

ELEMENTAL IMPURITIES IN REGISTERED HERBAL SUPPLEMENTS IN NIGERIA: A LOOK AT MERCURY, ANTIMONY AND TIN

C.N. Amadi, O.E. Orisakwe* and I.I. Roberts

Department of Clinical Pharmacy, Faculty of Pharmacy,
University of Port Harcourt, Rivers State, Nigeria.

*E-mail: eorish@aol.com

ABSTRACT

The use of traditional and alternative medicine has increased worldwide. Although heavy metal poisoning has been associated with traditional medicines, little is known about the exposure to heavy metal toxins from herbal supplements consumed in Nigeria. This study determined the concentrations of mercury, antimony and tin in orally-administered herbal supplements commonly sold in Nigeria.

Twenty four different Nigerian Herbal supplements (NHS) were randomly sampled from herbal medicines stores in the Niger Delta in December, 2010. They were analyzed for mercury, antimony and tin contents and to ascertain their compliability with the recommended limits of the World Health Organization (WHO), European Union (EU) and the United States Environmental Protection Agency (USEPA).

Herbal supplements were ashed before digestion using conc. aqua regia, HCl:HNO₃ (3:1) and mercury, antimony and tin were assayed with AAS 205A. The highest levels of mercury, antimony and tin were 0.01945mg/l (super cleanser capsules), 0.00381mg/l (Super clean capsules), 0.00926mg/l (Reliva Caplets) respectively, whereas lowest levels of mercury and tin were 0.00488mg/l (Eroxil 5000 syrup) and 0.00205mg/l (Evans Bitters). About 29.2% of the sampled NHS had non-detectable levels of antimony. The solid samples (tablets, caplets and soft gels) had the highest concentrations of mercury, antimony and tin. One hundred percent of the sampled NHS violated the permissible limits of 0.001mg/l and 0.002mg/l for mercury and tin as recommended by WHO and EU respectively. Also, 79.2% and 33.3% of the samples exceeded the 0.006mg/l and 0.002mg/ml as recommended by USEPA for mercury and antimony respectively. One hundred per cent of the NHS was found to be below the limits of 0.005mg/l as prescribed by EU and WHO for Antimony.

It is feared that indiscriminate use of these supplements may constitute a significant source of mercury and tin exposure and should therefore be considered a public health problem especially in chronic exposure/ingestion given the resurgence of interest. The public health hazards from ingestion of these supplements should be identified and disclosed by in-depth risk assessment.

Keywords: Herbal supplements, Heavy metals, toxicity, public health, Nigeria.

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INTRODUCTION

Chemical element composition of consumables is of interest because of their essential or toxic nature¹. There has been a resurgence of interest in traditional and alternative systems of medicine worldwide²⁻⁷. The growing use of herbal medicines to treat a wide range of illnesses has been enhanced by the recognition that some diseases do not have any appropriate treatments, and by the belief that herbal remedies are innocuous. There is also the belief that what is natural can only be good and that herbal medicines are superior to synthetic drugs^{8, 9}. However, the risks contributing to the toxicity of herbal remedies are among others, presence of contaminants such as microorganisms, heavy metals, microbial toxins, pesticides, fumigation agents, radioactivity, and synthetic and animal drug substances¹⁰. Attention has been drawn specifically to the metal content of herbal remedies¹¹⁻¹⁴. It is known that in certain groups, such as Indian communities worldwide, traditional remedies have been shown to contain significant or even toxic levels of metals¹⁵⁻¹⁸. Metal contamination in the form of arsenic, cadmium, lead and mercury has also been demonstrated in traditional Chinese¹⁹⁻²².

The accumulation of heavy metals can have middle-term and long term health risks, and strict periodic surveillance of these contaminants is therefore advisable²³. If metal poisoning is identified, the true source may be wrongly associated with environmental occupational exposures, not medication²⁴. Failure to establish the true cause of exposure means that the patient continues taking the metal-containing medication. Thus the screening of traditional remedies for efficacy, and safety has been recommended to protect public health²⁵.

