DETERMINATION OF THE SELECTED HEAVY METALS IN CARPOLOBIA LUTEA, G. DON (POLYGALACEAE) LEAVES AND FRUITS

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Abstract

Contamination of herbal medicines with heavy metals has been reported widely. In trace amounts some heavy metals are essential to the human body however they maybe toxic if present in a higher concentration. Herbal medicines are widely used in Africa and all over the world, Carpolobia lutea G. Don (polygalaceae) is a plant well distributed in West and also Central Africa; it is extensively used as traditional medicine for treatment of various ailments by local physicians in most communities in Nigeria. Therefore, there is need to investigate the levels of heavy metals. The objective of this study was to determine whether the concentration of selected heavy metals present in Carpolobia lutea leaves and fruits are within the acceptable range for human consumption. The evaluated metals were cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe) and zinc (Zn). Atomic absorption spectrophotometry (wet digestion) was used for the analyses, and content of metals per samples was expressed in ppm. The results revealed that Carpolobia lutea accumulate these elements at different concentrations. Most of the high concentrations of the metals were found in the leaves of the plant, these include iron (449.54±0.02 ppm), copper (20.96±0.00 ppm) and cadmium (1.37±0.00 ppm). Chromium (5.64±0.00 ppm) and zinc (6.21±0.00) were found in higher concentration in the fruits than the leaves. Monitoring concentration of heavy metals in medicinal plants is of great importance for health planners, health care professionals, and policymakers in protecting the public from the adverse effects of these heavy metals.

Keywords: Carpolobia lutea, heavy metals, atomic absorption spectrophotometer, medicinal plant.

Introduction

About 70 – 80 % of the world population continues to rely on non-conventional medicines which predominately consist of herbal sources in their primary health care [1]. Herbal medicines are likely to be contaminated with heavy metals [2, 3]. In trace amounts some heavy metals are essential for the human body however they maybe toxic if present in higher concentrations [4, 5]. They have the ability to bioaccumulate and disrupt functions of vital organs and glands in the human body such as brain, kidney and liver [6]. Medicinal plants can be contaminated by heavy metals via root uptake or by direct deposition of contaminants from the atmosphere onto plant surfaces. Some plants even have the ability to accumulate metals that have no known biological function to them, as mercury (Hg), Chromium (Cr) and others. The excessive accumulation of metals is toxic to most plants [7]. Carpolobia lutea, G. Don (Polygalaceae) is a small plant that often grows to 15 ft in height. Its juicy fruits are consumed by people of Southern Nigeria. The plant is well distributed in West and also Central Africa [8]. The plant Carpolobia lutea (C. lutea) is called cattle stick (English), Agba or Angalagala (Igbo) and Egbo Oshunshun (Yoruba) in Nigeria [9, 10]. The leaf is used to cure rheumatism, fever, pains, insanity, dermal infection, venereal diseases and to promote child birth. In addition, it is used as vermifuge and stomach medicine [11, 12]. The root decoction is reportedly used as malarial remedy [13, 14], anthelmintic and antisterility agent [8]. Triterpenic saponins have been reported in the leaves of Carpolobia lutea [8], as well as cinnamoyl 1-deoxy glucosides, cinnamic acid
and coumaroyl 1-deoxy glucosides [15]. Phytochemical screening confirmed the presence of tannins, saponins and flavonoids in the leaf and roots of *C. Lutea* [13, 16]. Tannins, flavonoids, saponins, cardiac glycosides and anthraquinones were found to be present in *C. Lutea* chewing stick [17]. Pharmacological assay on the leaf extract confirms ethnomedicinal use as anti-diarrheal, anti-ulcer [13], and gastroprotectives [15]. Study have revealed the mineral component of *Carpolobia lutea* roots to contain phosphorus (60.00 ± 2.83), calcium (75.00± 1.41), iron (6.3 ± 0.21), manganese (0.02 ± 0.01), magnesium (4.50 ± 0.14), zinc (0.05 ± 0.01) in mg/100g [18]. Due to the high consumption of *Carpolobia lutea* in our community, there is a need to analyse the concentrations of heavy metals in this medicinal plant. Hence, the concentrations of some heavy metals: iron (Fe), chromium (Cr), zinc (Zn), cadmium (Cd) and copper (Cu) in the leaves and fruits of *Carpolobia lutea* G. Don was determined using the Atomic Absorption Spectrophotometer (AAS) method.

**Materials and Methods**

**Collection and identification of plant material**

The leaves and fruits of *Carpolobia lutea* used in the study were collected from Surulere estate, Iyesi- Otta, Ado- Odo Local Government Area of Ogun State, Nigeria. The plant was identified at the Department of Pharmacognosy, University of Lagos, Nigeria with voucher specimen number PCGH-35.

**Preparation of powdered plant materials for experiment**

The test plant parts were washed, cut into small pieces and air dried at room temperature (25 ± 2°C) for seven weeks until completely dried. The dry plant materials were ground into powder and stored in air-tight glass bottles at room temperature prior to experiments.

**Sample preparation (digestion procedure)**

About 1 – 2g of samples (plant leaves or fruits powder) were measured in the digestion flask and acid (HNO₃ + HCl) was added in ratio 1:3 (50 ml: 150 ml) and was heated for further drying. Few drops of distilled water were added to the sample, dried until the brown colour formed became clear. After the clear formation, it was cooled and filtered. The filtrate was made up to 100 ml volumetric flask. The prepared samples were then analyzed for heavy metal using the Atomic Absorption Spectrophotometer (AAS).

