Determinaton of cadmium, chromium and lead in four brands of herbal bitters preparation sold in Benin-city, Southern Nigeria

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This study evaluated the level of three toxic heavy metals (cadmium, chromium and lead) in four selected brands of herbal bitter preparations sold in Benin City, Southern Nigeria purchased from chemists' shops, using the flame atomic absorption spectrophotometric technique. The result of the atomic absorption spectroscopy (AAS) analysis showed that Chromium (Cr) was not detected in any of the four brands. Lead (Pb) was present in only two herbal bitters B (28.0 ppm) < S (75.0 ppm) while Cadmium (Cd) was detected in all the herbal bitters with a trend A (3.2 ppm) < Y( 5.3 ppm) < B( 31.0 ppm) < S (45.8 ppm). This observed trend could be attributed to the use of untreated organic manure, poor waste management and disposal practices, and the use of unsafe portable water for the preparations. It signals an epidemiological timed bomb that should be prevented by the Foods and Drug regulatory bodies.

Key words: Epidemiology, heavy metal, herbal bitter preparations, waste disposal, waste management.

INTRODUCTION

Over three-quarter of the third world's population relies on traditional herbal remedies to meet their primary health care needs (WHO, 2007; Osamor and Owumi 2010). Herbal preparations are sold in major markets, motor parks and in health shops. They are in form of herbal teas and bitters, packaged liquid preparations, capsules, packaged powdered medicinal plant parts, and fresh medicinal plants part.

In most countries, these products although not licensed as drugs or pharmaceutical products by the appropriate regulatory agencies, are recognized as dietary supplements. Of the herbal preparations, the use of herbal bitters is on the increase with scarce documentation on the usage extent and pattern among any given population (Showande and Amokeodo, 2014).

These poly-herbal liquid preparations which contain bitter herbs are commonly used as carminatives, aphrodisiacs, immune boosters, anti-infectives, aperitifs and to improve digestion (Showande and Amokeodo, 2014). Most of these preparations are made from plants

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collected from the environment with water as a medium for the extraction of the bioactive constituents. This underscores the need for proper waste disposal and management practices in addition to quality assessment of water used for these preparations. Also of concern is that most of these products have not been certified safe for patient’s use. They find their way into the market with little or no data on their safety and efficacy due to poor regulation and monitoring by the appropriate agencies in the third world countries.

In Nigeria today, like most third world countries, these products are ubiquitous with acclaimed cure-all potencies despite little or no scientific documentation on their safety, potencies, stability, and relevant physico-chemical profile.

The medicinal plants used for the formulation of these herbal preparations are collected from the environment with reported high incidence of pollution due to unregulated emissions from industrial and agricultural activities. This further underscores the urgent need for quality assessment of these herbal products found in the drug markets which a large percentage of the population depend on for the treatment of illnesses. This will provide information on their safety, potency and stability that could be used to develop a monograph for their standardization thus improving on public health. Medicinal plants like every other plant are vulnerable to bioaccumulation of toxic heavy metals from the environment. Several factors like the nature of soil and its heavy metal concentration, proximity of farmlands to dumpsites and automobile traffic, use of untreated organic manures and sewages sludge, atmospheric depositions and stage of development of the plant have been known to affect the bioaccumulation of heavy metals in plants (Lake et al., 1984; Scott et al., 1996; Voutsia et al., 1996, Sinha et al., 2005; Sharma et al., 2006, Liu et al., 2007; Nwachukwu et al., 2010).

The control of their level in medicinal plants used for medicinal herbal preparations is therefore an imperative to safeguard their quality and safety. In view of this, the objective of this study is focused on the use of atomic absorption spectrophotometry to evaluate the level of three toxic heavy metals: Pb, Cd and Cr in four selected brands of herbal bitter preparations purchased from chemist shops in the Oba market area of Benin City, Edo State, Nigeria.

MATERIALS AND METHODS

Study area and sample collection

The study area, Benin City (6.34°N and 5.63°E), is located in Edo State, and it is one of the major cities in the South-South geopolitical region of Nigeria with a population of approximately 1.2 million people. The study samples were purchased in August 2013 from the chemist shops in the Oba market that is one of the major markets in the city.

Sample collection and description

Four herbal bitters preparation (coded as A, B, S and Y) and containing extracts from various medicinal plants (Table 1) were bought from the Village Chemist shops in August 2013. The samples were selected such that they were still within the expiration limit specified by their respective manufacturers. The samples were kept in the refrigerator at 4°C prior to analysis carried out at the Springboard Research Laboratory, a private laboratory in Awka, South Eastern Nigeria.

Experimental methodology

The wet digestion method (Adrian, 1973; Allen et al., 1986) was used with modification. The concentrations of the toxic heavy metals (Pb, Cd and Cr) in the four selected brands were determined using a 240FS Agilent flame Atomic Absorption Spectrophotometer (AAS) after prior digestion (on a hot plate) of 1 ml of the sample in a fume chamber. 15 ml of a ternary mixture of the concentrated acids, HNO₃:H₂SO₄:HClO₄ (5:2:8 v/v/v) was used for the digestion. The digestion was completed when a transparent solution was obtained. The digested mixture was allowed to cool and filtered using an ashless filter paper and the filtrate diluted to 50 ml with deionised water. This resulting diluted filtrate solution of the digested sample was then analysed for the presence of the heavy metals using the AAS calibrated using the standard nitrate salt solutions of the respective heavy metals. The instrument was operated following the Manufacturer’s Instruction (Agilent, 2013).

