

Evaluation of Elemental Contents of Wild Mango (*Irvingia gabonensis*) Fruit in Ghana

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Abstract: A preliminary study to provide information on the elemental composition of the *Irvingia gabonensis* which is used for various purposes such as cooking, medicine, soap and as fresh fruit was conducted in Ghana. Elements determined includes Aluminium (Al), Arsenic (As), Chlorine (Cl), Cobalt (Co), Copper (Cu), Iron (Fe), Iodine (I), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na), and Zinc (Zn). Samples from multiple locations in the southern part of Ghana were analyzed using Instrumental Neutron Activation Analysis (INAA). The seed cover (endocarp) presented the highest concentrations of all the elements except Mg and Cu. Toxic and potentially toxic elements including Al and As were detected at average concentrations of 37.78 ± 1.36 and 9.34 ± 0.66 . Iron had the hight concentration in all the parts of the fruit analyzed in this study with its highest concentration at 1730 ± 180.83 in the seed coat (endocarp) of the wild mango fruit. The results of this present investigation show that all the parts of the wild mango a rich source of many important elements that have a very positive effect on human health.

Keywords: Endocarp, INAA, *Irvingia gabonensis*, mesocarp, seed

INTRODUCTION

Fruits and vegetables are nutrient suppliers, acting on the metabolism of several functions in the human organism, and their main nutrients (minerals and vitamins) influence the performance of these functions. The macro and microelemental composition of well-known tropical fruits such as banana, sweet lime, African pear, orange, passion fruit and others have been reported (Eromosele *et al.*, 1991; Aremu and Udoessien, 1990; Burguera *et al.*, 1992; Oliva and Valdes, 2003). The exploration of fruits and vegetables and other plants derivatives and their products used as food continue to attract the attention of researchers in both developed and developing nations. This has induced great deal of work to be done on fruits and vegetables by scientists in Ghana. These studies have primarily hinged at the biochemical and molecular biological levels. Asibey-Berko and Tayie (1999) analysed seven proximate factors in fresh vegetables.

Many sub-saharan countries, including Ghana, do not produce enough food to meet their daily requirement and many people are deficient in one micronutrient or the other. Thus, most rural communities depend on wild fruits to meet their food needs. Although Rehm and Espig (1991) suggest that majority of these fruits add very little

to total daily energy expenditure or supply, other sources maintained that the use of some of the wild fruits can do much to combat malnutrition (Spore, 2008).

Irvingia gabonensis (family: *Simarubaceae*) grows in the tropical and subtropical forests of Central and West Africa, attaining a height of up to 35 m (100 feet). Its fruits are 4 to 7 cm in diameter and yellow at maturity. Although it does not belong to the same botanical family as the cultivated mango, this tree is commonly called "wild mango tree" or "African mango tree" because its fruit resembles a small mango. In Ghana it is popularly known as "Ato". Because of its excellent nutritional value, the fruit is often used for preparing food dishes. This fruit is like that of a small cultivated mango in appearance although they are unrelated.

Irvingia gabonensis is a commercially and indigenous fruit tree of West and Central Africa, which has been identified as the most important tree for domestication. The kernels of *Irvingia gabonensis* are widely marketed domestically, nationally and between these countries (Ndoye *et al.*, 1998). Traditionally, the pulp of this fruit is eaten fresh and the kernel of the nut is a food additive. The hard shell is cracked to reveal the kernel inside which is dried and split into to parts which are used as seasoning in various meals (Abaelu and Akinrisimi, 1980). The flesh of the fruit is juicy and is a

mixture of sweet and sour. The pulp though can be freshly eaten and can also be used for the preparation of juice jelly and jam.

In most parts of Southern Ghana, although wild mango fruits are eaten as fruits and also in preparation of meals understudied. The lack of information on elemental composition of this fruits may have contributed to their underutilization and exploitation. The chemical properties of the kernels have been the subject of earlier studies (Giami *et al.*, 1994). But the majority of studies are base on the ethno-botanic character of *Irvingia gabonensis* tree. The aim of this study therefore, was to provide preliminary information on the elemental composition of the *Irvingia gabonensis*. The present study examines the elemental contents of the mesocarp, endocarp and the seed of wild mango in Ghana.

