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Trace Elements Analysis of Some Antiparasitic Medicinal Plants in Côte d'ivoire Using Energy-Dispersive X-ray Fluorescence (EDXRF) Technique

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Abstract: Trace elements concentrations in eight plants with antiparasitic potency in Côte d'Ivoire were studied using Energy-dispersive X-ray Fluorescence (EDXRF) technique. The aim of this study is to determine qualitatively and quantitatively trace elements in these plants and their medicinal roles in the human body. Leaves, stems, stem barks and roots were analysed for their trace element contents. The plant samples were found to contain essential trace elements such as Fe, Zn, Cu, Co, Ni, Mn and Se which are well known for their important roles in antiparasitic preparations (herbal drugs). Most of the medicinal plants were found to be rich in one or more of the essential elements under study. The elemental concentrations in different part of the medicinal plants and their biological effects are discussed.

Key words: Antiparasitic, energy-dispersive X-ray fluorescence technique, medicinal plants, trace elements

INTRODUCTION

In Africa and more specifically Côte d'Ivoire, parasitic diseases like malaria, leishmaniasis and trypanosomiasis can be equally found in both the rural and urban dwellings. It has been found to be among the major causes of death on the continent of Africa. This can be attributed to several factors such as lack of good environmental and sanitation practices and adequate medical care. In most African countries the doctor to patient ratio is very low and coupled with inadequate health posts, it thus becomes quite evident that orthodox medicine alone cannot cater for the health needs of the people. For this and other reasons, coupled with the high cost of pharmaceutical drugs, the population mostly among the rural dwellings resort to the use of herbal or plant medicine which has been the tradition of old.

These herbs are now being increasingly used as alternative medicine, in food as well as cosmetics (Bakhru, 1998). Traditional medical herbs used for strengthening the body's immune system and for therapeutic purposes are known to have many essential and nutritional elements. The excess or deficiency of these nutritional elements may disturb normal biochemical functions of the body (Lyengar, 1989). Most studies on such medicinal plants pertain to their organic contents, viz. essential oils, glycosides, vitamins, alkaloids and other active components and their Pharmacological or therapeutic effects.

It is now well established that many trace elements play a vital role in the general well-being of humans as well as in the cure of diseases (Underwood, 1977; Prasad, 1993). Several studies have reported elemental contents in plant extracts, which are consumed either as a herbal health drink or in orthodox medicine (Powel *et al*., 1998; Abou Arab and Donia, 2000; Kumar, *et al*., 2005) These elements are presented at varying concentrations in different parts of the plants, especially in roots, seeds and leaves which are used as a dietary item as well as ingredient in medicinal preparation.

The aim of this study is to investigate the trace element contents in plants and their therapeutic properties. Due to increasing industrialization and environmental pollution, the study was also extended to estimate the level of toxic elements present in the medicinal plant samples. The possibility of having some traces of toxic element in plant materials makes it necessary for scientific research to be conducted into plant medicine to ensure safe methods of application especially considering the tolerable Upper intake Level (UL) and Recommended Daily Dietary Allowance (RDA) values.

This study can be of help in deciding the proportion of various active constituents and managing dose of a particular formulation since dosage has been a major challenge facing traditional herbalists or healers. Eight medicinal plants were studied by using X-ray fluorescence technique (EDXRF) to determine their trace element contents. The following are the plants and their

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Table 1: Some antiparasitic medicinal plants used ethnomedically in Côte d'Ivoire

Scientific name	Family	Parts used	Biological activities	Method of use	Code
Mareya micrantha	Euphorbiaceae	Leaves and stems barks	antiparasitic	Decoction/infusion	PT29
Aframomum sceptrum	Zingiberaceae	S ems	antiparasitic	Decoction/infusion	PT03
Isolona cooperi	Annonaceae	Leaves	antiparasitic	Decoction/infusion	PT05
Uvaria afzelii	Annonaceae	Leaves. roots	antiparasitic	Decoction/infusion	PT10
Ocimum americamum	Lamiaceae	Leaves	antiparasitic	Decoction/infusion	PT26
Enantia polycarpa	Annonnaceae	Stems barks	antiparasitic	Decoction/dried powder	PT32
Phyllanthus amarus	Euphorbiaceae	Leaves	antiparasitic	Decoction/infusion	PT33
Trichilia emetica	Meliaceae	Stems barks	antiparasitic	Decoction/infusion	PT17

parts that were analysed: leaves of *isolona cooperi*, *ocimum americamum*, *phyllanthus amarus*, leaves and stem barks of *mareya micranta*, *enantia polycarpa*, *trichilia emetica*, stems of *aframomum sceptrum*, roots and leaves of *uvaria afzelii*. These plants are well known for their antiparasitic biological activities.