Table-1: Concentration of Mercury in Herbal Samples (Liquid Samples)

S. No.	NHS	Batch No.	NAFDA C No.	Mercury Level (mg/L)	USEPA (mg/l)	EU limit (mg/l)	WHO (mg/l)	% Violation (USEPA)	% Violation (EU)	% Violation (WHO)
1	EVANS BITTERS	9108	A7-0249L	0.00618	0.006	0.001	0.001	2.1	518	518
2	SUPER BITTERS	251210	A7-030L	0.00728	0.006	0.001	0.001	21	628	628
3	JIMJAD BITTERS	L3	0384L	0.00511	0.006	0.001	0.001	NIL	411	411
4	IIEBU HERBAL TONIC	010	04-9922L	0.00522	0.006	0.001	0.001	NIL	422	422
5	EMI BLOOD TONIC	067	04-6219L	0.00689	0.006	0.001	0.001	14.8	589	589
6	VENESTEN CLEANSER	068	04-6220L	0.00714	0.006	0.001	0.001	19	614	614
7	ALIVE ULCER FAST	001	N/A	0.00589	0.006	0.001	0.001	NIL	489	489
8.	EROXIL 5000	241210	A7-0263L	0.00488	0.006	0.001	0.001	NIL	388	388
9.	BAKER CLEANSER	BWBL05	A7-0273	0.00510	0.006	0.001	0.001	NIL	410	410

Table-1, Cont.: Concentration of Mercury in Herbal Samples (Solid Samples)

S. No.	NHS	Batch No.	NAFDA C No.	Mercury Level (mg/g)	USEPA Limit (mg/l)	EU limit (mg/l)	WHO Limit (mg/l)	USEPA % Violation	EU % Violation	WHO % Violation
10.	Reliva Caplets	SA046	A7-0285L	0.01430	0.006	0.001	0.001	138	1330	1330
11.	Rejuver Herbal Antioxidant	SA058	A7-0292L	0.01487	0.006	0.001	0.001	148	1387	1387
12.	Super Cleanser Capsules	001	04-9813L	0.01945	0.006	0.001	0.001	224	1845	1845
13.	Super 24/7 Capsules	068	A7-0213L	0.01325	0.006	0.001	0.001	121	1225	1225
14.	Super Clean Capsule	N/A	A7-0536L	0.01026	0.006	0.001	0.001	71	926	926
15.	Supa-A1	110	A7-0374L	0.01466	0.006	0.001	0.001	144	1366	1366
16.	Me & You Herbal Formula Capsules	012	04-9914L	0.01493	0.006	0.001	0.001	148	1393	1393

17.	Unic Capsules	001	04-9782L	0.01378	0.006	0.001	0.001	130	1278	1278
18.	Elimax Capsules	0002	A7-0549L	0.01563	0.006	0.001	0.001	161	1463	1463
19.	Ababio Capsules	001	04-9782L	0.01751	0.006	0.001	0.001	192	1651	1651
20.	Verocin Capsules	N/A	A7-0949L	0.00734	0.006	0.001	0.001	22	634	634
21.	Alpham Capsules	001	A7-0816L	0.01355	0.006	0.001	0.001	126	1255	1255
22.	AZOQ Capsules	A04	A7-0408L	0.01422	0.006	0.001	0.001	137	1322	1322
23.	HP Capsules	001	04-9782L	0.01328	0.006	0.001	0.001	121	1228	1228
24.	Smart herbal capsules	002	A7-0860L	0.01287	0.006	0.001	0.001	115	1187	1187

<DL= value less than detection limit of 0.0005mg/L.; **NAFDAC**- National Agency for Foods, Drugs Administration & Control; N/A= Not available

In the present study, we have investigated the heavy metal hazards of NHS with a focus on most often ignored heavy metals in public health- mercury, antimony and tin which is believed by many to be almost non existent in the Niger delta region of Nigeria. We have also investigated the percentage violations of mercury, antimony and tin in these NHS using the limits recommended by WHO, USEPA and EU in consumables and water.

EXPERIMENTAL

Using a basket market protocol, twenty four different Nigerian Herbal supplements (NHS) randomly sampled from herbal medicines stores in the Niger Delta in December, 2010 were used for the study. They were analyzed for mercury, antimony and tin contents and to ascertain their compliability with the recommended limits of the World Health Organization (WHO), European Union (EU) and the United States Environmental Protection Agency (USEPA).

