



# Analysis of Some Selected Toxic Heavy Metals in Some Branded Nigerian Herbal Products

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## ARTICLE INFO

### Article history:

Received on: 01/02/2013

Revised on: 17/02/2013

Accepted on: 05/03/2013

Available online: 27/04/2013

### Key words:

Copper, Manganese,

Chromium, Cadmium, Nickel,

Toxicity, Herbal Products.

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## ABSTRACT

The use of herbal medicine has been in the increase in many developing and developed nations and Nigeria in particular has been using herbal medicine for many centuries. The approval of these herbal remedies by regulatory bodies has further encouraged the use of herbal remedies. The safety of these herbal remedies is however poorly understood. The present study was designed to estimate the concentration of heavy toxic metals in branded Nigerian herbal products frequently used for treatment of various ailments. Nine brands of herbal medicines were selected for the analysis of trace metals quality using Atomic Absorption Spectrometer. The samples were prepared for analysis by wet digestion method using nitric acid and perchloric acid treatment and then analysed using a flame Atomic Absorption Spectrometer. The contents of Copper, Manganese and Cadmium were below toxic limits in all the samples analysed. However, Chromium and Nickel were not detected in the samples. There is need for continuous monitoring of branded herbal drugs sold in the market to ensure wholesome and safe herbal drugs are sold for human consumption.

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## INTRODUCTION

Branded herbal drugs are commonly used in various countries. They are available in different shapes such as Ayurvedic, Traditional Chinese Medicines (TCMs) and homeopathic (Saeed *et al.*, 2010).

The popularity of herbal drugs increased in the past decade, probably due to rapid increase in Allopathic drugs prices and media report on their safety (Marcus and Grollman, 2002). In Nigeria, people use herbal products especially in the rural areas because of availability, affordability and safety.

There is a general belief that herbal products are safer and harmless but most of these products are not validated according to the recommended pharmaceutical guidelines, often herbal products contained toxic and lethal concentration of toxic heavy metals (Chan, 2003).

It is well documented in literature that medicinal plant based herbal; products contained toxic concentration of heavy metals (Saeed *et al.*, 2010; Adepoju-Bello *et al.*, 2012). Recent scientific advancement in terms of chemical, pharmacological and

biological technologies facilitated health care professionals to explore the potential health care benefits of herbal products (Saeed *et al.*, 2010).

In recent years, it has been discovered that some of these herbal products contains a considerable amount of toxic metals such as arsenic, cadmium, lead and mercury (Martena *et al.*, 2010). Some traditional Chinese herbal medicine, traditional Tibetan medicine and other Asian traditional medicine systems were found to contain significant amounts of mercury, arsenic or lead (Martena *et al.*, 2010). It has been shown that herbal remedies incorporated in Asian traditional herbal preparation for therapeutic purposes caused intoxications in users (Martena *et al.*, 2010; Robert *et al.*, 2008).

The heavy metal contamination in traditional medicines may occur due to polluted environment in which the medicinal plants grow, the polluted conditions in which the plants are dried and processed, the storage conditions or during manufacturing of the final dosage form (Saeed *et al.*, 2010).

Higher levels of toxic metals can also be found due to the metals containing agricultural expedient and contaminated irrigation water (Saeed *et al.*, 2010). The aim of this study was to evaluate the toxic heavy metals content of some branded herbal products sold in Nigeria.

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**Table 1:** Basic information on the herbal products.

S/N	Product Name	Nafdac No.	Manufacturer	Indication (S)	Dose
1	Tropical herbal powder	A7383865L	DR ND Herbal Clinic	Malaria, typhoid fever, pile, fibroid, staphylococcus	2 sachets/day
2	Aloe vera Dental Powder	A7/0219L	SAMIJ TRADO ENT. (NIG)	Retaining the colour of teeth, clean and restores the tooth and protects it from decay and stains.	6 applications/day
3	THUJA 1000 Powder	04-6222L	THUJA Life hospital Limited	Typhoid, malaria, bacteria, infection	2 sachets/day
4	Omega	04:8618L	EAC global Trado Limited	Gastrointestinal diseases, pile, amoebic dysentery, syphilis, staphylococcus.	2 sachets/day
5	Rinbacin Forte	012	Mabro Medicinal Herbs Limited	Candidiasis, staphylococcus, parathyroid, noisy stomach and gastrointestinal disease	2 sachets/day
6	Virgy-virgy	A704-4415L	Superlative (WA) Medical Services	Toothache, hookworms, and stomach ache	15 – 30ml/twice per day
7	Jalin Powder	A7-6734L	Frija Nig Limited	Typhoid, malaria, gonorrhoea, staphylococcus.	2 sachets/day
8	Goodwill Herbal	A7-0240L	Goodwill tradomedical care Limited	Hepatitis, general body weakness, joint pain, painful period, vaginal discharge, noisy stomach	5 – 10ml/day
9	ATU wonder	A7/3010L	Ajuwonder tradomedical health centre	Immunity restoration, purgative and curative	5 – 10ml/twice daily

