BEST: International Journal of Humanities, Arts, Medicine and Sciences (BEST: IJHAMS)
ISSN(E): 2348-0521
Vol. 2, Issue 2, Feb 2014, 7-16

MARKET SURVEY AND HEAVY METAL SCREENING OF SELECTED MEDICINAL PLANTS SOLD IN SOME MARKETS IN BENIN CITY, NIGERIA

MACDONALD IDU, ERHABOR JOSEPH, TIMOTHY ODARO & OVUAKPORIE-UVO OGHALE

Department of Plant Biology and Biotechnology, University of Benin, Benin, Edo, Nigeria

ABSTRACT

Market survey was conducted in five markets (uselu, New Benin, Oba, Oliha and Lagos Street) in Benin City, Nigeria. Fifty medicinal plants used for the cure of various ailments (including malaria, stomach disorder, skin infection, dysentery, cough, constipation, veneral diseases, and also as anthelminthic and purgatives) were documented. Heavy metals (Cu, K, Na, Mg, and Ca) and ions (PO_4^{3-}, So_4^{2-} and No_3^-) were quantified in fifteen randomly selected medicinal plants sold in the surveyed markets using atomic absorption spectrometry. The main purpose of this study was to document the medicinal plants sold in major markets in Benin City, their uses and also determine the possible presence of some macronutrients and heavy metals in the selected plants which are extensively used in the preparation of herbal products and standardized extracts. The maximum level of anions, macronutrients and heavy metal analyzed were 18.72 Mg/ kg, 0.65 Mg/ kg, 1.62 Mg/ kg, 2.80 Meq/100g, 3.67 Meq/100g, 42.73 Meq/100g, 57.05 Meq/100g, and 2.03 µg/g for PO_4^{3-} $S0_4^{2-}$, NO_3^-, Ca, Mg, Na, K and Cu respectively. All these values were below the World Health Organization recommended permissible limits for such heavy metals and could be considered safe.

KEYWORDS: Medicinal Plants, Heavy Metals, Macronutrients, Permissible Limits

INTRODUCTION

Phytomedicines are preparations consisting of complex mixture of one or more plant materials (Calixto, 2000). This is synonymous to traditional medicine (herbalism) which is the most ancient method of curing diseases and it has been said that plants are the very first and only true medicines ever used (Mume, 1973). Despite the fact that most of the Nigerian population depends on herbal medicine, a record of medicinal plants in earliest period in Nigeria is virtually not available because there was no documentation for their isolation, selection and preparation. Every fact about potent herbal plants was passed by word of mouth from generation to generation (Kochhar, 1981). Although scanty information abound on market surveys conducted and documented in time past on medicinal herbs sold in local markets in Benin City (Gill et al., 1993; Idu et al., 2005), there is need still for more documentation of medicinal plants by carrying out more markets survey which is an efficient means of acquiring data on local values and conservation status of indigenous species (Idu et al., 2005; Idu et al., 2010) and it is also desirable that the microbiological status and potential toxicity as a result of heavy metal contamination of medicinal plants be ascertained before they are used.

The term “heavy metals” refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (Anonymous, 2004). It is a general collective term, which applies to the group of metals and metalloids with atomic density greater than 4 g/cm^3 or 5 times or more, greater than water (Hutton and Symon, 1986; Battarbee et al., 1988; Nriagu and Pacyna, 1988; Nriagu, 1989; Garbarino et al., 1995; Hawkes, 1997). The term also covers micronutrients (non-essential elements), macronutrients (essential elements) and semi metals. They include mainly lead, arsenic, cadmium, mercury, nickel, chromium, iron, magnesium, potassium, calcium, sodium, manganese, copper, zinc and tungsten. Some are essential nutrients needed in trace amounts (for example copper, iron, zinc), others have

relatively low toxicity (for example nickel, chromium) and some of their water extractable, bio available chemical forms such as phosphate, nitrate and sulphate may have strong biological effects (Borkowski, 1994; Lozak et al., 2002; Lesniewicz et al., 2006).

