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X – RAY FLOURESCENCE (XRF) ELEMENTAL COMPOSITION of *Ocimum basilicum (Ob)*

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ABSTRACT
Ocimum basilicum (Ob) was subjected to elemental analysis using X-ray fluorescence (XRF), and the results revealed the following concentrations of the elements : sulphur (2.976 mg/kg), potassium (73.360 mg/ kg), calcium (19.617 mg/kg), scandium (0.132mg/kg), titanium (0.150 mg/kg), iron (0.577 mg/mg), zinc (0.034 mg/kg), rubidium (0.038 mg/kg), strontium (0.084mg/kg), zireonium ((0.021mg/kg), molybdenum (0.005 mg/kg), and thorium (0.005) respectively. All elements analysed above were within the permissible limit set by World Health Organization (WHO) and Food and Agricultural Organization (FAO).Vanadium, chromium, manganese, cobalt, nickel, copper, arsenic, selenium, palladium, silver, cadmium, tin, antimony, tellurium, caesium, barium, tungsten, gold, mercury, lead and uranium were not detected in the sample .
Key words: Ocimum basilicum (Ob), elements, X-ray fluorescence (XRF).

INTRODUCTION

***Ocimum basilicum :* linn (Sweet basil)**

Ocimum basilicum (*Ob*) is one of the most famous, annual or perennial herb belonging to the family *Lamiaceae*. Physically, basil is characterized by square, branching stems, opposite leaves, calyx and corolla bilabiate brown or black seeds (also called nutlets) as seen in Plate 1 (Meyers, 2013).

Plate 1*: Ocimum basilicum* (source : Herbarium unit, Department of Biological sciences, ABU, Zaria).

The cosmetic industries use basil in soap, shampoos, lotions, oils and perfumes. Its oil has many aromatic therapeutic uses and as a medicine it is applied for stress management, migraine, cold and hay fever. Basil tea is also reported to be good for digestion, to expel gases, stomach cramps, constipation, diarrhea,vomiting and as a form of female aphrodisiac (Grieve,2010). The result of element content of *Ob* revealed the presence of high concentrations of K (483mg/100g), Ca (460mg/100g), moderate amount of Na (159mg/100g), appreciable concentration of P (35.9mg/100g), and Fe (10.5mg/100g). Danial *et al.*,(2011) showed that the Mineral composition of *Ob* had high concentration of K (28770 mg/ Kg) and Ca (17460 mg/ Kg).

The curative effects of medicinal plants used in the traditional system of medicines include the presence of very minute quantities of trace elements. Important constituents of the body such as enzymes are intimately associated with chemical elements. Elements, particularly essential trace elements play both curative and preventive roles in fighting diseases such as iron in anemia and iodine in goiter. At present about 14 such elements are considered to influence the state of health and diseases of animals, plants and human beings, these elements are iron(Fe), copper (Cu), cobalt(Co), nickel (Ni), zinc (Zn), manganese (Mn), magnesium (Mg), molybdenum(Mo), chronium (Cr), vanadium (V), lithium (Li), selenium (Se), flourine (F) and iodine (I). The deficiency of trace elements in human subjects can occur under most practical dietary conditions.

Many diseases which have been considered incurable may now possibly be treated by balancing the equilibrium of these elements in the human body.Trace elements like Fe, Cu, Zn, Cu, Mn, and Ni are essential nutrients but they become harmful and toxic when their concentration exceeds the recommended standards. Lead (Pb) and cadmium (Cd) are nonessential element they are extremely toxic even in very minute amounts. There are many elements present in the living organisms and scores of metabolic reactionsare attributed to them (Dghaim *et al.*,2015). It is well established that plants pick up elements from the soil, e.g., banana takes up potassium andturmeric accumulates large quantity of lead (Lynch and Braithwaite, 2005). It is generally believedthat herbal and natural products are safer than the synthetic or modern medicines but even some indigenous herbal products contain elements as essential ingredients. Prolonged exposure to elements such as Cd, Cu, Pb, Ni, and Zn can cause deleterious health effects in humans.

All though many of traditional remedies are used safely, there have recently been an increasing number of case reports being published of elements poisoning after consumption (Zhang *et al.*, 2010). Dghaim *et al.,(*2015) indicated that most of the 68 analysed medicinal plants contained unsafe levels of elements that exceeded the World Health Organization (WHO) permissible limits (PL), Cd (0.1–1.11 mg/kg), Pb (1.0–23.52 mg/kg) , Cu (1.44–156.24 mg/kg), Zn (12.65–146.67 mg/kg) and Fe (81.25–1101.22 mg/kg).Indian Ayurvedic remedies. were showed to have high levels of Pb , Hg and As in Ayurvedic products sold in US,(Lynch and Braithwaite,2005).

