Potassium is an essential macro element which is necessary in muscle contraction, proper function of the brain and protein synthesis. High potassium diet lower blood pressure. The necessary daily intake is between 2 g/day to 4 g/day (WHO 2005).

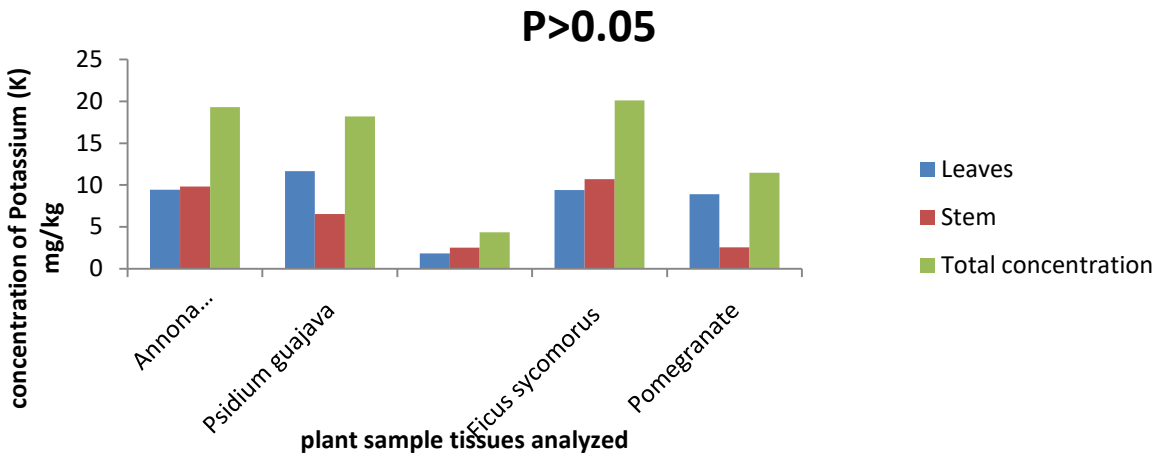

Figure 3: Concentration of Potassium (K) in the plant sample tissues analyzed

MANGANESE (Mn)

The concentrations of manganese were observed to range between 0.039±0.004 to 1.269±0.277mg/kg *Anacardium occidentale*was found to be highest 1.7775mg/kg and *Pomegranate* has the least 0.1845mg/kg.(Figure 4). Though, there was no significant difference between the plants (P>0.05). The WHO (1998) permissible limits of manganese in medicinal plants is 200mg/kg, while its daily intake is 11mg/day. The results obtained in this study showed the concentrations of Mn were below the recommended permissible limit. Similar research was reported by Lasisi*et al*.,(2005) who conducted a research on heavy metals and macronutrients content in selected herbal plants in Ibadan Nigeria by the use of AAS and reported the concentration of Mn 80.90±0.04 mg/l below the WHO (2006) limits also lower than the results obtained in this work. Manganese is very essential trace heavy metal for plants and animal growth. Its deficiency produces severe skeletal and reproductive abnormalities in mammals (Jarup, 2003).

