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Biomedical Significance of the Elemental and Anti-nutritional Composition of Bombax buonopozense Leaves (Red Flowered Silk Cotton Tree)

[1]A. Bawa, *[2]Bassey Eyo Edem, [3]J. Daniel and [3]Y.D.Umar

[1]Science Laboratory Technology Department, Federal Polytechnic Mubi.

[2]Biomedical Science Technology Department, Federal Polytechnic Mubi.

[3]Chemical Science Technology Department, Federal Polytechnic Mubi.

Email Address: skygold12@gmail.com

ABSTRACT

The role of plants as a source of nutrients to mankind for survival and development cannot be over emphasized. Bombax buonopozense is an under-utilized non-conventional leafy plant (tree) found in the wild in Nigeria, which is consumed in some part of Nigeria as food. The elemental and anti-nutritional components of the plant (leaves) were determined using standard analytical procedures. The elemental analysis unraveled the presence of ten (10) elements- which comprises of the following: potassium, Calcium, Cobalt, Zinc, Iron, Manganese, Magnesium, Sodium, Copper, and Lead. Potassium was found to be the highest 162.38±0.01mg/100g, followed by Calcium87.28±0.01mg/100g. The least of them all was found to be lead with a value of 0.08±0.01mg/100g. The antinutritional analysis showed considerable low amounts of anti-nutrient factors: Cyanide (0.34±0.06mg/100g), Phytates (10.86±0.01mg/100g), Oxalates (14.55±0.01mg/100g).The elements and anti-nutrients present in the sample were juxtaposed with their ethno medicinal significance and from this, it could be deduced that *B. buonopozense* leaves could be of great health benefit if well harnessed.

Keywords: Medicinal plants, Bombax buonopozense, Anti-nutrients, Elements.

INTRODUCTION

Bombax buonopozense is of the family *Malvaceae* formerly *Bombacaceae* and is commonly known as Gold coast *Bombax* or red flowered silk cotton tree (Beentje et al., 2001). It is known by the following localnames: Akpe (Igbo), Ponpola (Yoruba), Kurya (Hausa), Ukim (Efik) and IdoUndu (Ijaw). It is native primarily to West Africa where it is found in rainforests of Sierra Leone in the North West, East Gabon and some parts of Nigeria [1]. It is a large tree and often reaches heights of 40 meters (130feets) and up to 3 meters trunk diameter. The bark of younger trees is covered with spine but sheds the spine with age to some degree and large deep pink tored flowers emerge while the tree is leafless [2]. According to [1],[2]; many parts of this plant is utilized for medicinal and traditional purposes.

Medicinal plants have been used as herbal drugs since time immemorial. All plant parts (leaves, flowers, stem, roots, seeds, barks etc.) maybe used as herbal drugs in particular or in combinations of each other [3]. The medicinal properties of plant species have made an outstanding contribution in the origin and evolution of many traditional herbal therapies [4] and as such, plants continue to be a major source of medicine, as they have throughout human history. Nowadays, there is a widespread interest in evaluating drugs derived from plant sources [5]. This interest primarily stems from the belief that herbal medicine is safe and dependable compared to costly synthetic drugs which are invariably associated with adverse effects (Gordan *et al.,* 2001)[6]. The use of traditional medicine has increased in developed countries also, mainly due to the failure of modern medicine to provide effective treatment for chronic diseases and emergence of multi-drug resistant bacteria and parasites (Umera *et al.,* 2010)[7]. Various medicinal plants have been studied using modern scientific approaches. However, only few drugs of plant origin could reach clinical uses; for this reason, a special effort is needed for the development of herbal drugs having therapeutical ability [8].

Elements play a vital role in maintaining general wellbeing and also possess therapeutic activity (Underwood, 1997)[9]. There is a great interest in macro and trace element composition of medicinal plants. It is believed that great majority of elements act as key components of essential enzymes for vital biochemical functions [3]. Various minerals or inorganic nutrients are also required for maintaining the health of the body and accordingly are consumed as herbal health drinks or in orthodox medicines [10], [11]. The quantitative estimation of these elements is important for determining the effectiveness of medicinal plants in treating various diseases and also to understand the pharmacological action [12]. Also, there are some elements which are found in plants but are not required by the body, in fact, these create toxic effects on the human body. Therefore, it has been an established fact that over dose or prolonged ingestion of herbals may cause chronic accumulation of trace elements leading to various health issues [13].