The samples were ashed and digested in Teflon lab ware that had been cleaned in a high-efficiency particulate air (HEPA) filtered (class 100), trace-metal-clean laboratory to minimize contamination. This protocol involved sequential cleaning of the lab ware in a series of baths in solutions (1 week each) and rinses (five per deionized water rinses, then 6-NHCl (reagent grade) solution and ultrapure water rinses, finally 7.5 N HNO₃ (trace metal grade) solution and ultra pure water rinses. The lab ware was then air dried in a polypropylene laminar air flow-exhausting hood. Dry ashing method was used by adding 30 ml of each sample into a conical flask and heated on a hot plate at 200 °C, for 45min, then in a furnace at 500 °C until the volume was drastically reduced to near dryness. Digestion was done by addition of 10 ml conc. aqua regia (HCl:HNO₃, 3:1), it was then heated to dryness. 20 ml deionized water was added, stirred and filtered. The filtrate was made up in standard volumetric flask and mercury, antimony and tin were assayed with atomic absorption spectrophotometry 205A. The limit of detection for mercury, antimony and tin was 0.0005ppm with blank values reading as 0.00 ppm for the three metals in deionized water with electrical conductivity value of lower than 5 µS/cm. Samples were analysed in triplicates. The true intake using the arithmetic mean according to²⁷ was calculated by multiplying contaminant level i.e., heavy metal level by amount/ average daily dose of supplement. In all the estimated or calculated levels of mercury, antimony and tin in the herbal supplements, 80mg was assumed to be the average daily dose for all the supplements.

RESULTS AND DISCUSSION

Table-1, 2 and 3 show the mercury, antimony and tin levels (mg/l) of Nigeria herbal supplements respectively in comparison with recommended guidelines of USEPA, WHO and EU. The mercury levels ranged from 0.00488mg/l in EROXIL 5000 to 0.01945mg/l in Super Cleanser Capsules. The highest levels of mercury, antimony and tin were 0.01945mg/l (super cleanser capsules), 0.00381mg/l (Super clean capsules), 0.00926mg/l (Reliva Caplets) respectively, whereas lowest levels of mercury and tin were

0.00488mg/l (Eroxil 5000 syrup) and 0.00205mg/l (Evans Bitters). About 29.2% of the sampled NHS had non-detectable levels of antimony while 100% of the sampled supplements had detectable levels of mercury and tin. The solid samples (tablets, caplets and soft gels) had the highest concentrations of mercury, antimony and tin. One hundred percent of the sampled NHS violated the permissible limits of 0.001mg/l and 0.002mg/l for mercury and Tin as prescribed by WHO and EU respectively. Also, 79.2% and 33.3% of the samples exceeded the 0.006mg/l and 0.002mg/ml as prescribed by USEPA for mercury and antimony respectively.

Table-2: Concentration of Antimony in Herbal Samples (Liquid Samples)

S. No.	NHS	Batch No.	NAFDAC No.	Antimony (mg/L)	USEPA limits (mg/l)	EU limit (mg/l)	WHO limits (mg/l)	% Violation (USEPA)	% Violation (EU)	% Violation (WHO)
1	EVANS BITTERS	9108	A7-0249L	<DL	0.002	0.005	0.005	NIL	NIL	NIL
2	SUPER BITTERS	251210	A7-030L	0.00057	0.002	0.005	0.005	NIL	NIL	NIL
3	JIMJAD BITTERS	L3	0384L	<DL	0.002	0.005	0.005	NIL	NIL	NIL
4	IJEBU HERBAL TONIC	010	04-9922L	<DL	0.002	0.005	0.005	NIL	NIL	NIL
5	EMI BLOOD TONIC	067	04-6219L	<DL	0.002	0.005	0.005	NIL	NIL	NIL
6	VENESTEN CLEANSER	068	04-6220L	<DL	0.002	0.005	0.005	NIL	NIL	NIL
7	ALIVE ULCER FAST	001	N/A	<DL	0.002	0.005	0.005	NIL	NIL	NIL
8.	EROXIL 5000	241210	A7-0263L	0.00052	0.002	0.005	0.005	NIL	NIL	NIL
9.	BAKER CLEANSER	BWBL05	A7-0273	<DL	0.002	0.005	0.005	NIL	NIL	NIL

Table-2, Cont.: Concentration of Antimony in Herbal Samples (Solid Samples)