Querlter *et al. (*2005) reported macro and micro elements contents of five medicinal plants (*Taraxacum officinale* weber, Eucalyptus globules labill, Plantagplanceolata L, Matricaria chamomilla L and Menthapiperita L) , their infusions were evaluated by the combined use of XRF and inductively coupled plasma (ICP-MS) techniques. These analytical methods allow the determination of seventeen (17) elements (Na, Mg, Al, Si, P, S, K, Ti, Mn, Fe, Cu, Zn, As, Rb, Sr and pb).The use of XRF techniques offer a good multi elemental approach for the rapid quality control of bulk raw plant materials. Erick et al., (2015) reported that for best detection of light elements (Mg-P), direct analysis on the surface of an XRF provides data of highest sensitivity and accuracy. The aim of this research was to evaluate the elemental composition of *Ocimum basilicum* with a view to suitability as a source of trace elements.

MATERIALS AND METHODS

The plant sample was obtained within Kaduna metropolis and was identified at the herbarium section in botany department of Biological Sciences A.B.U Zaria, and Voucher number 1055 was given. The identified plant was air dried at ambient temperature, then crushed to powder using motor and pestle and stored separately in a sealed bottle.

XRF Spectroscopy

Modern XRF instruments are capable of analyzing solid, liquid, and thin-film samples for both major and trace (ppm-level) components. The analysis is rapid and usually sample preparation is minimal or not required at all. The identification of elements by X-ray methods is possible due to the characteristic radiation emitted from the inner electronic shells of the atoms under certain conditions. The emitted quanta of radiation are X-ray photons whose specific energies permit the identification of their source atoms (Buhrke *et al.*, 1998). This method is based on the assumption that the absorption coefficient of radiation in the sample can be represented by a power of energy E of the radiation incident. Individual atoms when excited by an external energy source emit X-ray photons of a characteristic energy or wavelength, by counting the number of photons of each energy emitted from the sample, the element present may be identified and quantitated.

In this study a handheld thermo scientific NITON XL3t XRF analyzer with serial number #81072 and model numberXl3t950 was used. This model can detect the following elements sulphur (S), potassium (K), calcium (Ca), scandium (Sc), titanium (Ti), vanadium (V), chromium(Cr), manganese (Mn), iron (Fe),

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cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), rubidium (Rb), strontium (Sr),zireonium (Zr),molybdenum (Mo), paladium (Pd), silver (Ag), cadnium (Cd), tin (Sn), antimony (Sb), tellurium (Te), caesium (Cs), barium (B a), tungsten (W),gold (Au), mercury (Hg), lead (Pb), thorium (Th) and uranium (U) The grounded powdered sample was placed on Thermo Scientific NITON XL3t XRF analyzer sample holder. The sample holder containing the sample was covered with a cellophane paper capped with sample holder cover. The covered sample holder was placed in XRF analyzer stand. The handheld XRF analyzer was powered on and the handheld XRF analyzer was placed on the cellophane covered sample holder for a period of 180 seconds. The handheld XRF analyzer was removed from the top of the sample and it was connected to PC where the NitonXRF software was powered on and the element detected by the analyzer along with their composition in % ppm and spectra was exported on Microsoft Excel and PDF software respectively.

RESULTS AND DISCUSSION

The XRF elemental composition of *Ob* as seen in Table 1 showed the presence of following elements in various concentrations, such as sulphur (2.976 mg/kg), potassium (73.360 mg/ kg), calcium (19.617 mg/kg), scandium (0.132mg/kg), titanium (0.150 mg/kg), iron (0.577 mg/mg), zinc (0.034 mg/kg), rubidium (0.038 mg/kg), strontium (0.084mg/kg), zireonium (0.021 mg/kg), molybdenum (0.005 mg/kg) and thorium (0.005 mg/kg) respectively. The following elements were not detected : V, Cr, Mn, Co, Ni, Cu, As, Se, Pd, Ag, Cd, Tn, Sn, Te, Ba, Tg, Au, Hg, Pd, and U. Co, Mn and Ni are essential elements and they play an important role in biological systems, there absence here is a deficiency, whereas Hg, Ld and Cd are non- essential (Okwu and Ohenhen, 2010).