METHODOLOGY

Sample collection and preparation: Plants species shown in Table 1 were collected from July 2007 to July 2008 at AGBAN-Bingerville, a village of Bingerville, a town situated at about 20 km from Abidjan, in Côte d'Ivoire in the forest zone (sampling sites shown in Fig. 1). They were made up of leaves, stems and roots. They were gently and thoroughly washed with distilled water to do away with surface contamination. They were then dried at ambient laboratory temperatures in the range of 20º-30ºC and then grinded into fine powder. About 300 mg of each sample were pelletized using a SPECAC press with a pressure of 2 tons/cm^2 to produce an intermediate thick pellet sample. The pellets produced were kept in a desiccator for at least 24 h to get rid of the moisture contents. Olive leaves (BCR No 62) was used as the standard reference materials for the validation of the analytical results.

Instrumentation and sample analysis: The irradiation was done using an EDXRF spectrometer at the XRF laboratory of Ghana Atomic Energy Commission (GAEC). Tube excited X-ray photons from a Mo-anode in a Mo secondary target excitation arrangement was used. The tube was operated at 45 kV/5 mA. A 30 mm^2 active area Si(Li) detector with an energy resolution (FWHM) of 165 eV at 5.9 keV Mn Kα, placed at 45º to the sample surface area was used for detection of characteristic photons. An ortec maestro multichannel analyser programme was employed for the data collection (peak collection).

Three irradiations were made for each sample, being the intermediate thick sample, multielement target and Sample+Target for a spectrum collection life time of 1500 s. Linear least squares fitting of the AXIL software programme was used for the spectrum deconvolution (IAEA, 2005). Emission-Transmission method in the QXAS package was used to convert spectrum peak areas to concentrations.

RESULTS AND DISCUSSION

The results of the elemental analysis of the selected antiparasitic medicinal plants presented in Table 2 show seventeen elements. The Recommended daily Dietary Allowance (RDA) and the Tolerable Upper Intake Level (UL) values of some of these elements for adults (DRI, 2001) are also reported in the table. The major elements detected were potassium and calcium. Vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, selenium, bromine, rubidium and strontium, were present in trace quantities. An element is considered toxic if its concentration exceeds the tolerable upper intake level (UL) (DRI, 2001). The Recommended Daily Dietary Allowance (RDA) per day for some detected elements for adults is given in Table 2. The elemental concentrations were determined to verify the biological role of trace elements in antiparasitic medicinal plants. The variation in elemental concentration is mainly attributed to the differences in botanical structure, as well as in the mineral composition of the soil in which the plants are cultivated. Other factors responsible for variation in elemental content are preferential absorbability of the plant, use of fertilizers, irrigation water and climatological conditions (Rajurkar and Pardeshi, 1997).

The following are known plants materials with antiparasitic biological activities: leaves of *isolona cooperi* (Okpekon, 2006), *ocimum americamum* (Clarkson *et al*., 2004), *phyllanthus amarus* (Hanumanthachar and Milind, 2007), leaves and stems barks of *mareya micranta*, (Guédé-Guina *et al*., 1995), *enantia polycarpa* (Atindehou *et al*., 2004), *trichilia emetica* (Okpekon *et al*., 2004), stems of *aframomum sceptrum* (Okpekon, 2006), roots and leaves of *uvaria afzelii* (Okpekon, 2006). These plants have been identified to possess the potency to cure parasitic diseases such as malaria, trypanosomiasis and leishmaniasis. The elements Fe, Co, Cu, Ni, Zn, Mn and Se are essential trace elements (micro-nutrients) for living organisms and well known for their role against parasitic diseases.