S. No.	NHS	Batch No.	NAFDAC No.	Antimony Level (mg/g)	USEPA Limit(mg/l)	EU limit (mg/l)	WHO Limit (mg/l)	% Violation (USEPA)	% Violation (EU)	% Violation (WHO)
10.	RELIVA CAPLETS	SA046	A7-0285L	0.00106	0.002	0.005	0.005	NIL	NIL	NIL
11.	REJUVER HERBAL ANTIOXIDANT	SA058	A7-0292L	0.00239	0.002	0.005	0.005	19.5	NIL	NIL
12.	SUPER CLEANSER CAPSULES	001	04-9813L	0.00238	0.002	0.005	0.005	19	NIL	NIL
13.	SUPER 24/7 CAPSULES	068	A7-0213L	0.00103	0.002	0.005	0.005	NIL	NIL	NIL
14.	SUPER CLEAN CAPSULE	N/A	A7-0536L	0.00381	0.002	0.005	0.005	91	NIL	NIL
15.	SUPA-A1	110	A7-0374L	0.00237	0.002	0.005	0.005	18.5	NIL	NIL

16.	ME & YOU HERBAL FORMULA CAPSULES	012	04-9914L	0.00256	0.002	0.005	0.005	28	NIL	NIL
17.	UNIC CAPSULES	001	04-9782L	0.00173	0.002	0.005	0.005	NIL	NIL	NIL
18.	ELIMAX CAPSULES	0002	A7-0549L	0.00124	0.002	0.005	0.005	NIL	NIL	NIL
19.	ABABIO CAPSULES	001	04-9782L	0.00247	0.002	0.005	0.005	23.5	NIL	NIL
20.	VEROCIN CAPSULES	N/A	A7-0949L	0.00256	0.002	0.005	0.005	28	NIL	NIL
21.	ALPHAM CAPSULES	001	A7-0816L	0.00186	0.002	0.005	0.005	NIL	NIL	NIL
22.	AZOQ CAPSULES	A04	A7-0408L	0.00187	0.002	0.005	0.005	NIL	NIL	NIL
23.	HP CAPSULES	001	04-9782L	0.00186	0.002	0.005	0.005	NIL	NIL	NIL
24.	SMART HERBAL CAPSULES	002	A7-0860L	0.00289	0.002	0.005	0.005	41.5	NIL	NIL

One hundred per cent of the NHS was found to be below the limits of 0.005mg/l as prescribed by EU and WHO for Antimony. The estimated or the calculated intake of mercury, antimony and tin is contained in Table 4. The calculated amounts of mercury, antimony and tin in the 3 most contaminated supplements (Super clean 0.01026, 0.00381, and .00652 of mercury, antimony and tin respectively), Super cleanser (0.01945, 0.00238 and 0.00844 of mercury, antimony and tin respectively) and Reliva (0.1430, 0.00106 and 0.00926 of mercury, antimony and tin respectively) with average daily dosage of 80mg each were 27.82 mg/mL, mercury, 0.58 mg/mL, antimony, and 1.94 mg/mL, tin.

Table-3: Concentration of Tin in Herbal Samples (Liquid Samples)

S. No.	NHS	Batch No.	NAFDAC No.	Tin Level (mg/l)	USEPA Limit	EU limit	WHO (mg/l)	%Violation (USEPA)	%Violation (EU)	%Violation (WHO)
1	EVANS BITTERS	9108	A7-0249L	0.00205	-	-	0.002	-	-	2.5
2	SUPER BITTERS	251210	A7-030L	0.00355	-	-	0.002	-	-	75
3	JIMJAD BITTERS	L3	0384L	0.00389	-	-	0.002	-	-	94.5
4	IJEBU HERBAL TONIC	010	04-9922L	0.00406	-	-	0.002	-	-	103
5	EMI BLOOD TONIC	067	04-6219L	0.00422	-	-	0.002	-	-	111
6	VENESTEN CLEANSER	068	04-6220L	0.00510	-	-	0.002	-	-	155
7	ALIVE ULCER FAST	001	N/A	0.00312	-	-	0.002	-	-	56
8.	EROXIL 5000	241210	A7-0263L	0.00327	-	-	0.002	-	-	63.5
9.	BAKERCLEANSE R	BWBL05	A7-0273	0.00344	-	-	0.002	-	-	72

Table-3, Cont.: Concentration of Tin in Herbal Samples (Solid Samples)