**Table 2:** Operating parameters for Atomic Absorption spectrophotometer

Metal Name	Wavelength	Slit Width (nm)	Acetylene Flow (L/Min)	Cathode lamp current (mA)
Lead	283.3	0.7H	2.0	10
Cadmium	324.8	0.7H	2.0	15

## MATERIALS AND METHOD

Materials: Nitric acid and perchloric acid (both from sigma), deionizer (Elga, B114), whatman 42 filter paper, glassware, hot plate (Lab Tech), and atomic absorption spectrophotometer (Perkin Elmer Analyst 700).

Collection of Samples: the herbal products were purchased from a pharmacy shop in Portharcourt, River state, Nigeria. The manufacturer, brand name, manufactured date, expiry date, NAFDAC registration number, indication and dosage form were recorded. Selection of the products was based on the popularity of the products among the general public and the reputation manufacturers. The list of the nine herbal products selected is given in Table 1.

Digestion of Sample: the method of Saeed *et al.* (2011) was used for sample digestion. The nine samples were analysed for their toxic metals concentrations.

They were available only in the solid form. A 1g of the powdered sample was taken in a beaker; 10ml of concentrated nitric acid (67%) was added and kept at room temperature for 24 hours in a fume cupboard.

Perchloric acid (4ml) was added to the sample and concentrated on a hot plate at 60°C until a suspension of approximately 1ml was left in the beaker.

The residue was cooled, diluted with deionised water up to 50ml and filtered through whatman filter paper No. 42. Sufficient deionised water was added to make the volume up to 100ml and was kept in a transparent bottle until used for Atomic Absorption Spectrometer (AAS) analysis for the various toxic heavy metals with results expressed

in parts per million (ppm). AAS operation parameters are as shown in table 2. Statistical analysis: data are presented as mean of triplicate determination and were analysed using SPSS version 17.0.

## RESULTS

**Table 3:** Heavy metals content (ppm/mean) of some selected herbal products used in Nigeria.

Product Name	Cadmi-um	Chromi-um	Mangane-se	Nick-el	Copp-er
Tropical herbal powder	ND	ND	0.492	ND	0.939
Aloe vera Dental Powder	ND	ND	0.702	ND	0.831
THUJA 1000 Powder	ND	ND	0.077	ND	1.121
Omega	ND	ND	0.070	ND	0.025
Rinbacin Forte	0.002	ND	0.085	ND	0.374
Virgy-virgy	0.003	ND	ND	ND	1.121
Jalin Powder	ND	ND	0.012	ND	0.764
Goodwill Herbal	ND	ND	0.013	ND	0.947
ATU wonder	ND	ND	0.060	ND	0.657

ND – not detected

Table 3 shows the heavy metals content of some selected herbal products. The results showed that cadmium, chromium and nickel were not detected in most of the herbal products analysed. Only manganese and copper were detected in the herbal products.

**Table 4:** Recommended daily limits for some metals. Source:

Metal	Recommended daily limit
Cadmium	70µg
Chromium	11 – 25µg (Child), 30 – 35µg (adult)
Manganese	8000 - 11000µg
Nickel	35µg
Copper	340 - 400µg (child), 900µg (adult)

**Table 5:** Daily consumption of metals ( $\mu\text{g/day}$ ) based on manufacturers' recommended dose of the respective products.

Product Name	Cadmium	Chromium	Manganese	Nickel	Copper
Tropical herbal powder	ND	ND	0.984	ND	1.878
Aloe vera Dental Powder	ND	ND	4.212	ND	4.986
THUJA 1000 Powder	ND	ND	0.154	ND	2.242
Omega	ND	ND	0.140	ND	0.050
Rinbacin Forte	0.004	ND	0.170	ND	0.748
Virgy-virgy	0.04 – 0.18	ND	ND	ND	33.63 – 67.26
Jalin Powder	ND	ND	0.024	ND	1.528
Goodwill Herbal	ND	ND	0.065 – 0.13	ND	4.785 – 9.570
ATU wonder	ND	ND	0.6 – 1.2	ND	3.285 – 6.570

ND – not determined

Table 5 shows the daily consumption of metals in the herbal products based on manufacturers' recommended dose. Copper could be consumed more in a single day than manganese and not much is consumed for cadmium, chromium and nickel since they were not detected in branded herbal drugs.