The elemental composition of *Ob* as presented in Table 1 showed decreasing concentration of element as follows: K > Ca >S > Fe > Ti >Sc >Sr > Rb >Zn >Zr > Mo >Th. K was observed to have had the highest value of 73.360mg/kg and the lowest value of 0.005mg/kg was seen in Th. This study was found to be similar to the work done by Daniel *et al*. (2011) which showed that the Mineral composition of *Ob* had high concentration of K (28770 mg/ kg) and Ca (17460 mg/ kg).

Elements are very important in human nutrition. The presence of trace elements showed that the plants samples analysed will be useful in influencing various body functions and activities positively. These elements are also beneficial in chemotherapy and are essential in human and animal health (Moses *et al*., 2002). The presence of high concentration of some elements seen in the samples may be due to the topography, soil-water-plant exchange complex and evapo-transpiration of the environment (Adoum *et al*., 1998). Some classes of chemical compounds and elements found in the sample have been known to exert pharmacological effects while others are capable of protecting the active ingredients in the herb from decomposing either chemically or physiologically (Abdulrahman and Onyeyili, 2001). Herbs are significant nutritional sources of minerals. The major minerals (such as Ca, P, Mg, S, K, and Na) are structural components of tissues and function in cellular/ basal metabolism and acid-base balance and minor (trace) minerals (such as Zn, Si, Mn, Cu, Fl, I and Cr) are very important for hormones, vitamins and enzyme activity.(Okwu and Ohenhen, 2010)

Potassium (K) is reported to be responsible for the repair of worn out cells, strong bones and teeth, building of red blood cells and for body mechanisms (WHO, 1996). Epidemiological studies and studies in animals subject to hypertension indicate that, diets high in potassium can reduce the risk of hypertension and possibly stroke (Yoshimura *et al*., 1991). It is good for pregnant women especially at the time of delivery. Requirements of potassium in the body depend on factors such as age and health status and sex. Potassium is needed by the body for strong bones, healthy heart and muscles.

Calcium is an essential nutrient that plays a vital role in neuromuscular function, many enzyme-mediated processes, blood clotting, metabolic processes as well as providing rigidity to the skeleton. Calcium fluxes are also important mediators of hormonal effects on target organs through several intracellular signalling pathways (WHO,2004) . Where calcium intake is low, calcium supplement as part of the antenatal care is recommended for the prevention of preeclampsia (high blood pressure, sometimes with fluid retention and proteinuria) in pregnant women (WHO/FOA, 2013) . The highest recommended daily intake of calcium is 750-800mg/day as seen in Table 2. Excess Calcium in blood stream may result to nausea, poor appetite, vomiting and constipation (Dietary Guidelines for Americans, 2010). Amount of calcium in the sample was within MPL. Sulphur helps to maintain a dark green color while encouraging more vigorous plant growth. Sulphur is needed to manufacture chlorophyll. Excess sulphur can cause skin and kidney irritations. Titanium is used in biomedical implants. Excessive exposure may

lead to coughing and difficulty in breathing at Fe in human body has three main functions. It is a part of haemoglobin and is responsible for oxygen transport, maintains a healthy immune system and being a constituent of several enzymes, is responsible for energy production. It is also an active site for several enzymes. Fe deficiency is probably the most common nutritional deficiency in the world though it performs the most vital functions in the body. An estimate based on WHO criteria indicated that around 600–700 million people worldwide have marked iron deficiency anaemia especially in developing countries. In developed countries, the prevalence of iron deficiency anaemia is between 2% and 8% . The MPL of iron as seen in Table 2 is 9.1-26.0 mg/day while in medicinal plant is 20mg/kg.

Iron salts have an astringent action resulting in irritation of the gastrointestinal mucosa, which gives rise to gastric discomfort, nausea, vomiting and diarrhea or constipation. Therefore, the presence of these symptoms commonly associated with the intake of some medicinal plants may be due to iron toxicity (Obi *et al.*, 2006). Amount of Iron in the sample was below the permissible limit. However there is no recommended intake of Rubidium, intake of about is 1.5 mg/day is considered adequate, rubidium has tranquilizing effect and is also used in treatment of nervous disorders or epilepsy. No effect of deficiency or toxicity has been reported. Sample was below 1.5mg.

Strontium helps in the proper functioning of neurons, formation of bones and teeth, excess Rb can cause nausea, diarrhea, headaches, fainting, blood clotting (Jiang and Gament,2008).