Ca, K, Mg and Na being macronutrients, are important for the proper functioning of vital organs in the body. They also play vital roles as structural and functional components of metalloproteins and enzymes in living cells (Ansari et al., 2004; Zaidi et al., 2005). Both the deficiency and excess of essential macronutrients and trace of toxic metals may cause serious effects on human health (Underwood, 1997; Reilly, 1980). Medicinal plants which form the raw materials for finished products (drugs) may be checked for the presence of heavy metals (WHO, 1989;WHO 1998), and the maximum permissible limit of toxic metals be regulated because, it has been reported that whatever is taken (ingested) as food could cause metabolic disturbance subject to the allowed upper and lower limits of trace metals (Prasad, 1976).The purpose of this research is to update the record of the medicinal plants sold in the major local markets in Benin City, their uses and also to determine the presence of some heavy metals present them (plants).

MATERIALS AND METHODS

Study Area: The study area covered five major markets within Benin City, situated between $6^0$15'N and 5^0 25'E within the tropical rainforest zone of Nigeria in an estimated land mass of 550 sq km. The total population of Benin City is approximately 1, 114, 188 (Anonymous, 2006) with a growth rate of 3.5% annually. The main ethnic groups are the Binis, but due to the cosmopolitan nature of the city, there are other ethnic groups like Yoruba, Hausa, Esan, Ibo Calabar, Urhobo e.t.c. inhabiting in the Benin City.

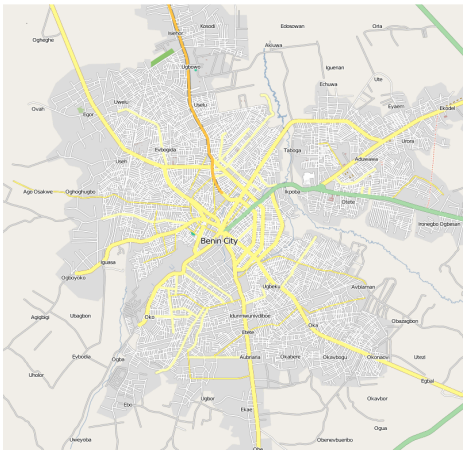

Figure 1: Map of Benin City

Survey

Market survey was carried out in five markets namely; uselu, New Benin, Oba, Oliha and Lagos street. These are markets with high daily economic activities. Sellers were sampled via oral interview based on the plants they sold, Local names of the plants, parts of the plants used and of course their medicinal values. Ten traders were interviewed. In each market, two shops with one or two traders were randomly selected and interviewed.

Collection and Identification of Plants: Fifty medicinal plants were purchased from and kept in sample collection bags in the course of the markets survey. All 50 plants were identified with the assistance of Prof. MacDonald Idu and Dr. Osawaru of the Department of Plant Biology and Biotechnology, University of Benin, Benin City. Some texts (Keay, 1989; Gill, 1992; Odugbemi and Akinsulire, 2006) were also consulted in the identification process.

Determination of Heavy Metals in Samples

Preparation of Plant Samples: For the heavy metal analysis, 15 medicinal plants were randomly selected from the 50 medicinal plants surveyed which included leaves, roots, barks, stems, fruits and seeds. Plant parts were washed (to remove possible dirt) with distilled water, cut into small pieces and dried at 105^0C for 24 hours. Once dry, the individual plant parts (seeds, stems, barks and roots) were ground into powder form using a manual miller while the leaves and seed were pounded with mortar and pestle. The ground samples were then wrapped with foil paper and kept in a plastic bowl at room temperature prior to digestion.

Digestion of Plant Samples: Plant sample (0.2g) was ashed at 550 ^{o}C overnight in a muffle furnace. As hed samples were then transferred quantitatively to 100ml glass (Pyrex) beaker. Crucibles used for ashing were washed with 25ml of 20% nitric acid (HNO_3) solution as part of qualitative transferring. The washouts were added to the ashed samples in a beaker and then warmed in fume hood just up to boiling. The solution was left to cool and then filtered using gravity into a 50ml volumetric flask and made to the mark with distilled water (AOAC, 1990). Samples were run on Atomic Absorption Spectrophotometer to obtain the absorbance values. Concentrations of heavy metals in the plant samples were then calculated from the equation of the calibration curve.