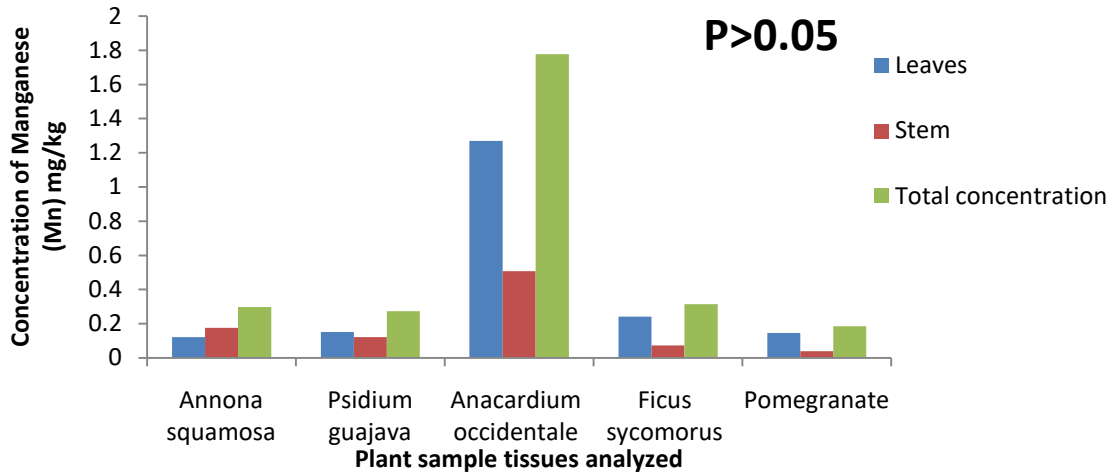

Figure 4: Concentration of manganese (Mn) in the plant sample tissues analyzed

IRON (Fe)

The results obtained in this showed that the concentrations of Iron varied between 0.019±0.001 mg/kg to 0.107±0.032 mg/kg. Highest concentrations was found in *Anacardium occidentale* 0.14mg/kg and lowest was observed in *Pomegranate* 0.09mg/kg(Figure 5). The WHO (1998) permissible limit for iron in medicinal plants is 200mg/kg from the results obtained the concentration were below the permissible limit. The Analysis of variance shows no significant difference between the plants (P>0.05).

Many researchers have reported similar results, Lasisi*et al*.,(2005) conducted a research on heavy metals and macronutrients content in selected herbal plants in Ibadan Nigeria and reported the concentration of Fe 208.10±0.08mg/l below the WHO (2006) limits. Iron is the most abundant and an essential constituent for all plants and animals, Supply oxygen and energy production. On the other hand, at high concentration, Fe causes tissues damage and some other diseases in humans. Hence, it's deficiency results in anemia (Fuortes and Schenck, 2000)

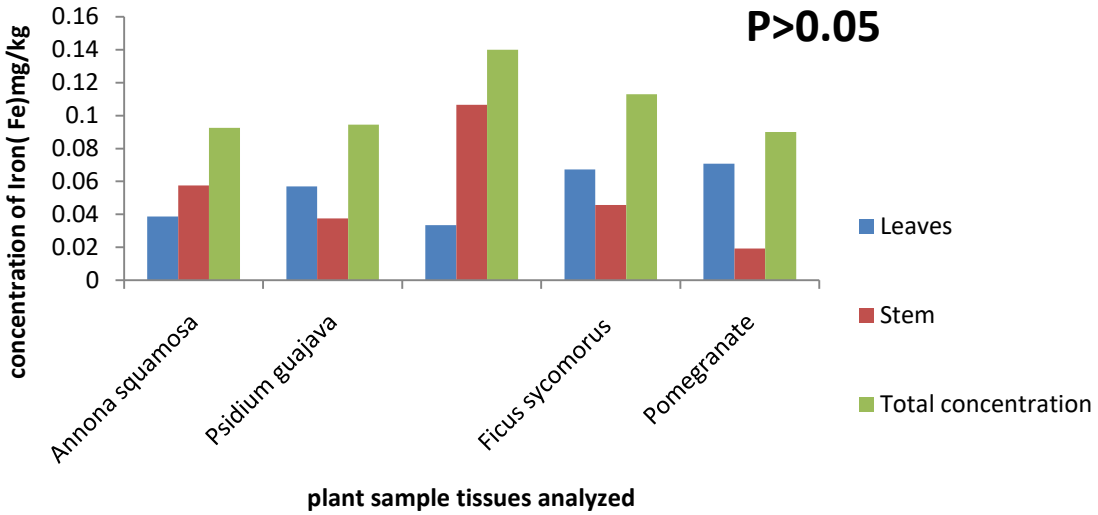

Figure5: Concentration of Iron (Fe) in the plant tissue samples analyzed

NICKEL (Ni)

Figure 6 showed the concentrations of nickel in the plant sample tissues analyzed which range between 0.054±0.006 mg/kg to 0.144±0.013 mg/kg .Among the plant sample analyzed *Ficussycomorus*has the highest mean concentration of 0.232mg/kg and *Annona squamosa* has the least mean concentration of 0.149mg/kg.(Fig 6). (P>0.05) which reveals no significant difference between the plants. The maximum permissible limit of nickel in consumed medicinal plants is1.5mg/kg, while its routine requirement for humans is 1mg/day. From the results obtained in this study, all the concentrations were below the WHO (2005) limits.