The role of iron in the body is clearly associated with hemoglobin and the transfer of oxygen from lungs to the tissue cells (Linder and Hazegh-Azam, 1996). Iron deficiency is the most prevalent nutritional deficiency in humans (May *et al*., 1998) and is commonly caused by insufficient dietary intake, excessive menstrual flow and

Fig. 1: A map showing the sampling sites

multiple births. The Fe content in various medicinal plants analyzed varies from a minimum of 45.5 mg/kg in PT29 Stems barks to a maximum of 244.3 mg/kg in PT33 leaves (Table 2). The graphical presentation of Fe levels is seen in Fig. 4. Hence the use of PT33 in general tonic preparation will have the potency to cure anaemic disorders. The Fe concentration levels of PT05 (leaves), PT26 (leaves), PT03 (stems), PT10 (Roots) and PT32 (stems barks) renders them good enough to be used for the treatment of anaemia.

Cobalt is an important component of vitamin B12, which has multiple benefits for the human body, example being the regeneration of folic acid (Spreeuwel *et al*., 1998). The folic acid is involved in the metabolism of fats, proteins and nucleic acids. The deficiency in vitamin B12 provokes general fatigue,

Table 2: The various plant parts analysed and their elemental concentrations

Elements ppm	PT29SB (Stem bark)	PT29L (Leaves)	PT03S (Stems)	PT05L (Leaves)	PT10R (Roots)	PT10L (Leaves)
K	1479.6 ± 73.98	1553.3 ± 76.67	1760.9±61.2	1881.5±97.2	375.3±18.77	815.4±40.78
Ca	14000.0±700.0	14000.0±700.0	704.0±34.7	7459.8±380.3	917.2±45.86	3470.4±171.52.
Ti	-	-	26.1±5.2	-	10.4±2.6	-
V	5.5 ± 1.0	-	-	13.2±25	-	-
Cr	7.4±4.1	5.0±4.0	-	-	7.1±2.8	12.5±4.3
Mn	6.2±1.1	7.8±2.1	171.6±23.1	92.6±9.5	12.8±2.2	225.5±12.2
Fe	45.5±15.7	61.4±4.2	140.0±40.7	186.5±117.5	108.7±6.3	173.9±30.6
Co	-	2.3±1.3	-	-	1.4±1.0	1.5±1.1
Ni	1.9±1.2	2.4±0.9	3.3±1.1	3.1±1.3	1.5±0.7	5.2±1.1
Cu	3.7±1.2	3.7±0.8	4.0±1.1	7.9±2.6	4.2±0.7	6.5±1.1
Zn	1.9±0.7	2.0±0.5	28.2±3.8	12.1±2.3	3.4±0.5	7.0±1.1
As	-	-	-	0.7±0.6	-	-
Se	-		-	0.6±0.4	-	-
Br	4.2±0.7	4.2±0.4	2.7±0.4	5.3±1.9	1.0±0.3	3.9±0.4
Rb	9.4±1.1	9.4±0.5	20.3±2.1	9.0±2.7	13.0±0.7	11.9±0.8
Sr	89.4±3.4	85.3±3.7	17.0±1.6	96.2±5.8	11.6±0.6	27.1±1.7
Pb	2.4±0.8	1.5±0.8	2.7±0.9	-	1.4±0.7	2.1±0.7
Elements ppm	**PT26L (Leaves)**	**PT32SB (Stem_bark)**	**PT33L (Leaves)**	**PT17L (Leaves)**	**RDA (per day) adults. mg[19]**	**UL(per day) adults[19]**
K	5247.6±206.38	3105.8±1412.7	4068.3±2474.6	1496.8±74.98	1525-5625 mg	-
Ca	4750.0±285.1	9069.7±4035.1	3181.2±191.7	1034.5±81.4	800-1200 mg	-
Ti	-	-	-	15.8±3.5	-	-
V	-	-	-	-	<1.8 mg	1.8mg
Cr	-	5.4±3.5	6.2±5.2	-	-	-
Mn	29.7±1.2	20.4±1.7	64.6±3.7	35.9±3.3	1.0-5.0 mg	11mg
Fe	145.0±26.4	119.9±88.4	244.3±11.6	77.6±4.8	8-18 mg	45mg
Co	3.1±2.1	-	3.8±2.7	1.8±1.0	-	-
Ni	1.4±1.0	4.4±3.1	2.9±1.7	3.7±0.7	0.13-0.4 mg	1.000 µg
Cu	10.5±2.0	6.7±4.3	7.0±3.1	6.7±0.9	0.9 mg	10mg
Zn	40.2±6.0	7.4±4.3	37.8±4.6	8.8±0.7	11 mg	40mg
As	2.1±0.8	-	-	-	-	-
Se	-	-	-	-	55 µg	400µg
Br	3.2±0.6	1.5±0.6	11.7±2.6	1.6±0.2	1.5-2.5 mg	-
Rb	20.6±1.7	9.8±2.6	16.8±2.9	7.1±0.4	-	-
Sr	17.8±1.3	117.9±7.0	24.0±3.7	26.5±1.2	-	-
Pb	1.8±1.1	1.3±1.0	1.4±0.9	2.0±0.7	-	-