Calibration and Analysis of Trace Heavy Metals and Heavy Metals: Single elemental working standard solutions were prepared by diluting 1000 mg/l stock solutions of the individual elements (Cu, K, Na, Mg, Ca, PO_4^{3-}, So_4^{2-} and No_3^-).

External calibration was done by running deionised water then known calibrated standards for each element. The calibration curve was then generated for each metal. The extracted solutions and blanks were then run on an Atomic Absorbance Spectrometer (AAS) to obtain the absorbance values. Concentrations of the metals in the plant samples were then calculated from the equation of the calibration curve.

Concentration of Element in sample, (mg/l) = A – B

Where A = Concentration of Element in Sample, X (mg/l)

B = Concentration of Blank (mg/l)

Analysis of Anions

Determination of Nitrate (NO_3^-): 10 ml of digested samples was pipette into a 50 ml flask, after which 2 ml of Brucine was added and then 10 ml of concentrated H_2SO_4. The solution was mixed thoroughly and allowed to stand for 10 minutes. The standards were also treated similarly, thereafter; both the samples and standards were made to the mark of a standard volumetric flask. Reading was then done with an Ultraviolet (UV) spectrometer at 470nm.

Determination of Sulphate (SO_4^{2-}): 10 ml of digested sample was pipette into a 50 ml flask, distilled water was then added to bring the volume to about 20 ml. 1 ml of Gelatin (Barium chloride reagent) was added to the mixture, left to stand for 30 minutes and then made to mark with distilled water followed by thorough mixing. The standard was also treated similarly. The turbidity was read at 420nm in an Ultraviolet (UV) spectrometer.

Determination of Phosphate (PO_4^{3-}): 5 ml of digested sample was pipetted into a 25 ml volumetric flask. Distilled water was then added to bring the volume to approximately 15 ml. 8 ml of P-developer/Ascorbic acid was added and the solution was mixed thoroughly. The absorbance values were determined at 660nm with a Ultra-violet (UV) spectrometer.

RESULTS

The botanical names, families, local names, uses and seasonal availability of 50 medicinal plants sold in major markets in Benin City are shown in Table 1. They are reported in the treatment of diverse ailments including malaria fever (6 species), appetite boosters (3 species), stomach disorders (4 species), anthelmintic (2 species). Others are used for skin infections, dysentery, cough, boils, jaundice, constipation, purgative, gonorrhoea and so on. The seasons (of their bulk availability) were mainly rainy season for forty species and dry season for ten species.