Anti-nutritional factors have been described as substances that block or inhibit important metabolic pathways, especially digestion [14]. These substances generally reduce the bioavailability of nutrients such as proteins, vitamins and minerals. This causes a reduction in the ability of the body to use the nutrients even when they are present in the food [15]. Many minerals and trace elements are inefficiently and variably absorbed from diet due to many factors such as the presence of anti-nutrients e.g. phytates, oxalates, tannins, cyanides, and polyphenols in food, fiber, competition with other nutrients and acidity of the intestinal environment [16, 17, 18].

Paucity therefore demands the biomedical evaluation of the elemental and antinutritional composition of the *Bombax buonopozense* leaves.

MATERIALS AND METHOD

SAMPLE COLLECTION, PREPARATION AND ANALYSIS

The fresh leaves of the plant (*Bombax buonopozense*) was obtained from an open farmland in Dazalla, Mubi South Local Government Area of Adamawa State, Nigeria, in October 2016; Voucher number: UNIBEN/2167. The leaves were dried at room temperature so as to prevent the decomposition of volatile chemical compounds present in them and were pounded into fine powder using mortar and pestle.

MINERAL ANALYSIS

ASHING

5.00g of the dried fine powder was weighed into a porcelain crucible which was then placed into a Vester ECF3, UK furnace and the temperature regulated to 550°C, and left for the sample to burn completely into ash (whitish residue).

A wet digestion was performed on the resulting ash residue using nitric acid and perchloric acid, the filtered aliquots was used for the determination of Ca, Co, Zn, Fe, Mn, Mg, K, Na, Cu, and Pb content. K and Na were determined using flame photometric method while others were determined using atomic absorption spectrophotometric method as described by James 1995 and AOAC, 2010.

ANTI-NUTRIENTS

Methods as described by AOAC, 2000 were adopted for the anti-nutrient analysis (phytates, oxalates and cyanide).

STATISTICAL ANALYSIS

Each experiment was carried out in triplicate and results expressed as Mean±SD (n=3) using the IBM-SPSS software version 22, 2015 edition.

RESULTS AND DISCUSSIONS

ELEMENTAL ANALYSIS

Table 1: Elemental Results for *B. buonopozense leaves*

Elements	Leaves (mg/100g)	RDA (mg/day)
Calcium	87.28±0.01	1000-3000
Cobalt	0.28±0.06	5-8
Zinc	1.87±0.01	4-40
Iron	3.12±0.01	0.27-27
Manganese	21.70±0.06	0.003-11
Magnesium	37.51±0.02	30-410
Potassium	162.38±0.01	300-4700
Sodium	50.28±0.01	1500
Copper	1.08±0.06	200µg/day-1300µg/day
Lead	0.08±0.01	10µg/day-40µg/day

The Recommended Dietary Allowance or RDA sometimes referred to as the Recommended Daily Allowance is defined as the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all healthy individuals (approximately 98%) (www.dietandfitnesstoday.com).

DISCUSSIONS

The data presented in table 1 above revealed that the *Bombax buonopozense* leaves contains ample amounts of macro and micro elements with values compared to the daily recommended allowance as cited by various authors.

Calcium was evaluated to be 87.28mg/100g. the National Academy of Sciences (NAS) guidelines for calcium in its 2010 public health recommendation established the following maximum recommended amounts (which they called tolerable upper intake levels or ULS) for calcium:

- Infants (1000-1500mg/day)
- Children (2500-3000mg/day)
- Adults (18-30yrs) 2500mg/day
- 31-50years (2500mg/day)
- 51 years + (2000mg/day)

(Wikipedia, 2016)

However, 65.00mg/100g is documented for *Jatropha curcas* leaf (Atamgba *et al.*,2015)[17]. The presence of calcium, magnesium and potassium collectively are known to reduce hypertension and reduce blood pressure as well as used in the prevention and treatment of high blood pressure (Wardlaw *et al.*, 2004)[18]. Therefore, the presence of these elements in the leaf gives a positive weight to the nutritional importance of the plant.