Zireonium is used in biomedical application such as dental implants, knee and hip replacements etc. Zr can cause irritation to the skin and eyes. The daily human intake as shown in Table 2 is 125mg/day (Shahid, 2006), plant sample contained low concentration of Zr.

the chest, and irritation on the eyes and skin.

Molybdenum is an essential element in human nutrition necessary for processing amino acids and acts as a catalyst for enzymes. Ingestion of 10–15 (mg/day) of molybdenum, for prolonged periods of time, may lead to an increase of uric acid in the blood. Lower-limb osteoporosis may be associated with ingestion of cereals with high molybdenum content. Mo is safe in amounts that does not exceed 2mg/ day for human consumption (Krishnamachari and Krishnaswamy, 1974).

Thorium increase chances of lung cancer and changes in genetic material of the body which open doors for diseases (Chen, 2003). Zinc is an essential component of many enzymes participating in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids as well as in the metabolism of other micronutrients. It stabilizes the molecular structure of cellular components and membranes and in this way contributes to the maintenance of cell and organ integrity. Furthermore, Zinc has an essential role in polynucleotide transcription and thus in the process of genetic expression. Its involvement in such fundamental activities probably accounts for the essentiality of Zn for all life forms. It plays a central role in the immune system, affecting a number of aspects of and humoral cellular immunity. Zn is an extremely important part of insulin and it is known to improve the sensitivity of insulin in the management of diabetes (Shankar and Prasad, 1998). FAO/WHO daily intake of Zn is 4.2-14.0 mg/day while the permissible limit in medicinal plants is 50mg/kg. Ingesting more than 200mg/ day of Zn can cause abdominal pain, laziness, headache, anaemia, fever, nausea, vomiting and diarrhea (Das and Dasgupta, 2002).

The overall result clearly shows that most elements were present in the plant as stated above and that the contents of these elements were within acceptable and safe limits as represented in Table 2.

The following result as shown in Table 1 is the elemental compositions as analysed in the plant.

Table 1: Elemental Composition o*f Ob* (mg/kg)

Element	Weight	Element	Weight	Element	Weight
Sulphur	2.976	Copper	ND	Tin	ND
Potassium	73.360	Zinc	0.034	Antimony	ND
Calcium	19.617	Arsenic	ND	Tellurium	ND
Scandium	0.132	Selenium	ND	Caesium	ND
Titanium	0.150	Rubidium	0.038	Barium	ND
Vanaduim	ND	Strontium	0.084	Tungsten	ND
Chronium	ND	Zireonium	0.021	Gold	ND
Manganese	ND	Molybdenum	0.005	Mercury	ND
Iron	0.577	Palladium	ND	Lead	ND
Cobalt	ND	Silver	ND	Thorium	0.005
Nickel	ND	Cadmium	ND	Uranium	ND

KEY: ND = Not detected

Table 2: Established recommended daily intake and permissible limit of trace elements according to WHO/FAO

Elements	Recommended daily intake	Permissible limit in plant
Mo	2mg/day	NE
Ca	750-800mg/day	NE
Cr	25-35 µg//day	NE
Mn	1.8-2.3mg/day	200mg/kg
Fe	9.1-26.0 mg/day	20mg/kg
Ni	1mg/day	1.5mg/kg
Cu	10mg/day	20-150mg/kg
Zn	4.2-14.0 mg/day	50mg/kg
Rb	1.5mg/day	NE
Zr	125mg/day	NE
Cd	7.0 µg//day	0.3mg/kg
Pb	1.5mg/day	10mg/kg

Sources :WHO/FAO 2007 (Aweng *et al.*,(2011) and Abdulmajeed *et al.*,(2011))
Keys; Not established (NE),World Health Organization(WHO), Food and Agricultural Organisation (FAO).

CONCLUSION

Toxic elements such as Nickle, Arsenic, Lead, Cadmium and Mercury were not detected in the plant sample, while all elements detected were below the MPL. Therefore, herbal formulations of this plant specie can also be beneficial sources of appropriate and essential elements.

Recommendations

The following recommendations were observed in the course of the study:

(i) These plants extract contain mineral elements (calcium and potassium) and should be included in diets to supplementthe body's daily need.

(ii) The use of other intruments such as Atomic Absorption Spectroscopy (AAS), Graphite Furnace Atomic Absorption Spectroscopy (GFAAS), Industrial Coupled Plasma Spectrometer – Optimal Emission Spectrometer (ICP-OES) can be employed to compare the elements contents of the plant.

(iii) Medicinal plants are consumed like normal diet in our society; therefore consumption should be regulated by appropriate agencies.

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