Table 1: Medicinal Plants Sold in Local Markets in Benin City

No	Scientific Name and Family	Local Name (S)	Uses	Season
1	*Adenopus breviflorus* (Curcubitaceae)	Akiehe (Bn)	The seeds are chewed as intoxicants. It could be placed in a house with a child with measles to chase the disease.	Rainy season
2	*Aframomum melegueta* (Zingiberaceae)	Ehin- edo (Bn)	Used as a stimulants and vermifuge.	Rainy season
3	*Aframomum sceptrum* (Zingiberaceae)	Omoriemen (Bn)	It is used as a stimulant and added in many medicinal preparation.	Rainy season
4	Ageratum conyzoides (Asteraceae)	Ebe-gbedore (Bn)	The leaf juice is used for dressing wound, decoction of leaves is used as an emetic.	Rainy season
5	*Allium cepa* (Liliaceae)	Alubarha (Bn)	Crushed onion or its juice is used to remedy rashes and insect bites.	Dry season
6	*Allium sativum* (Liliaceae)	Ayo (yr)	The juice is used as a disinfectant and as an anthelmintic.	Dry season
7	*Alstonia boonei*(Apocyanaceae)	Ukhu (Bn)	Decoction of the bark is used as febrifuge, tonic and an antidote.	Rainy season
8	*Aristolochia repens* (Aristolochiaceae)	Ako-gun (yr)	Used to remedy dysentery and rheumatism.	Dry season
9	*Azadirachta indica* (Meliaceae)	Dongoyaro (Bn)	Used in malaria fever concoction and to relieve stomach pain	Rainy season
10	*Borillantiasa Oweirensis* (Acanthaceae)	Ehaghalo (Bn)	Used as remedy for poison intake.	Rainy season
11	*Caesalpina bondue* (Fabaceae)	Akwei (Bn)	Used as remedy for cough and rashes in babies.	Rainy season
12	*Chrysophyllum delevoyi* (Sapotaceae)	Ekpiro (Bn)	Infusion of bark is used as carminative (abdominal discomfort).	Rainy season
13	*Citrullus colocynthis* (Cucurbitaceae)	Ba-ara (yr)	The pulp is used as purgative.	Rainy season
14	*Citrus aurantifolia* (Rutaceae)	Alimoi (Bn)	The fruits is used as remedy for stomach disorder and tongue peel.	Rainy season
15	*Cola acuminata* (Sterculiaceae)	Evbe (Bn)	It is used as nerve stimulant and also used in concoction for infertility problems.	Rainy season
16	*Cola millennii* (Sterculiaceae)	Obi-gidi (yr)	Used as an antibiotic.	Rainy season
17	*Croton zambesicus* (Euphorbiaceae)	Agekobale (yr)	Decoction of leaves is used for bathing to seek God's blessing.	Dry Season
18	*Curculigo pilosa* (Amaryllidaceae)	Epakun (Yr)	The powdered root is used a remedy for diseases of blood and gonorrhoea.	Rainy season
19	*Curcuma longa* (Zingiberaceae)	Aghioyo(Bn)	The crushed rhizome is made into paste by adding few drops of palm oil and is applied to cuts, wounds and boils.	Rainy season
20	*Cymbopogon citratus* (Poaceae)	Ebe-eti (Bn)	Decoction of the leaves along with union and honey is used to cure malaria fever and chest pains.	Rainy season
21	*Cynometra manii* (Fabaceae)	Eku (yr)	Poultrice is used to remedy swollen cheek.	Rainy season

Table 1: Contd.,

22	*Dialium guineense*(Fabaceae)	Ohiome (Bn)	The infusion of the leaves and fruits is to remedy fever.	Rainy season
23	Eugenia aromatica (Myrtaceae)	Konofuru (Yr)	Used as carminative and also to relieve toothache.	Dry season
24	*Garcinia cola*(Guttiferae)	Edun (Bn)	Seeds are chewed to relieve cough and hoarseness of voice.	Rainy season
25	*Gossypium hirsutum* (Malvaceae)	Ukpowu (Bn)	Seeds decoction is used as a remedy for dysentery and as nervine tonic.	Rainy season
26	Heterotis rotundifolia (Melastomataceae)	Afor (Bn)	Used to remedy constipation and poison.	Rainy season
27	*Hunteria umbellata* (Apocyanaceae)	Osunmadun (Bn)	The root is used to remedy rheumatism and also used as an anthelminthic.	Rainy season
28	*Icacinia trichanta* (Icacinaceae)	Ebe-kpowo (Bn)	Leaves paste is used to remedy chest pain and asthma.	Dry season
29	*Irvingia gabonensis* (Irvingiaceae)	Ogwe (Bn)	Decoction of bark is used to remedy jaundice.	Rainy season
30	*Jathropha gossypifolia* (Euphorbiaceae)	Oraebo (Bn)	The latex of the leaves and stem is used for curing ring worms.	Rainy season
31	*Justicia flava* (Acanthaceae)	Oridun (yr)	Used in Dysentery concoction and crushed leaves are applied on fungal skin diseases.	Rainy season
32	*Khaya ivorensis* (Meliaceae)	Oguwagho (Bn)	Used in fever concoction.	Rainy season
33	*Lagenaria vulgaris*(Cucurbitaceae)	Uko (Bn)	The pulp of the fruit is used as a purgative and for chest pains.	Dry season
34	*Mangifera indica* (Anacardiaceae)	Mangoro (Yr)	Stem bark and leaves along with cashew leaves, lemon grass and Guinea corn leaves are boiled and drank to remedy malaria fever.	Rainy season
35	*Mondora brevipes* (Myristicaceae)	Ukposa (Bn)	Used as appetizer and in fever concoction.	Rainy season
36	*Newbouldia laevis* (Bignoniaceae)	Ikhimi (Bn)	Used as a remedy for inflammation of the eye and to relieve toothache.	Rainy season
37	*Nicotiana tabacum* (Solanaceae)	Itaba (Bn)	Leaves crushed to powder form is used for curing ring worm.	Rainy season
38	*Pentaclethra macrophylla* (Fabaceae)	Akhoro (Bn)	Used as a remedy for fever, stomach ache and as appetizer.	Rainy season
39	*Piper guineensis* (Piperaceae)	Oziza (Bn)	Used as an anti-vomiting during pregnancy.	Rainy season
40	*Raphia hookeri* (Arecaceae)	Omogoro (Bn)	Seed when roasted is used in treatment of pile.	Dry season
41	*Schrebera arborea* (Oleaceae)	Opele (yr)	An infusion of the inner bark is used for the relief of pain caused by toothache and sore throat, it can also be used to remedy fontanelle in children.	Rainy season
42	*Solanum anguvi* (Solanaceae)	Ikhueirhinmwin (Bn)	Used as remedy for boils and other inflammations.	Rainy season
43	*Solanum vervascifolium* (Solanaceae)	Ekue (Bn)	Decoction is used to remedy gonorrhoea.	Rainy season
44	*Solenostemon monostachyus* (Lamiaceae)	Aranpolo (yr)	Used in stomach-ache concoction.	Rainy season
45	*Sorghum bicolor* (Poaceae)	Okababa (Bn)	Used in fever concoction and as blood supplement.	Dry season
46	*Tetracarpidium conophorum* (Euphorbiaceae)	Okhue (Bn)	Seeds are used in the treatment of fibroid.	Rainy season
47	*Tetrapleura tetraptera* (Fabaceae)	Ighimiakia (Bn)	Decoction of pod and bark is used as emetic, it is also used as remedy for dysentery.	Rainy season
48	*Xylopia aethiopica* (Annonaceae)	Unien (Bn)	Used as remedy for cough and as purgative.	Rainy season