RESULTS AND DISCUSSION

Cr was not detected in any of the four brands. Lead was present in the herbal bitters B (28.0 ppm) and S (75.0 ppm) but was not detected in the herbal bitters A and Y. Cadmium was detected in all the four herbal bitters with a trend A (3.2 ppm) < Y (5.3 ppm) < B (31.0 ppm) < S (45.8 ppm) (Figure 1). In all the selected brands, the values of the evaluated heavy metals were above approved limits in Table 2 (WHO, 1998; FAO, 2005, WHO, 2007).

Similar findings on high level of the heavy metals: Cd (0.83-10.6 ppm) and Pb (2.6-48 ppm), in herbal preparation were reported by Nwoko and Mgbabeuruoke (2011) from Aba, Abakaliki, Enugu and Onitsha South Eastern Nigeria. Kalagbor et al. (2014) and Umeh et al. (2014) also reported on heavy metal pollution in medicinal plants collected from farmlands in Nigeria. Similar reports by other authors from other parts of the world are also documented (Gasser et al., 2009; Maobe et al., 2012; Lakshmi et al., 2013).

Toxic heavy metals are of no physiological use with deleterious health implication even at low exposure. Several cases of human disease, disorders, malfunction and malformation of organs due to metal toxicity have been reported (Adepoju-Bello and Alabi, 2005; Obi et al., 2006). Pb causes hyperactivity in children affecting the cognitive performance (Owen and Pikering, 1994),
### Table 1. Samples description.

<table>
<thead>
<tr>
<th>Herbal bitters code</th>
<th>A</th>
<th>B</th>
<th>S</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Packaging</strong></td>
<td>Supplied as 200ml liquid content in slight greenish opaque plastic bottle</td>
<td>Supplied as 200ml liquid content in a brownish plastic bottle</td>
<td>Supplied as 330ml net volume in a brownish opaque plastic bottle</td>
<td>Supplied as 200 ml liquid content in a transparent plastic bottle</td>
</tr>
<tr>
<td><strong>NAFDAC registration status</strong></td>
<td>Registered</td>
<td>Registered</td>
<td>Not registered</td>
<td>Registered</td>
</tr>
<tr>
<td><strong>Indication</strong></td>
<td>None</td>
<td>None</td>
<td>Management of hypertension, insomnia and strengthening the immune system.</td>
<td>Anti-oxidants</td>
</tr>
</tbody>
</table>

**Figure 1.** Concentration of Cr, Pb and Cd in four market brands of herbal bitters preparation in Nigeria.
impaired blood synthesis and hypertension. Cd is extremely toxic causing bone porosity, inhibition of bone repairs and death. The observed trend in the level of the heavy metals evaluated in this study could be attributed to environmental pollution due to industrial activities, poor waste management and disposal practices, and the use of unsafe portable water for the preparations (Adeyeye, 2005).

This underscores the need for the provision of waste handling facilities in most developing and underdeveloped countries, use of treated organic manure and sewage sludges in farmlands, cleaning of contaminated sites and strict enforcement of relevant environment and waste management and disposal laws by the relevant authorities, strict enforcement of town/urban planning master plan, strict monitoring of quality assurance procedures and market surveillance for medicinal herbal preparations by the relevant foods and drug regulatory authorities in third world countries as it is done for orthodox preparations.

**Conclusion**

This study revealed high levels of Cd in all the four brands of herbal bitters, and Pb in only two brands with values higher than allowed limits (FAO 2005) while Cr was below detection limit for all brands. The values for lead were generally higher compared to that for Cd. The observed trend in the toxic heavy metal content could be attributed to industrial and automobile effluents, poor waste management and disposal practices as well as harmful agricultural practices which predisposed medicinal plants to bioaccumulation of toxic heavy metals (Lake et al., 1984; Scott et al., 1996; Voutsa et al., 1996, Sinha et al., 2005; Sharma et al., 2006, Liu et al., 2007, Nwachukwu et al., 2010). This calls for the need for proper legislation to guide the cultivation and collection of medicinal plants used for herbal preparation and also enforcement of stringent quality control regulation by the Foods and Drug regulatory bodies.

**CONFLICT OF INTERESTS**

The authors have not declared any conflict of interests.

**REFERENCES**


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**Table 2. Limits of Cd, Cr and Pb in medicinal herbals.**

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>FAO* (ppm of Food products)</th>
<th>WHO** (mg/Kg of HM)</th>
<th>Canada*** (ppm of HM)</th>
<th>Canada*** (mg/day for FHP)</th>
<th>China*** (ppm of HM)</th>
<th>Malaysia*** (mg/Kg of FHP)</th>
<th>Thailand*** (ppm of HM/FHP)</th>
<th>NSF*** (ppm of RDS)</th>
<th>NSF*** (mg/day for FDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>0.01</td>
<td>3.0</td>
<td>0.3</td>
<td>0.006</td>
<td>1.0</td>
<td>na</td>
<td>0.3</td>
<td>0.3</td>
<td>0.006</td>
</tr>
<tr>
<td>Cr</td>
<td>0.08</td>
<td>na</td>
<td>2.0</td>
<td>0.02</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>2.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Pb</td>
<td>0.01</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>0.02</td>
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