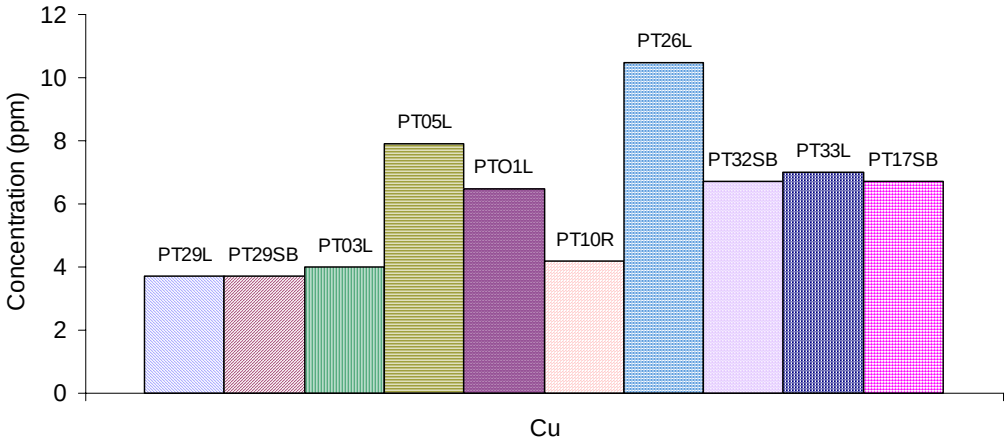

Fig. 2: Copper concentrations in sample plants

loss of the appetite and megaloblastic anaemia. The Co concentrations in the samples ranged from 1.4 mg/kg in PT10 (Roots) to a maximum of 3.8 mg/kg in PT33 (leaves). The high Co and Fe content in PT33 (leaves) suggest its use in medicinal preparation for treatment of pernicious anaemia.

Copper is actively involved in the synthesis of haemoglobin and thus can play a vital role in the control