Experimental:

Sampling and sample preparation: Care was taken to obtain fresh fruit samples from multiple locations from markets in the southern eastern part of Ghana. The Greater Accra Region and Volta Regions were considered in the study. This was done in order to even out soil and environmental effects on the elemental concentrations. Samples were collected over a period in 2010 due to the seasonal trends of the fruit.

The samples in the laboratory were thoroughly washed using deionised water. By means of a sharp stainless steel knife, the pulp is completely removed and placed in a clean petri dish and freeze dried. Similar treatments were given to the seed cover and seeds. Each of the dried samples was pulverized in a stainless steel blender. For each of the petri dish, the dried samples were pooled together into a composite powder. These were then packaged in air tight transparent plastic labeled containers.

For each of the homogenized analytical samples, 200 mg was weighed directly onto a precleaned polyethylene film and heat sealed. The samples were then placed individually into polyethylene vials and heat sealed. Five (5) samples were prepared for each analyte.

A series of Standard Reference Materials (SRM) were prepared in the same conditions as the analytical sample. The standards used were, Pine Needle (SRM 1575), Peach Leaves (SRM 1547), all from National Institute of Standards and Technology and Hay Powder from the International Atomic Energy Agency. Standards were prepared in triplicate. The standards were used to validate the analytical method used.

Irradiation, counting and analysis: Samples and standard reference materials were irradiated at the Ghana Research Reactor - 1 center (GHARR- 1), at the Ghana Atomic Energy Commission using a Miniature Neutron Source Reactor (MNSR). Irradiation times ranged from

120 sec - 6 h depending on the elements of interest. Decay times were 24 h for medium live element and 10-14 days for long lived elements. After appropriate cooling the samples are then counted. The measurement for the gamma ray spectra was done using a spectroscopy system comprising of a high purity germanium detector coupled with an ORTEC multi channel analyzer.

RESULTS AND DISCUSSION

The elemental concentrations for the standard reference materials and samples are presented in Table 1 and 2 respectively. For the purpose of validation, the concentrations of the elements in the standards for this work is compared to the reported values on the certificate. As shown in Table 1, results from this work compares favourably with the certified values.

A total of twelve (12) elements were obtained from the components of the fruit samples studied. The elements include; Al, As, Cl, Co, Cu, Fe, I, K, Mg, Mn, Na and Zn. These elements and their corresponding concentrations are shown in Table 2. All elements stated were present in samples except for As which was not present in the pulp (mesocarp). Arsenic exhibited a concentration of 10.45 ± 0.34 ppm in the seed coat (endocarp) and 8.22 ± 0.98 ppm in the seed. The presence of Arsenic in the samples may be attributed to either contamination or selective absorption from the soil on which the fruits were harvested.

Al concentrations also ranged between 24.03 and 38.88 ppm. The highest concentration of Al was seen in the endocarp. The concentration of this element in food is of concern due to its linkage with Alzheimer's disease. In 'dialysis dementia', corresponding cortical aluminium concentrations are reported to be 20-30 tig/g in adults. (Van de Vyver and De Bore, 1985)

Minerals in the diet are required for proper growth and good health. Those needed in macro, or major quantities are calcium, magnesium, potassium, sodium, and chlorine, and those needed in micro (trace) amounts are iron, iodine, copper, cobalt, manganese, and zinc. Calcium, Chlorine, Potassium, and Sodium act as electrolytes for ionic and osmotic balance, to strengthen cells and the endoskeleton (Ekanayake and Nair, 1998). In this study calcium was not detected either because it was not present or below the detection limit of the analytical method used. Chlorine, Potassium and Sodium were present in all samples analyzed. The concentration of Potassium in this study was highest in its endocarp with a concentration of 1.331% and lowest in the mesocarp with a concentration of 0.303%. Sodium is an essential nutrient, the cation mainly responsible for regulating extracellular fluid volume and plasma volume (Institute of Medicine, 2004). Its concentrations ranged from 43.83 to 81.39 ppm. The least concentration was in