S. No.	NHS	Batch No.	NAFDAC No.	TIN level (mg/g)	USEPA limit	EU limit	WHO Limit (mg/l)	% Violation(U SEPA)	% Violation (EU)	% Violation (WHO)
10.	RELIVACAPLETS	SA046	A7-0285L	0.00926	-	-	0.002	-	-	363
11.	REJUVER HERBAL ANTIOXIDANT	SA058	A7-0292L	0.00718	-	-	0.002	-	-	259
12.	SUPER CLEANSER CAPSULES	001	04-9813L	0.00844	-	-	0.002	-	-	322
13.	SUPER 24/7 CAPSULES	068	A7-0213L	0.00533	-	-	0.002	-	-	166.5
14.	SUPER CLEAN CAPSULE	N/A	A7-0536L	0.00652	-	-	0.002	-	-	226
15.	SUPA-A1	110	A7-0374L	0.00724	-	-	0.002	-	-	262
16.	ME & YOU HERBALFORMULA CAPSULES	012	04-9914L	0.00827	-	-	0.002	-	-	313.5
17.	UNIC CAPSULES	001	04-9782L	0.00367	-	-	0.002	-	-	83.5
18.	ELIMAX CAPSULES	0002	A7-0549L	0.00688	-	-	0.002	-	-	244
19.	ABABIO CAPSULES	001	04-9782L	0.00673	-	-	0.002	-	-	236.5
20.	VEROCIN CAPSULES	N/A	A7-0949L	0.00644	-	-	0.002	-	-	222
21.	ALPHAM CAPSULES	001	A7-0816L	0.00256	-	-	0.002	-	-	28
22.	AZOQ CAPSULES	A04	A7-0408L	0.00304	-	-	0.002	-	-	52
23.	HP CAPSULES	001	04-9782L	0.00255	-	-	0.002	-	-	27.5
24.	SMART HERBAL CAPSULES	002	A7-0860L	0.00722	-	-	0.002	-	-	261

Table-4: Examples of intake calculation

True metal intake	Calculation	Total intake of metal
Mercury	$80 \times 0.01026 + 80 \times 0.01945 + 80 \times 0.01430$	27.82mg/L, mercury
Antimony	$80 \times 0.00381 + 80 \times 0.00238 + 80 \times 0.00106$	0.58mg/L, antimony
Tin	$80 \times 0.00652 + 80 \times 0.00844 + 80 \times 0.00926$	1.94mg/L, tin

*(That is, assumed supplement dosage multiplied by heavy metal contaminant level for each of the three products: the dosage of the NHS was assumed to be 80mg each).

Studies of heavy metal contents of herbal medicines have been documented in literature²⁸⁻³⁰. There has also been a documentation of the heavy metal hazards of Nigerian herbal supplements showing high levels of some heavy metals which did not include antimony and tin³¹. The primary aim of this study is to ascertain the levels of heavy metals such as mercury, antimony and tin in registered Nigerian herbal supplements (NHS). The study revealed that the NHS contained high levels of mercury, and tin sufficient to cause adverse health effect when regularly taken as recommended. Exposures will be expected to vary from high doses to sub-acute doses. In South Africa it is known that a number of traditional herbal remedies give rise to severe renal pathology, the mechanism of which is unclear but which could be related to metal toxicity³². The maximum permissible limit (MPL) of mercury is 0.006mg/l as recommended by USEPA and 0.001mg/l as recommended by WHO and EU, but in this study, the lowest level of mercury found was 0.00488mg/l as contained by Eroxil 5000 syrup, while the highest level was 0.01945 mg/l by Super cleanser capsules. One hundred percent of the sampled herbal remedies violated

the permissible limits for mercury as stipulated by WHO, and EU guidelines respectively while 79.2% of the tested remedies exceeded the 0.006mg/l limits as prescribed by USEPA for antimony respectively.

Mercury has a spectrum of toxic effects, including being a reproductive toxicant. Among the adverse effects caused by the presence of mercury are the induction of testicular deformation in seminiferous tubules and Leydig cells and sperm abnormality in human^{33, 34}. Higher blood mercury concentration is associated with male infertility³⁵. Further studies showed that membranes of acrosomal cap, the midpiece, and the tail of human sperm are potential binding sites for mercury³⁶. Subsequently, disruptions of sperm membrane permeability, mitochondrial function, DNA synthesis by the microtubules, and motion generation by the microtubule sliding assembly are possible mechanisms of mercury toxicity³⁶⁻³⁸. Other than the sperm themselves, supporting cells in the testis, epididymis, and the seminal vesicles are also possible targets of mercury toxicity³⁹⁻⁴¹. This will finally result in semen abnormality and clinical infertility. Infertility is a common problem, affecting perhaps one couple in six, the majority of whom now seek medical care. Although diagnostic problems make it difficult to establish the extent of the male partner's contribution with certainty, a number of studies suggest that male problems represent the commonest single defined cause of infertility⁴².