## DISCUSSION

The safety and quality of medicinal herbal products have become a major concern for health authorities, pharmaceutical industries and the general public (WHO, 2007). The practice of herbal treatment is well established in Nigeria. The products have substantial share in drug market. Apart from affordability and availability, the advocates of herbal products believe that they are safe and harmless because of their natural origin without any scientific evaluation. Similarly, the potential serious side effects of synthetic drugs also diverted people's attention towards natural products. But unfortunately, most of the herbal products contain undisclosed components or toxic concentration of heavy metals. It has been noticed that the exposure to heavy metals like cadmium and chromium etc, are toxic to human health even in traces (Marcus and Grollman, 2002).

The concentration of metals like cadmium, chromium, manganese, nickel and copper were investigated in herbal products collected from the local pharmacy shops of known manufacturers using atomic absorption spectrophotometer.

Cadmium is one of the most toxic natural elements. Chronic exposure to cadmium through environment or using contaminated food causes kidneys and lungs failure, affect bones and stomach. The toxic effects of cadmium on humans are same in both adults and children (Saeed *et al.*, 2010). However, the experimental data showed that younger animals absorb more cadmium than adults (ATSDR, 2008). According to food and drug administration (FDA) and world health organisation (WHO), the tolerable weekly intake of chromium per kilogramme body weight is  $7\mu\text{g}$  (ie  $70\mu\text{g/day}$  for normal adults) (JECFA, 2005). The concentration range of cadmium in tested samples was  $0.002 - 0.003\mu\text{g/g}$  as shown in table 3. According to manufacturers recommended dose, the daily consumption of cadmium was calculated as shown in table 5. The tested product had low concentration of cadmium as daily consumption is below the permissible limit. According to the agency for toxic substances and disease registry (ATSDR), chronic exposure to nickel is commonly associated with allergic reactions in humans, especially skin rashes, which appear at the site of contact. Animal data

blood, stomach, liver and kidney disorders (ATSDR, 2005). The daily dietary intake of nickel estimated by various authors is  $35\mu\text{g}$  (Forstner and Wittman, 1981) or  $25 - 35\mu\text{g}$  (Anke, 1995). Nickel was not detected in tested samples.

Manganese is also an essential element for health. In the tested samples, manganese was present in the concentration of  $0.012 - 0.702\mu\text{g/g}$ . The highest concentration was found in Aloe vera dental powder followed by tropical herbal product ( $0.492\mu\text{g/g}$ ). However, manganese was not detected in Virgy-virgy herbal product. The recommended dietary allowances for children are  $1.2 - 1.5\text{ mg/day}$ , for men  $2.3\text{mg/day}$ , and for women  $1.8 - 2.0\text{mg/day}$  (FNB, 2001).

Chromium is available in two ionic forms, that is, trivalent and hexavalent. The trivalent chromium is present in food and is utilised by humans because of its safety. Chromium participates in glucose metabolism. The information to set the recommended dietary allowance for chromium is not enough. However, the food and nutrition board set out an adequate intake level based on chromium contents in normal diet, that is, for children  $11 - 25\mu\text{g/day}$  and for adult  $30 - 35\mu\text{g/day}$ . Exposure to high level of chromium causes lungs cancer and dermatitis (FNB, 2001; ATSDR, 2004). Chromium was not detected in our tested sample (Table 3).

Copper is an essential element for the human metabolic system. It regulates various biological processes inside the body like oxidation-reduction (redox) reactions, energy production, connective tissues formation, iron metabolism, synthesis of neurotransmitter etc (Anke, 1995; Linder and Hazegh-Azam, 1996). However, chronic exposure to high concentration of copper causes irritation of nasal mucosa, vomiting, nausea, diarrhoea, damaging kidney and liver (ATSDR, 2004). The recommended dietary allowance for children is  $340 - 440\mu\text{g/day}$  and for adult  $890 - 900\mu\text{g/day}$  (FNB, 2001). As shown in table 5, the daily consumption of copper did not exceed the permissible limit in both children and adult.

## CONCLUSION

It is evident from the analysis that all the samples analysed measured concentrations of trace metals below the permissible limits. The herbal medicines analysed are therefore to an extent safe for human consumption. Some of the samples also did not contain detectable levels of trace metals such as chromium and nickel. Since medicinal plants have been used and continue to be used therapeutically all around the world and being an important aspect of various traditional medicines systems, it is

imperative to monitor the quality of these preparations. Although, the selected herbal drugs used for this analysis are registered with the National Food and Drug Administration and Control (NAFDAC) in Nigeria, the fact that most herbal drugs sold in the open market are not registered with NAFDAC is very discouraging. There is need for continuous monitoring of herbal drugs sold in the market to make sure wholesome and safe drugs are sold for human consumption.

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### How to cite this article:

Ekeanyanwu, R.C., Njoku, J.O., Nwodu, P.O., Njokuobi, A.E., Analysis of Some Selected Toxic Heavy Metals in Some Branded Nigerian Herbal Products. *J App Pharm Sci*, 2013; 3 (04): 088-091.