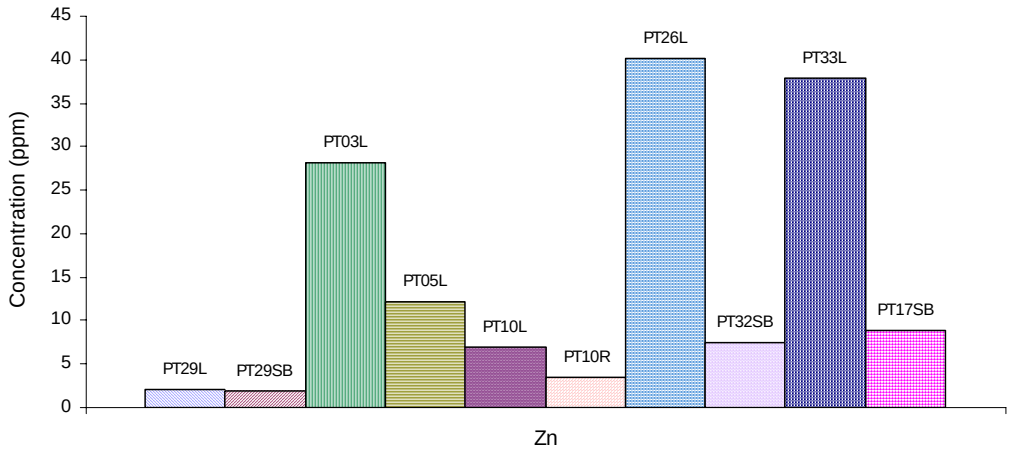

Fig. 3: Zinc concentrations in sample plants

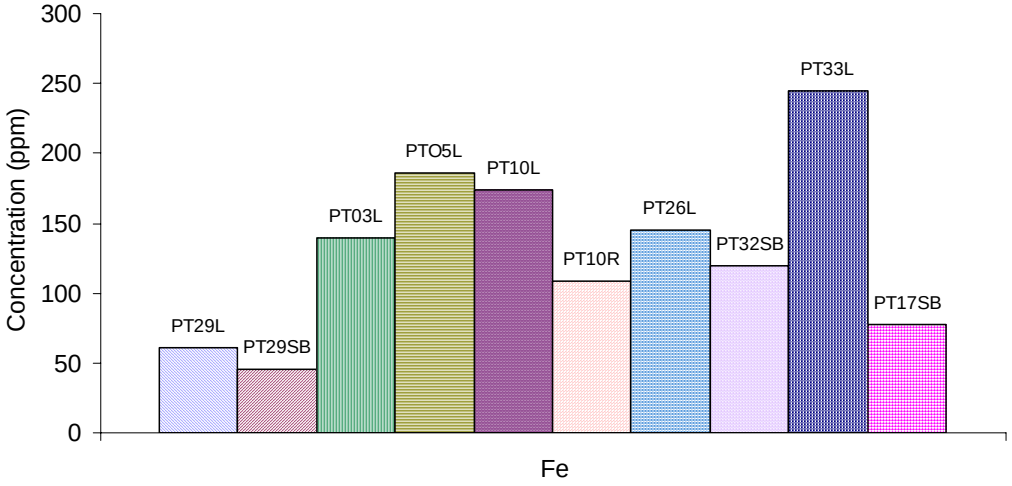

Fig. 4: Iron concentrations in sample plants

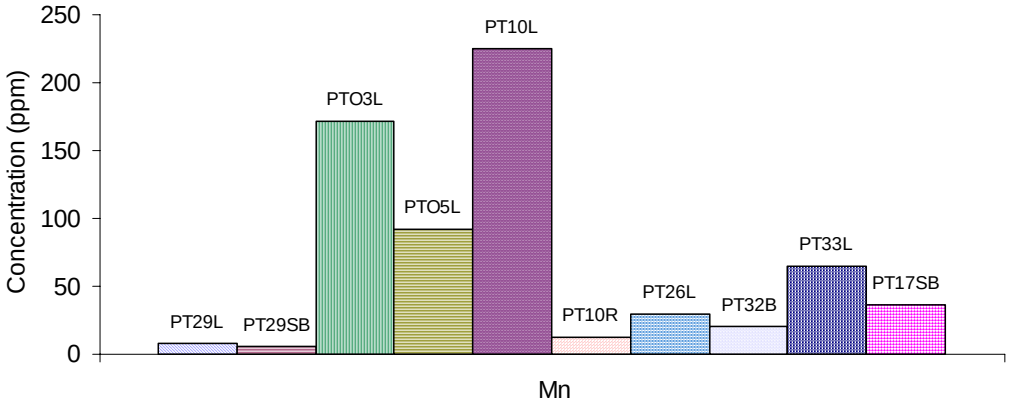

Fig. 5: Manganese concentrations in sample plants

of anaemia (Harris, 1997; Turnlund, 1999) Copper concentrations varied from a minimum of 3.7 mg/kg in *mareya micrantha* stem bark to a maximum of 10.5 mg/kg in *ocimum americamum* leaf which can be seen in Fig. 2.

Nickel is a cofactor that facilitates the absorption of iron (Nielsen, 1985) to avoid anaemia (WHO, 2001). All plants investigated here contain nickel but it is quite prominent in leaves of *Uvaria afzelii* (5.2 mg/kg), stem barks of *enantia polycarpa* (4.4 mg/kg). These two plants can be more adapted for anaemia disorders than the others.

Zinc is necessary for the growth and multiplication of cells (enzymes responsible for DNA and RNA synthesis) (Hercberg, 1988). Zinc deficiency is characterized by recurrent infections, lack of immunity and poor growth. Growth retardation, male hypogonadism, skin changes, poor appetite and mental lethargy are some of the manifestations of chronic zinc deficiency in humans (DRI, 2001).