Table 1: Contd.,

49	*Zea mays* (Poaceae)	Oka (yr)	Can be chewed and sprinkle on with swollen cheek.	Rainy season
50	*Zingiber officinale* (Zingiberaceae)			

Key: Bn = Benin, Yr = Yoruba

Table 2 shows the values of some heavy metals (macro and micro nutrients), in 15 randomly selected medicinal plants sold in major markets in Benin City surveyed in the course of this study. Of the monitored trace heavy metals, the highest concentration found was that of potassium in *Mangifera indica* (57.05 Meq/100g) and the lowest concentration found was that of calcium in *Solanum anguvi* (0.77meq/100g). The highest concentration of anion was that of phosphate (PO_4^{3-}) in *M. indica* (18.72mg/kg) while the lowest concentration was that of sulphate ($S0_4^{2-}$) in*S. anguvi* (0.10mg/kg).

Table 2: Heavy Metal Concentration on Some Medicinal Plants Sold in Markets in Benin City

Plant Species Metal Concentrations								
	Cu (µg/g)	**K (Meq/100g)**	**Na (Meq/100g)**	**Mg (Meq/100g)**	**Ca (Meq/100g)**	**PO43- (Mg/Kg)**	**$S0_4^{2-}$ (Mg/Kg)**	**NO_3^- (Mg/Kg)**
Lagenaria vulgaris	0.68	38.17	28.59	3.17	2	13.36	0.43	1.08
Eugenia aromatica	0.92	23.06	17.28	2.15	1.36	9.07	0.26	0.65
Hunteria umbellata	0.5	12.58	9.42	1.45	0.91	6.1	0.14	0.36
Tetrapleura tetraptera	0.56	14.13	10.59	1.55	0.98	6.54	0.16	0.4
Aframomum sceptrum	0.77	19.37	14.51	1.91	1.2	8.02	0.22	0.55
Xylopia aethiopica	2.03	51.07	38.26	1.04	2.55	17.02	0.58	1.45
Mangifera indica	1.22	57.05	42.73	2.45	2.8	18.72	0.65	1.62
Cymbopogon citrates	0.9	43.75	32.77	3.55	2.24	14.94	0.5	1.24
Schrebera arborea	0.63	15.74	11.79	1.66	1.05	6.99	0.18	0.45
Solanum anguvi	0.37	9.23	6.91	1.22	0.77	5.14	0.1	0.26
Garcinia cola	1.52	38.07	28.52	3.17	2	13.33	0.43	1.08
Heterotis rotundifolia	1.81	45.39	34.01	3.66	2.31	15.41	0.51	1.29
Curcuma longa	0.72	18.16	13.6	1.82	1.15	7.68	0.21	0.51
Borillantiasa oweirensis	1.81	45.51	34.09	3.67	2.31	15.44	0.52	1.29
Adenopus breviflorus	0.55	13.73	10.28	1.53	0.96	6.42	0.16	0.39