Similar findings was reported by Hussain *et al*., (2013) who conducted a research to determine the levels of different trace heavy metals present in commonly edible vegetables and fruits which are available in local market of Shorkot city and the result obtained showed that nickel ranged from 0.0117-0.1190 mg/kg which is below the permissible limit and lower than the results obtained in this research. Nickel is also an essential element for plants and animals. In small quantity, nickel is necessary for the regulation of lipid contents in tissues and for the formation of red blood cells. But at high level, it becomes toxic and causes severe diseases like, loss of vision, as well as heart and liver failures(McGrath and Smith, 1990).

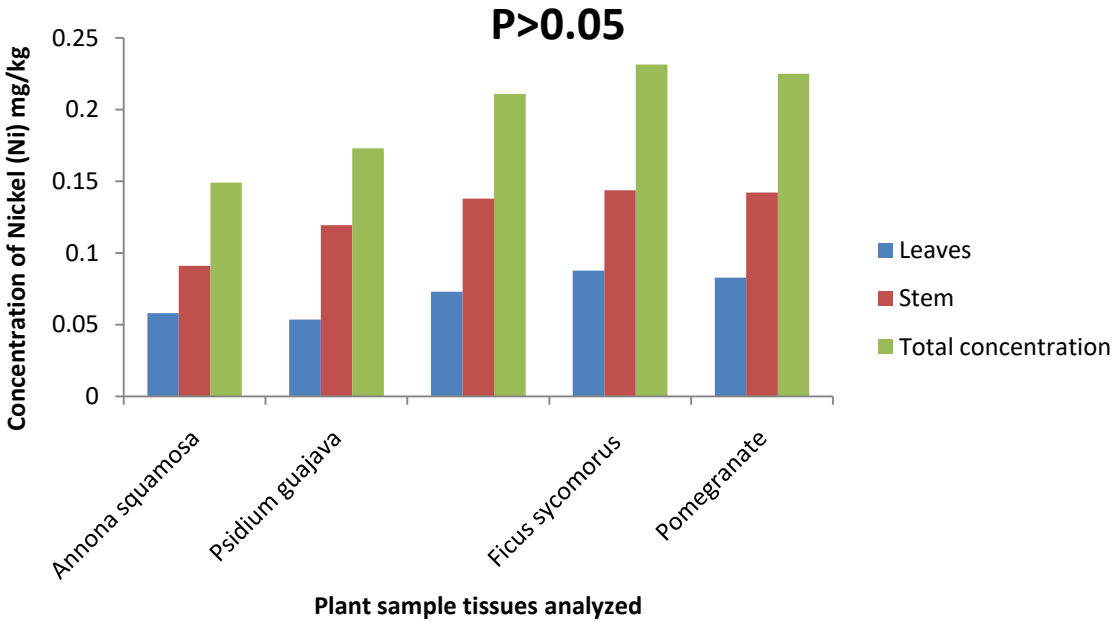

Figure 6: Concentration of nickel (Ni) in the plant sample tissues analyzed

CONCLUSIONS

This study presents the concentrations of heavy metals in some medicinal plants consumed by populace in Kano metropolitan. *Ficussycomorus*contained the highest concentrations of metals among all the plant samples analyzed, while *Pomegranate* contained the least concentration of all the metals analyzed. Potassium (K) had the highest concentration among all the metals in the plant sample tissues analyzed. The study revealed the concentration of metals determined in the research work were below permissible limit WHO (1998, 2005, 2006) standard. Also there was no statistically significant difference between the plant tissues sample analyzed for Zn, Cu, K, Mn, Fe and Ni (P>0.05).Thus, the plants are safe for consumption and recommended to be use for medicinal treatments. It is essentially required that every medicinal plant should be checked for contaminant load before processing it for further pharmaceutical purposes or for local human consumption.

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