The conclusions of the works of Shankar and Prasad (1998) showed that the zinc deficiency is associated with an increase in the frequency of infections. Samples that were found to be rich in zinc contents are the leaves of *phyllanthus amarus* (37.8 mg/kg), *isolona cooperi* (12.1 mg/kg), *ocimum americamum* (40.2 mg/kg), *enantia polycarpa* (7.4 mg/kg) (Fig. 3). The appreciable high concentration of Zn in these plants suggest their possible use for the improvement of the immune system and treatment of parasitic infections.

Selenium, which synthesizes ascorbic acid (May *et al*., 1998) (vitamin C) helps to revive patients and also instils the desire to eat properly (appetite). It is also involved in the metabolism of glucose, collagen, folic acid and certain amino acids. Only one of the sampled plants had Se element. This is the leaves of *isolona cooperi* (0.6 mg/kg). This plant can possibly be used to prepare herbal drugs to be administered to patients to strengthen their immune system and also treat parasitic infections.

Manganese is widely distributed in the body as an enzyme activator. For humans, Mn deficiency could cause skin damage, anaemia and hypercholesterolemia (Shenkin, 1998). It helps in eliminating fatigue and reduces nervous irritability. Mn concentrations varied from 6.2 mg/kg in stems barks of *mareya micrantha* to 225.5 mg/kg in leaves of *uvaria afzelii*. Appreciable high concentrations are found in leaves of *uvaria afzelii* (225.5 mg/kg), *isolona cooperi* (92.6 mg/kg), *ocimum americamum* (29.7 mg/kg), *phyllanthus amarus*, (64.6 mg/kg), *trichilia emetica* (35.9 ppm), and stems of *aframomum sceptrum* (17.6 ppm). Mn concentration levels are presented graphically in Fig. 5. These plants can be used for medicinal preparations to supplement Mn for various body functions.

All the antiparasitic plants analysed in this work with the exception of *isolona cooperi* (PT05, leaves) are found to contain some traces of Pb which is a known toxic element. This can be mainly due to the mineral composition of the soil in which the plants are growing.

CONCLUSION

This study is aimed at verifying the pharmacological action of herbs with emphasis on the medicinal values of the trace element contents. The elemental analysis of some medicinal plants used for the treatment of parasitic diseases by EDXRF technique revealed nineteen elements in varying concentrations. These plants contain appreciable concentration levels of Fe, Cu, Zn, Se, Mn, Ni and Co which are elements well established for their pharmacological action in plants. These elements were found mostly in the leaves of *phyllanthus amarus*, *isolona cooperi*, *ocimum americamum*, *uvaria afzelii*, *mareya micrantha*, stem barks of *enantia polycarpa*, *blighia unijugata* and roots of *uvaria afzelii* which are used for herbal preparations for anti-parasitic remedies. Some of the common parasitic infections being malaria, leishmanicidal, trypanosomial and antihelminthiasis.

The data obtained in the present work, apart from revealing the curative potency of some well known herbs, will also be helpful in the working out of dosage to be administered to patients considering the elemental contents and concentrations. In order to develop a stronger basis for appreciating the curative effects of medicinal plants, there is a need to do investigations into the elemental composition of all medicinal plants.

Although the direct link between elemental contents and curative capability of these medicinal plants is yet not very well established, such studies are vital to understand the pharmacological action of herbs.

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REFERENCES

Abou Arab, A.A.K. and M.A.A. Donia, 2000. Heavy metals in Egyptian spices and medicinal plants and the effect of processing on their levels. J. Agri. Food Chem., 48: 2300.

Atindehou, K.K., C. Schmid, R. Brown, M.W. Koné and D. Traoré, 2004. Antitrypanosomial and antiplasmodial activity of medicinal plants from Côte d'Ivoire. J. Ethnopharmacol., 90: 21-22.

Bakhru, H.K., 1998. Herbs that Heal Natural Remedies for Good Health. Orient Paperbacks, Division of Vision Book Pvt. Ltd., New Delhi.

Clarkson, C., V.J. Maharaj and N.R. Crouch, 2004. Antiplaqsmodial In vitro activity of medecnal plants native to or naturalized in South Africa. J. Ethnopharmacol., 92: 177-191.