DISCUSSIONS

The fifty species collected in the survey part of this research belong to forty-six genera and thirty families (Table 1). It was observed that most of the traders were illiterate with little or no formal education and some of them could only communicate in their local dialect. The traders usually get their trade items (medicinal plants) from neighboring villages within and without Benin City and sometimes from other states within the country. Other items sold by these traders were mostly used for idol worship and sacrifices.

They include different colors of fabrics, portrait, animal parts, chalks, sculpture, cowries, earthen pots, bells and so on. Active trade in the markets starts from 10.00 am to 6.00 pm (GMT). The major challenge encountered in the survey part of the study was the reluctant attitude of knowledgeable traders to let out information about the uses of plants they sell while others just sell these plant parts having little or no knowledge of their use.

A total of 5 elements (i.e. Cu, Na, Mg, Ca, and K) and 3 anions (PO_4^{3-} $S0_4^{2-}$andNO_3^-) were determined in the powdered samples of 15 randomly selected medicinal plant (from amongst the 50 plants documented in the market survey) by Atomic Absorption Spectrophotometry (Table 2).With regard to heavy metals on medicinal plants, the extent of accumulation and toxic level will depend on the plant and heavy metal parameters investigated. In general, a deficiency of these essential/trace elements increases the toxicity of heavy metals, whereas excess appeared to be protective. The results obtained in this study show that, the concentration of trace elements were greater than those of heavy metals which suggest that these medicinal plant perform protective functions in humans.

Elemental studies of the selected plants showed that they contained reasonable amounts of macronutrients and were rich in Mg, Ca, Na and K (Table 2). Amongst the 15 plants analyzed for macronutrients, *Mangifera indica* had the highest content level the two most abundant elements present in all the plants studied with 42.73 Meq/ 100g content level of Na and 57. 05 Meq/ 100g of K which tells that *Mangifera indica* is a good natural source of these essential elements for the maintenance of human health. According to Hooker (1987), Mg plays an important role in the metabolism of cholesterol as well as heart diseases. Deficiency or excess of Cu, Mn, Zn, Cr, Ca, Mg and K may cause a number of disorders (Ahmed etal., 1994).

These elements also take part in neuro chemical transmission and also serve as constituent of biological molecules, as a cofactor for various enzymes and in variety of different metabolic processes (Mayer and Vyklicky, 1989). The abundance of K, Mg and Ca, in the result of this analysis, is in agreement with previous findings that these three metals represent the most abundant metal constituents of many plants (Chizzola & Franz, 1996; Lavilla et al., 1999). Copper plays a role in the oxidative defense system but chronic copper toxicity can result in severe poisoning (Uriu-Adams and Keen, 2005). In this study, the Cu concentrations varied from 0.37 to 2.03µg/g for *S. anguvi* which had the least concentration of Cu and *Xylopia aethiopica* which had the highest concentration of Cu which is far less than the WHO recommended level of copper in the acceptable range of 20µg/mg body weight per day (FDA, 1993 and Watson, 1993). However, copper could be toxic depending on the dose and duration of exposure (Obi et al., 2006).

