An Assay of Some Toxic Metals in Different Parts of Common Medicinal Plants in Nigeria

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Abstract: Concentrations of heavy metals in the top and sub soils and in Aloe vera and Moringa oleifera were investigated using X-ray Fluorescence (XRF) spectrometric method. Samples of roots, leaves and roots of the plants were collected from July and August 2015 and were analyzed for arsenic (As), cadmium (Cd), nickel (Ni), lead Pb) and mercury (Hg). The mean concentrations (ppm) of metals in the studied plants were of the range: As (0.02±0.01 – 0.42±0.06); Cd (0.12±0.01– 1.62±0.08); Ni (0.22±0.02– 2.12±0.16); Pb (0.02±0.01– 0.28±0.01) and Hg (0.001±0.001– 0.004±0.002). The concentrations of toxic metals in the plants was observed to increase in the order of roots > leaves > seeds. Cadmium in the seeds, leaves and roots of Aloe vera and Moringa oleifera, in addition to arsenic in the roots of both plants exceeded the WHO maximum acceptable limit of Cd and As respectively, hence they are unfit to be consumed as traditional medicine. Statistical analysis of variance (ANOVA) at p<0.05 showed variations in the heavy metal levels within the groups. Monitoring of heavy metal in medicinal plants is essential for promoting a healthy society.

Key words: Toxic metals - XRF - Nigeria - Aloe vera and Moringa oleifera

INTRODUCTION

Medicinal plants are vital sources of traditional medicine for millions of people in Africa and developing nation around the world. In addition, modern medicine explores medicinal plants so as to produce new drugs to meet the need of billions of people in the planet [1]. Due to poverty and illiteracy, many people in Africa have completely supplemented orthodox medicine with traditional medicine [2]. More importantly, the use of medicinal plant has increased in developed nations due to their reasonable price and a general assumption that natural products are safer than synthetic drugs [3]. According World Health Organisation (WHO), traditional medicine provided 80-90% of healthcare in Africa. It has been reported that more than 85% of Ethiopians rely on herbal medicine for primary health care. In Ghana, Mali, Nigeria and Zambia, 60% of children with high fever from malaria are administered with herbal medicines as the first-line treatment at home. According to [4], poverty is the main reason why over 70% of rural population in Nigeria relies almost exclusively on traditional medicine for their healthcare. Two of the medicinal plants in high demand in Nigeria are Aloe vera and Moringa oleifera. Aloe vera is used in traditional medicine as a multipurpose skin treatment. Extracts from Aloe vera are widely used in the cosmetics because they have rejuvenating, healing, or soothing properties [5]. Moringa oleifera leaves possess antioxidant properties while the seed extract exhibits ameliorative effect on liver fibrosis, contains antitumor promoter and essential oil possess anti-fungal activity against dermatophytes [6-9].

Anthropogenic activities of man often results to metallic pollutants in the environment [10]. Uptake and accumulation of heavy metals by plants is either via the roots and foliar surfaces [11]. Metals in living tissue, unlike other organic pollutants, are not degradable rather they undergo biomagnifications [12]. Water and mineral salts are transported from the soil through xylem into plant and the driving force is transpiration. Medicinal plant grown in an environment polluted with toxic metals will likely absorb the metals from the soil and transfer it to other parts of the plant such as the stem, leaves, fruits and seeds. These toxic metals are further transferred to human body when any part of the medicinal plant is consumed. Ingestion of medicinal plants leads to the
chronic accumulation of different elements which my result to various health problems [13 and 14]. It has been reported that presence of some toxic metals, irrespective of their concentration results to adverse effect on human health [15]. As a result, WHO recommends a thorough assay of heavy metals in medicinal plants that is used as raw materials for pharmaceutical drugs and herbal medicine. More importantly, WHO regulates maximum permissible limits of toxic metals in plants such as arsenic, cadmium and lead [16]. The presence of some heavy metals often alters even the potency of active ingredient in medicinal plants [17].

**MATERIALS AND METHODS**

Samples of *Aloe vera* and *Moringa oleifera* were collected from backyards of houses within Abakaliki metropolis collected from July and August 2015 and they were authenticated at Applied Biology Department of Ebonyi State University. The roots, leaves and seeds of the plants were separated in each case and the components were cut into pieces. The plant tissues were cleaned to remove dust, soil and other particles by putting them through a three step washing sequence [18]. First they were washed with water, then with P-free detergent and followed by de-ionized water. The moisture and water droplets were removed with the help of blotting papers. The samples were air dried and placed in a dehydrator at approximately 80°C for 48 hours so as to stop enzymatic activity. This was followed by mechanical grinding with the aid of an agate mortar which results to the samples been pulverized into fine powdery form. This was done with utmost care to avoid contamination with the elements to be analyzed. The ground tissues were further dried at 65°C in an oven to obtain a constant weight upon which to base the analysis [19]. The pre-treated plant samples were stored in treated plastic bottles and were sent to laboratory for XRF analysis.

**XRF Analyses of Heavy Metal in Plant Samples:** A 13mm pellet of the sample was formed using CAVER model manual palletizing machine at a pressure of 6 - 8 torr. Standard Operating Procedure for XRF adapted from [20], was followed. A voltage of 25KV and current of 50mA produced from X-ray tube was used to bombard the sample in XRF system for 18 minutes at 1000 counts. Si-Li detector was used to detect the characteristic X-ray of the metals and their corresponding concentrations were computed in the read out device. Analyses of the samples were done in triplicates.