DRI, 2001. (Dietary Reference Intakes) for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, And Zinc. National Academy Press Washington, D.C.

Guédé-Guina, F., C.S. Tsai, M.O. Smith, M. Vangah-Manda and B. Washington, 1995. The use of isolated functional heart to pharmacologically characterize active ingredients in the aqueous extracts of mareya micranta. J. Ethnopharmacol., 45: 19-26.

Harris, E.D., 1997. Copper. In: O'Dell, B.L. and R.A. Sunde, (Eds.), Handbook of Nutritional Essential Mineral Elements. Marcel, New York, pp: 231-273.

Hercberg, S., 1988. Iron Deficiency and in Human Nutrition. EMI, Lavoisier, pp : 203

Hanumanthachar, J. and P. Milind, 2007. Pharmacological evidences for antiamnesic potentials of phyllanthus amarus in mice. Afr. J. Biomed. Res., 10: 165-173.

IAEA, 2005. Quantitative X-ray Analysis System. Retrieved from: www.iaea.org/OurWork/ST/NA/NAAL/pci/ins/xrf/.../QXAS_Manual.pdf.

Kumar, A., A.G.C. Nair, A.V.R. Reddy and A.N. Garg, 2005. Analysis of essential elements in Pragya-peya-a herbal drink and its constituents by neutron activation. J. Pharma. Biomed. Anal., 37: 631.

Lyengar, G.V., 1989. Elemental Analysis of Biological Systems: Biomedical Environmental, Compositional and Methodological Aspects of Trace Elements, Boca Raton. CRC Press, Florida, 1: 242.

Linder, M.C. and M. Hazegh-Azam, 1996. Copper biochemistry and molecular biology. Am. J. Clin. Nutr. Clin. Métabol., 63: 797-811.

May, J.M., C.E. Cobb, S. Mendiratta, K.E. Hill and R.F. Burk, 1998. Reduction of the ascobyl free radical to ascorbate by thioredoxin reductase. J. Biol. Chem., 273: 23039-23045.

Nielsen, H., 1985. The importance of diet composition in ultra trace element research. J. Nutr., 115: 1239-1247.

Okpekon, T., S. Yolou, C. Gleye F. Robbot, P. Loiseau, C. Bopries, P. and G.A. Laurens, 2004. Antiparasitic activities of medicinal plants used in Ivory Coast. J. Ethnopharmacol., 9: 90-91.

Okpekon, T.A., 2006. Biological and chemical activities of Antiparasitic plants used in traditional medicine in Côte d'Ivoire: *Aframomum sceptrum* K. Schum. (Zigiberaceae), Bridelia ferruginea Benth. (Euphorbiaceae), *Isolona cooperi* Hutch. and Dalz. et *Uvaria afzelii* Sc. Elliot (Annonaceae). Ph.D. in Chemistry. Department of Pharmacy Châtenay-Malabry, University of Paris.

Turnlund, J.R., 1999. Copper. In: Shils, M.E., J.A. Olson, M. Shike, A.C. Ross, (Eds.), Moder Nutrition in Health an Disease. 9th Edn., Williams & Wilkins, Baltimore, pp: 241-252.

Powel, J.J., T.J. Burden and R.P.H. Thompson, 1998. In vitro mineral availability from digested tea: A rich dietary source of manganese. Analyst, 123: 1721.

Prasad, A.S., 1993. Essential and Toxic Elements in Human Health and Disease: An Update, Wiley-Liss, New York.

Rajurkar, N.S. and B.M. Pardeshi, 1997. Analysis of some herbal plants from India used in the control of diabetes mellitus by NAA and AAS techniques. Appl. Radiat. Isot., 48: 1059.

Shankar, A.H. and A.S. Prasad, 1998. Zinc and immune function: The biological basis of altered resistance to infection. Am. J. Clin. Nutr., 68: 447S-463S.

Shenkin, A., 1998. Clinical aspects of vitamin and trace element metabolism. Baillière's Clin. Gastroenter, 2: 765-798

Underwood, E.J., 1977. Trace Elements in Human and Animal Nutrition. 4th Edn., Academic Press, New York, pp: 543.

WHO, 2001. Iron Deficiency Anaemia Assessment, Prevention and Control. Geneva World Health Organization.