Cobalt is evaluated to be 0.028mg/100g of the sample. Atamgba *et al.*, (2015) [17] recorded ND (not detected) for *J. curcas* leaf while Ogbonna *et al.*,(2013)[19] documented 0.93mg/Kg for *Tetracarpidium conophorum* leaf. Cobalt are assimilated inly by intake of vitamin B_{12} and not in its metallic or ionic form. Therefore, there is no clear recommended amount of cobalt intake because they are just recommended for vitamin B_{12} and this vitamin is absorbed in 5-8mg/day (DRI reports, 2001). If the cobalt enters the body in some other form, then it can be very toxic. Lethal doses of cobalt (LD_{50}) are 150-500mg/Kg of body weight[20].

Zinc was found to be 1.87mg which is higher than that reported for *T. conophorum* leaf by Ogbonna *et al.*,(2013)[19] (51.55mg/Kg) but lower than *J.curcas* leaf as documented by Atamgba *et al.*,(2015)[17] with a value of 50.67mg/100g. the recommended daily allowance (RDA) is from 4-40mg/day as stipulated by DRI reports, 2001. Zinc helps in the regulation of gene expressions and also as a component of multiple enzymes and proteins. The presence of zinc in the leaf of *B. buonopozense* is an indication that the plant may have some effects on the functioning of the nervous system and in male fertility (Ogbonna *et al.*, 2013)[19]. So, the plant under discussion may be essential in sexual development and stimulation of the activity of vitamins and formation of red and white blood corpuscles.

Iron was found to be 3.12mg. 126.04mg/Kg is reported for *T. conophorum* leaf by Ogbonna *et al.*, (2013) and Atamgba *et al.*, (2015)[17], [19] documented 70.33mg/100g for *J.curcas* leaf and 0.27-27mg/day is recommended as the daily allowance by the DRI report, 2001. This element is a component of hemoglobin and numerous enzymes. It prevents microcytic hypochronic anemia. Excessive in take results in gastrointestinal distress (DRI reports, 2001). Iron is also important in immune functions, cognitive development, temperature regulation and energy metabolism [18]. It is therefore an important diet in pregnant and nursing women, infants and elderly people to prevent anemia and other related diseases [21].

Manganese was evaluated to be 21.70mg which is greater than that of *T. conophorum* leaf (29.50mg/Kg) as reported by Ogbonna *et al.*,(2013)[19] and not detected for *J. curcas* leaf (Atmgba *et al.*,2015)[17]. The amount of manganese one needs depends on the age and sex. The RDA/RDI ranges from, 0.003mg/day (infants) - 11mg/day (adults) as recommended by RDI reports, (1997). The presence of manganese supports the plant's use in the treatment of bone diseases. It is also necessary for the functioning of the pituitary gland, the pineal gland and the brain (Ogbonna *et al.*, 2013)[19]. It is also involved in the formation of bone as well as in enzymes involved in amino acids, cholesterol and carbohydrate metabolism.

Magnesium is evaluated to be 37.51mg/100g which is higher than that documented for *T. conophorum* leaf (1553.10mg/Kg) by Ogbonna *et al.*, (2013)[19] but lower than that of *J. curcas* leaf (127.30mg/100g) as documented by Atamgba *et al.*, (2015) [17]. However, DRI reports 1997 recommends a daily intake of 30mg/day - 420mg/day. This indicates that the magnesium content of the plant under discussion agree with the DRI. Magnesium is needed in over 300 enzymes that utilize adenosine triphosphate. It contributes to DNA and RNA synthesis during cell proliferation [17]. It is important for nerve and heart function as well as release of insulin and ultimate insulin action on cells and it decreases blood pressure by dilating the arteries and preventing abnormal heart rhythm (Wardlaw *et al.*, 2004)[18]. Deficiencies lead to irritability, convulsion and even death.