**RESULTS AND DISCUSSION**

Table 1 presents the levels of As, Cd, Ni, Pb and Hg in *Aloe vera* and *Moringa oleifera*. Figures 1 and 2 compared the concentrations of the metals in the roots, leaves and seeds. Since the greatest application of *Aloe vera* and *Moringa oleifera* is the use of their leaves, Figure 3 compare the level of metals in their leaves where it is observed that Ni was significantly higher than other metals in *Moringa oleifera* at p < 0.05.

![Fig. 1: Concentrations (ppm) of Some Toxic metals in Aloe vera](image)

**Table 1: Levels of As, Cd, Ni, Pb and Hg in Aloe vera and Moringa oleifera.**

<table>
<thead>
<tr>
<th>Plant samples</th>
<th>As (ppm)</th>
<th>Cd (ppm)</th>
<th>Ni (ppm)</th>
<th>Pb (ppm)</th>
<th>Hg (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aloe vera</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seed</td>
<td>0.02±0.01</td>
<td>0.12±0.01</td>
<td>0.22±0.02</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>leaves</td>
<td>0.06±0.02</td>
<td>0.22±0.02</td>
<td>0.28±0.02</td>
<td>0.20±0.01</td>
<td>nd</td>
</tr>
<tr>
<td>root</td>
<td>0.42±0.06</td>
<td>0.24±0.02</td>
<td>0.62±0.06</td>
<td>0.24±0.01</td>
<td>0.001±0.001</td>
</tr>
<tr>
<td><em>Moringa oleifera</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seed</td>
<td>0.01±0.01</td>
<td>0.12±0.01</td>
<td>0.42±0.04</td>
<td>0.02±0.01</td>
<td>nd</td>
</tr>
<tr>
<td>leaves</td>
<td>0.02±0.01</td>
<td>0.46±0.04</td>
<td>1.40±0.10</td>
<td>0.12±0.01</td>
<td>0.002±0.001</td>
</tr>
<tr>
<td>root</td>
<td>0.12±0.02</td>
<td>1.62±0.08</td>
<td>2.12±0.16</td>
<td>0.28±0.01</td>
<td>0.004±0.002</td>
</tr>
</tbody>
</table>

WHO ML = World Health Organization Maximum Acceptable Limit

nd = not detected
Arsenic: The concentration of As (0.42 ppm) in the roots of *Aloe vera* was significantly higher than in other parts of the plant at p < 0.05. The level of As in roots of *Aloe vera* and *Moringa oleifera* exceeded the WHO maximum acceptable level for As (0.10 ppm). Health implications for their consumption include kidney and liver damage, gastrointestinal effect, peripheral neuropathy, skin lesion, lung cancer and death [21].

Cadmium: High levels of Cd were observed in all the samples and they all exceeded WHO maximum acceptable level for Cd (0.10 ppm). Levels of Cd in this work were comparable to those observed in other medicinal plants by [22]. Plants containing excess Cd are known to result to bone fracture, cancer, diarrhea, stomach pains, severe vomiting, reproductive failure and damage of central nervous system and DNA [23].

Nickel: Accumulation of Ni in the root of *Moringa oleifera* was above other part of the investigated plants. All the values of Ni were lower than WHO maximum acceptable level (67 ppm). Deficiency of Ni have been linked with hyperglycemia, hypertension, depression, sinus congestion, fatigue, reproductive failures and growth problems in humans, while excess intake of Ni leads to hypoglycemia, asthma, nausea, headache and epidemiological symptoms like cancer of nasal cavity and lungs. The prescribed safety limit of Nickel is 3 to 7 mg/day in humans [23].

Lead: Lead was not detected in the seed of *Aloe vera*. Values of Pb obtained from this work ranged from 0.02 to 0.28 and they were comparable with those reported by [24]. The values of Pb obtained did not exceed the WHO maximum acceptable level (0.3 ppm) in plants. Lead was not detected in medicinal plants reported by [25]. Accumulation of Pb in the body is known to cause musculoskeletal, renal, ocular, immunological, neurological, reproductive and developmental effects [26]. Lead also causes both acute and chronic poisoning and also poses adverse effects on kidney, liver, vascular and immune systems [27].

Mercury: Hg was not detected in the seed and leaves of *Aloe vera* in addition to the seed of *Moringa oleifera*. Levels of Hg in the medicinal plants were the least among the metals determined in this work. The Food and Drug Administration (FDA) maximum permissible limit for Hg is 1.0 ppb. Excess Hg can damage to the central nervous system, kidneys and developing foetus, short- term exposure may cause lung damages, nausea, vomiting, diarrhea, skin rashes and eye irritation [28].
CONCLUSION

The concentrations of Cd in the seeds, leaves and roots of both plants, in addition to As in the roots of both plants exceeded the WHO maximum acceptable limit of Cd and As respectively. Consequently consumption of any of the affected parts of the plant, though may bring curative effect on the body, will eventually lead to more complicated health problems resulting from metal toxicity. Metals whose concentrations are low at the moment may undergo biomagnifications in human body resulting to health challenges. Evaluation of levels of metals in medicinal plants before they are applied in traditional medicine is indispensable. In line with [29], quality assurance of traditional medicine must involved assay of heavy metals in the herbs and roots used as raw materials.

REFERENCES