Nitrate (No_3^-) form of Nitrogen, known as potentially dangerous for health was often analyzed in raw medicinal plant materials or natural drugs (Atawodi, 2003). In this study, the concentration of nitrate was in the range of 0.26 to 1.62 mg/kg. These values were below the acceptable daily intake for nitrates as nitrate ion which is 3.7mg/kg (FAO/WHO, 1995). Phosphate (PO_4^{3-}) is known to react with essential metals, like iron, which diminishes bio available forms of this indispensable metal to humans (Duhan et al., 2002). In this study, the concentration of phosphate was in the range of 5.14 to 18.72mg/kg.

CONCLUSIONS

The present study have shown that market survey is an efficient means of collating medicinal plants and their uses, this should be encouraged by the government and non-governmental organization because it is a conservation strategy. The efficacy and safety of all the metals in the plants analyzed were low and well below the appropriate safety standards. The continuity of periodical assessment of these (Cu, K, Na, Mg, Ca, PO_4^{3-}, $S0_4^{2-}$ andNO_3^-) and other metal concentration in all herbal plants used in traditional medicine, which are sold in the local markets in Benin city and beyond would go a long way toward predicting the quality assurance and safer use of herbal products. The present work will be useful in this regard.

REFERENCES

1. Ahmed, S., Rehman, A., Qadiruddin, M., Badar, Y. (1994). Elemental analysis of a herbal drug Intella, a neuroenergiser. J.Fac. Pharm. Gazi University, Turkey. Vol.: 2, No.: 1pp83–90.
2. Anonymous (2004). Water Treatment, Lenntech, Rotterdamsewag, Netherlands. 55p.
3. Anonymous (2006). National population commission. Census News.
4. Ansari, T. M., Ikram, N., Najam-Ul-Hag, M., Fayyaz, O., Ghafoor, I., Khalid, N. (2004). Essential trace metal (Zn, Mn, Cu and Fe) levels in plant of medicinal importance. Journal of Biological Science, Vol.:4, pp 9 –99.

5. Association of Official Analytical Chemists (1990). Official methods of analysis, 15th Ed. Washington DC.

6. Atawodi, S. E. (2002). Occurrence of preformed volatile nitrosamines in preparation of some Nigerian medicinal plants: a preliminary report. Food Chemical Toxicology, Vol.:41, pp 551–553.

7. Battarbee, R., Anderson, N., Appleby, P., Flaver, R. J., Fritz, S., Haworth, E., Haggit, S., James, U., Kriser, A., Munron, M. A., Natkanski, J., Oldfield, F., Patrick, S. T., Richardson,N., Rippey, B., Stevenson, A. C. (1988). Lake Acidification in the United Kingdom. ENSIS, London. 260p.

8. Borkowski, B. (1994). Contamination of plants by heavy metals. Farm Pollution. Vol: 50, pp 697–710.

9. Calixto, J. B. (2000). Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicines (phytotherapeutic agents). Brazillian Journal of Medical and Biological Research, Vol.:33, pp 179–189.

10. Chizzola, R.,Franz, C. (1996). Metallic trace elements in medicinal and aromatic plants from Austrian Journal of Applied Biology, Vol.:70, pp52–56.

11. Duhan, A., Khetarpaul, N., Bishnoi, S. (2002). Content of phytic acid and HCL-extractability of calcium, phosphorus and iron as affected by various domestic processing and cooking methods. Food Chemistry, Vol.:78, pp 9-11.

12. FAO/WHO (1995). Forty-fourth report of the joint FAO/WHO expert committee on food additives: Evaluation of certain food additives and contaminants, Geneva. pp. 32–34.

13. FDA (1993). Quality standard for foods and with no identity standards; bottle water. Food and drug administration code of Fe. Reg. Vol: 58, pp 41-61.

14. Garbarino, J. R., Hayes, H., Roth, D., Antweider, R., Brinton, T. I., Taylor, H. (1995). Contaminants in the Mississippi River. United States Geological survey circular, Virginia, USA. 1133p.

15. Gill, L. S. (1992). Ethnomedical Uses of Plants in Nigeria. Uniben Press, Benin City. 276p.

16. Gill, L. S., Nyawamen, H. G. K., Omoigui, J. D. (1993). A survey of economic plants sold in the markets of Benin City (Edo State), Nigeira. Nigerian Journal of Technology and Education, Vol.:10, pp 67–77.