The MPL of antimony is 0.002 mg/ml as stipulated by USEPA and 0.005 mg/l as by WHO and EU guidelines. About 29.2% of the sampled herbal remedies had non detectable levels of antimony and was present in most cases in such a low concentration. One hundred per cent of the tested remedies contained levels of antimony below the maximum permissible limits of 0.005mg/l as prescribed by EU and WHO while 33.3% of the tested samples exceeded the 0.002mg/ml limits prescribed by USEPA for antimony. However, research shows that antimony, a proven carcinogen, is toxic⁴³. Soluble antimony salts, after oral uptake, exert a strong irritating effect on the gastrointestinal mucosa and trigger sustained vomiting. Other effects include abdominal cramps, diarrhoea and cardiac toxicity⁴⁴. Chronic respiratory uptake of antimony-containing dusts leads to irritation of the respiratory tract and myocardial and liver damage^{44, 45}. With respect to possible reproductive effects of antimony in humans, one incomplete study reported that respired antimony compounds could trigger premature births and spontaneous abortions⁴⁶. Repeated oral exposure to therapeutic doses of antimony (III) was associated with optic nerve destruction, uveitides and retinal bleeding. Specific symptoms of intoxication are generally accompanied by headache, coughing, anorexia, troubled sleep and vertigo⁴⁷.

The level of tin in the present study ranged from 0.00205mg/l to 0.00926mg/l. The maximum permissible level (MPL) of tin is 0.002mg/l as prescribed by WHO. This implied that 100% of the tested remedies contained high level tin. The uptake of tin can cause acute effects as well as long-term effects. Acute effects are: Eye and skin irritations, Headaches, Stomachaches, Sickness and dizziness, Severe sweating, Breathlessness, Urination problems. Long-term effects are: Depressions, Liver damage, Malfunctioning of immune systems, Chromosomal damage, Shortage of red blood cells, Brain damage (causing anger, sleeping disorders, forgetfulness and headaches).

Because these heavy metals are usually not identified as being present or associated with traditional and herbal remedies, the clinical identification of metal toxicity is unlikely during a clinical evaluation, especially if the patient hides the use of the NHS because of perceived embarrassment³¹. The metal constituents of NHS may be the silent etiologic agents of a variety of ailments. Several possibilities exist to explain the presence of heavy metals in NHS, heavy metals could be included intentionally for alleged medicinal properties, the presence of heavy metal may be the result of accidental contamination during manufacture, for instance, from grinding weights or lead-releasing containers or other manufacturing utensils⁴⁸. Medicinal herbs may contain heavy metals when grown in seriously polluted soil⁴⁹. Heavy metals may just be one of the several contaminants in herbal remedies produced in Nigeria. The presence of metals in seven key herbal mixture is of serious concern, as this drug is in high demand in Nigeria for treating measles⁵⁰. Therefore, it is important that doctors and health care practitioners are aware of the potential risks associated with these products and, therefore, finding ways to minimize them, including questions pertaining to the use of these remedies during the routine taking of a patient's history^{36,50}. Such information will go beyond the possibility of heavy metal contaminations and include the possibility of detecting herbal toxicities and herbal-drug interactions^{36; 52-54}.

The Nigerian herbal supplements in this study had high concentrations of mercury and tin, most especially the solid dosage forms (caplets, capsules and soft gels). One fact which is evident in this study is that all the herbal remedies were duly registered by the Food and Drug regulatory agency. It could therefore be inferred that heavy metals are not regulated in medicaments in Nigeria unlike most other countries. Therefore, it is expedient in the interest of public health to introduce mandatory testing for heavy metals for every batch of herbal supplement that is produced or imported into the country. Permissible limits for these heavy metals will be as recommended by WHO publication. Conspicuous display on the container or packaging of these medicines should bear the inscriptions like —Heavy metals within permissible limits.

CONCLUSION

It is feared that ingestion of these herbal supplements may constitute a significant route of heavy metal exposure to the Nigerian populace and should therefore be considered a public health problem especially with over dosages arising from self prescription by trado-medical practitioners. The public health hazards from ingestion of these supplements should be identified and disclosed by in-depth risk assessment studies.

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