Table 1: Mean values of elemental concentrations in seed, seed coat and pulp of wild mango fruit used in this study

Elements	Conc.	Pulp (Mesocarp)	Seed coat (Endocarp)	Seed
Al	ppm	28.13±1.33	45.51±1.37	35.67±1.39
As	ppm	BDL	10.45±0.34	8.22±0.98
Cl	ppm	507.79±26.61	1283.04±36.12	426.39±23.74
Co	ppm	0.323±0.022	0.739±0.023	0.836±0.032
Cu	ppm	44.12±3.97	11.93±0.55	57.22±4.20
Fe	ppm	64.58±5.23	1730.8±180.83	193.74±17.82
I	ppm	0.310±0.003	0.569±0.040	0.317±0.025
K	%	0.303±0.011	1.331±0.022	0.723±0.042
Mg	%	0.014±0.004	0.012±0.006	0.048±0.008
Mn	ppm	81.29±0.61	136.71±0.80	70.97±0.63
Na	ppm	74.71±1.23	81.39±1.22	43.83±1.06
Zn	ppm	6.72±0.62	63.54±5.99	57.86±5.50

Table 2: Comparison of certified concentrations with laboratory concentrations

Elements	Reference material	Reported	This work	Units
Al	Pine Needle (SRM 1575)	545.0±30	543.04±13.49	ppm
Ca	Peach Leaves (SRM 1547)	1.56±0.02	1.63±0.05	%
Cl	Peach Leaves (SRM1547)	360.0±19.0	344.05±19.47	ppm
Co	Hay Powder	0.13	0.15±0.02	ppm
Fe	Hay Powder	186	195.36±17.19	ppm
K	Hay Powder	2.1	1.927±0.025	%
Mg	Peach Leaves (SRM 1547)	0.432±0.008	0.419±0.022	%
Mn	Peach Leaves (SRM1547)	98.0±3.0	96.25±0.61	ppm
Na	Pine Needle (SRM 1575)	24.0±2.0	24.59±0.46	ppm
Zn	Hay Powder	24	28.67±2.26	ppm

the seed where as its highest concentration was found in the seed coat.

The seed contained the least concentration of Chlorine showing a concentration of 426.39 ppm where as the mesocarp was richest in Chlorine with a concentration of 934.29 ppm. The average concentration of manganese in the wild mango fruit from the study is 96.32±0.68 ppm. Iron and Copper were fairly distributed in the wild mango fruit with average concentrations of 663.04 and 37.77 ppm, respectively. The concentrations of these elements occurred predominantly in the seed coat for Iron (1730.8 ppm) and in the seed for copper (57.22 ppm). Zn constitutes about 33 ppm of adult body weight and is essential as a constituent of many enzymes involved in a number of physiological functions, such as protein synthesis and energy metabolism. This element also exhibited an average concentration of 42.71 ppm. The least concentration of zinc was 6.72±0.62 ppm in the pulp and the highest concentration which was in the seed coat was 63.54±5.92 ppm. Cobalt and Iodine also essential to human health presented average concentrations of 0.633 and 0.399 ppm, respectively.

CONCLUSION

The macro and micro elemental content in wild mango within ranges of common tropical fruits. The distribution of element in the fruit suggests that with the exception of Magnesium and Copper the seed coat (endocarp) contains the highest concentration of all elements considered in this study. With the exception of Arsenic captured in the analysis, no other toxic element

was detected. The presence of Arsenic could be attributed to either contamination or pollutions from soil and environmental conditions of where they were cultivated with the latter being prominent since Instrumental Neutron Activation Analysis does not require any chemical treatment of samples. Instrumental Neutron Activation Analysis therefore is a useful tool in multi elemental analysis in fruit samples.

The trace elements in these parts of the African bush mango can thus be further researched into to explore the possible uses and development of this fruit.

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