17. Hawkes, J. S. (1997). Heavy metals. Journal Chemistry Education, Vol.:74, pp 1374-1376.

18. Hooker, J. D. (1982). The flora of British India. Reeeve and Co. Vol. III, p. 640

19. Hutton, M., Symon, C. (1986). The quantities of cadmium, lead, mercury and arsenic entering the United Kingdom environment from human activities. Science and the Total Environment. Vol: 57, pp 129–150.

20. Idu, M., Osawaru, M., Orhue, E. S. (2005). Medicinal plants sold in some local markets in Benin City, Nigeria. Ethnobotany. Vol.:17, pp 118–122.

21. Idu, M., Omonigho, S. E., Erhabor, J. O., Efijuemue, H. M. (2010). Microbial load of some medicinal plants sold in some local markets in Abeokuta, Nigeria. Tropical Journal of Pharmacological Research, Vol.:9, pp 251–256.

22. Keay, R. W. J. (1989). Trees of Nigeria. Oxford Press, London. 466p.

23. Kochhar, S. L. (1981). Tropical Crops: A Textbook of Economic Botany. Macmillan Publishing Ltd, London. 290p.

24. Lavilla, I., Filgueiras, A. V., Bendicho, C. (1999). Comparison of digestion methods for determination of trace and minor metals in plant samples. Journal of Agricultural and Food Chemistry, Vol.:47, No.:12, pp 5072–5077.

25. Lesniewicz, A., Jaworska, K., Zyrnicki, W. (2006). Macro and micronutrients and their bioavailability in Polish herbal medicaments. Food Chemistry, Vol.:99, pp 670–673

26. Lozak, A., Soltyk, K., Ostapczuk, P., Fijalek, Z. (2002). Determination of selected trace elements in herbs and their infusions. Science of the Total Environment, Vol.:289, pp 33–34.

27. Mayer, M. L., Vyklicky, L. (1989). The action of Zinc on sunaptic transmission of mouse neuronal excitability in culture of mouse hippocampus. Journal of Physioliology, Vol.:415,pp 351–365.

28. Mume, J. O. (1973). Traditional Medicine in Nigeria. Jom nature care centre, Agbarho, Nigeria. 56p.

29. Nriagu, J. O. (1989). A global Assessment of natural sources of Atmospheric Trace metals. Nature, Vol.:338, pp 47-49.

30. Nriagu, J. O., Pacyna, P. (1988). Quantitative assessment of worldwide contamination of air, water and soil by trace metals. Nature, Vol.:333, pp 134-139.

31. Obi, E., Akunyili, D. N., Ekpo, B., Orisakwe, O. E. (2006). Heavy metal hazards of Nigerian herbal remedies. Science of the Total Environment, Vol.:369, pp 35–41.

32. Odugbemi, T., Akinsulire, O. (2006). Medicinal plants by species names In: Odugbemi, T. (eds). Outlines and Pictures of medicinal plants in Lagos Nigeria. University of Lagos Press, Lagos. pp. 73-161.

33. Prasad, A. S.(1976). Trace elements in human health and diseases Vols. 1 and 2, Academic Press, New York, USA.

34. Reilly, C.(1980). Metal Contamination of Food, 1st Ed. Chapter 5 and 6. Applied Science Publishers London.

35. Underwood, E. J.(1997). Trace element in human and animals nutrition. 4th edition, Academic Press Inc. New York.

36. Uriu-Adams, J. Y., Keen, C. L. (2005). Copper; oxidative stress and human health. Molecular Aspects of Medicine, Vol.:26, pp 268-269.

37. Watson, D. (1993). Safety of Chemical Contaminants in Food. Ellis, New York. 109p.

38. WHO (1989). Evaluation of Certain Food Additives and Contaminants. WHO Technical Report Series 776, Geneva: World Health Organization

39. WHO (1999). Monographs on selected medicinal plants. Vol. 1. World Health organization, Geneva.

40. Zaidi MI, Asrar A, Mansoor A, Farooqui MA (2005). The heavy metal concentrations along roadsides trees of Quetta and its effects on public health. Journal of Applied Science, Vol.:5, pp 708-711.