**Sample analysis (Atomic Absorption Spectrophotometer)**

Heavy metal analysis was investigated using flame atomic absorption spectrophotometer (AA – 7000 Shomadzu) for the leaf and fruit of *Carpolobia lutea* using the wet digestion method [19]. Standards of Fe, Cr, Zn, Cd and Cu were used as reference analytes for quantitative estimation of heavy metals as well as accurate calibration and quality assurance of each analyte. The standard stock solutions (1000 ppm) were diluted to obtain working standard solutions ranging from 1 ppm to 10 ppm and stored at 4°C. An acidity of 0.1 % nitric acid was maintained in all the solutions. A calibration curve was plotted between measured absorbance and concentration (ppm). All the samples were analyzed in triplicate using Flame Atomic Absorption Spectrophotometer.

**Results**

The results obtained from this study are summarized in (Tables 1) including the WHO recommended level of metals in medicinal plants. All the metals iron (Fe), Chromium (Cr), zinc (Zn), cadmium (Cd) and copper (Cu) analysed were present in the leaves and fruits of *Carpolobia lutea*. Most of the high concentrations of the metals were found in the leaves of the plant, these include iron, copper and cadmium. Chromium and zinc were found in higher concentration in the fruits than the leaves (Table 1).
Table 1: Mean metal concentrations (ppm ± SD) in *Carpolobia lutea* fruit and leaves

<table>
<thead>
<tr>
<th>S/N</th>
<th>Element</th>
<th>WHO Limit (ppm)</th>
<th>Fruits (ppm)</th>
<th>Leaves (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cr</td>
<td>1.5</td>
<td>5.64 ± 0.00</td>
<td>1.47 ± 0.00</td>
</tr>
<tr>
<td>2.</td>
<td>Cu</td>
<td>10</td>
<td>18.74 ± 0.00</td>
<td>20.96 ± 0.00</td>
</tr>
<tr>
<td>3.</td>
<td>Cd</td>
<td>0.3</td>
<td>0.9 ± 0.00</td>
<td>1.37 ± 0.00</td>
</tr>
<tr>
<td>4.</td>
<td>Fe</td>
<td>20</td>
<td>282.57 ± 0.00</td>
<td>449.54 ± 0.02</td>
</tr>
<tr>
<td>5.</td>
<td>Zn</td>
<td>50</td>
<td>6.21 ± 0.00</td>
<td>2.42 ± 0.02</td>
</tr>
</tbody>
</table>

Discussion
The concentrations of iron and copper were higher in the leaves (449.54±0.02 and 20.96±0.00) than the fruits (282.57±0.00 and 18.74±0.00) (Table 1). However, in all, iron reflects the highest concentration of metal reported in the leaves of *C. lutea*, 449.54 ± 0.02 ppm and at this high concentration it may cause tissue damage and some other diseases in humans [20]. High blood levels of free ferrous iron react with peroxides to produce free radicals, which are highly reactive and can damage DNA, proteins, lipids, and other cellular components. Thus, iron toxicity occurs when there is free iron in the cell, which generally occurs when iron levels exceed the capacity of transferrin to bind the iron. Iron typically damages cells in the heart, liver and elsewhere, which can cause significant adverse effects, including coma, metabolic acidosis, shock, liver failure, adult respiratory distress syndrome, long-term organ damage, and even death [21]. The accumulation of heavy metals in agricultural soils is of increasing concern because of food safety issues, potential health risks and its detrimental effects on soil ecosystem [22]. Even though WHO has formulated guidelines for quality assurance and control of herbal medicine, traditional practitioners lack enough knowledge which may results in medication with various types of heavy metal contamination. Heavy metals that are essential for the health of the body include Cu, Zn and Fe and are required in negligible quantities for the proper functioning of enzymes, haemoglobin formation and vitamin synthesis in humans [23]. In case of both deficiency and excess of these essential metals metabolic disturbances are encountered. Compared to the study of Gbadamosi and Oloyede 2014, metal analysis of *C. Lutea* root revealed iron (6.3 ± 0.21 ppm), zinc (0.05 ± 0.01 ppm). Cadmium is a non essential heavy metal. It is extremely toxic even at low concentration. It causes learning disabilities and hyperactivity in children [24]. The leaves of *Carpolobia lutea* contained a higher level of Cd than the fruits (1.37±0.00 and 0.9±0.00). Being a non essential metal, it is considered very toxic. The WHO recommended level of cadmium in medicinal plants is 0.3 ppm [25]. Chromium plays a vital role in the metabolism of cholesterol, fat, and glucose. Its deficiency causes hyperglycemia, elevated body fat, and decreased sperm count, while at high concentration it is toxic and carcinogenic [26]. In this study the fruits have a higher level of Cr than the leaves (table 1).

Conclusion
The results from this study showed that the levels of heavy metals reported in the leaf and fruit of *Carpolobia lutea*, a commonly used ethnomedicinal plant poses potential health risk to consumers. Most of the high concentrations of the metals were found in the leaves of the plant, these include iron, copper and cadmium. Chromium and zinc were found in higher concentration in the fruits than the leaves. Thus, it is essentially required that leaves and fruits of *Carpolobia lutea* should be checked for heavy metal load before processing it for further pharmaceutical purposes or for local human consumption.

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Reference