The potassium content of the sample was found to be 162.38mg which is higher than the values reported by Ogbonna *et al.*, (2013)[19] for *T. conophorum* leaf (5920.42mg/Kg) and *J. curcas* leaf (1.95mg/100g) as reported by Atamgba *et al.*, (2015)[17]. However, this value still falls short when compared to the DRI/RDA values for this element (300-4700mg/day) as reported by DRI reports, 1997. Potassium and Sodium are important extracellular and intracellular cations respectively which are involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction[22].

The sodium content was evaluated to be 50.28mg which is slightly higher than that of *J. curcas* leaf (47.00mg/100g) as documented by Atamgba *et al.,* (2015)[17] and 4316.29mg/Kg for *T. conophorum* leaf (Ogbonna *et al.,* 2013)[19]. The recommended daily allowance is reported to be 1500mg/day.

Copper content was found to be 1.08mg which is lower than the reported value for *T. conophorum* leaf (36.22mg/Kg) by Ogbonna *et al.,* (2013)[19] and ND (not detected) for *J. curcas* leaf as documented by Atamgba *et al.,* (2015)[17]. The RDA value ranges from 200µg/day - 1300µg/day indicating that the determined copper content of the sample is within the RDI/RDA limits. Copper aids in iron metabolism and excessive intake can result to liver damage and gastrointestinal distress (DRI reports, 2001).

The lead content is evaluated to be the least with a value of 0.08mg which is somewhat in agreement to that reported by Atamgba *et al.,* (2015)[17] for *J. curcas* leaf (0.03mg/100g). The RDA value for lead (Pb) in food is 10µg-40µg/day. Lead is present in small amounts throughout the environment due to its natural occurrence and is released into the environment by human activities. Lead in soil can be deposited on or absorbed by plants, including plants grown for food (www.fda.gov)[23].

ANTI-NUTRITIONAL ANALYSIS

Table 2: Results indicating the anti-nutritional composition of *Bombax buonopozense* leaves

S/N	Anti-nutrients	Leaves (mg/100g)	RDA
1	Cyanide	0.34±0.06	0.07mg/L
2	Phytates	10.86±0.01	4-9mg/100g
3	Oxalates	14.55±0.01	2-5g/day

Anti-nutrients affect the availability of nutrients required by the body and interfere with metabolic process so that growth and development of the body is negatively influenced (Richard *et al.,* 2006), the results obtained for the anti-nutritional factors of the plant under investigation is presented in the table above (i.e. Table II).

The cyanide content of the sample analyzed is 0.34±0.06mg/100g which is lower when compared to the amount reported for *Senna alata* leaf (21.69 mg/100g) Abubakar *et al.,*(2015); 26.05mg/100g for *Senna alata* leaf Abdulwaliyu *et al.,*(2013)[20] and 16.1mg/100g for *Chanca piedra* leaf (stone Breaker) Gafar *et al.,*(2012)[24]. However, the findingsof our study was higher when compared to the value documented for *Ipomoea alba Lam* (0.001mg/100g); *Ipomoea batatas* Lam (0.0001mg/100g) Essiett *et al.,*(2014). Toxic levels of 35mg/100g dry weight and 20mg/HCN equivalent per Kg sample is recommended by Standard Organization of Nigeria (SON).

The phytates content is found to be 10.86±0.01mg/100g which is higher than the documented values for *Senna alata* leaf (3.55mg/100g) Abdulwaliyu *et al.,*(2013)[20] and 0.0002mg/100g, 0.0001mg/100g for *I. alba* and *I. batatas* respectively (Essiett *et al.,* 2014), but lower than values documented for *Senna alata* leaf (15.07mg/100g) Abubakar *et al.,* (2015);*Chanca piedra* leaf (27.58mg/100g) Gafar *et al.,* (2012)[24]; and *Clerodendrum volubile* leaf (16.30g/100g) Ogunwa *et al.,*(2015). Phytic acid can bind to mineral elements such as calcium, zinc, magnesium, iron and manganese to form complexes that are indigestible, thereby decreasing the bioavailability of these elements for absorption (Gafar *et al.,* 2015)[24]. However, the low phytates content in the plant indicates that the consumption of the plant will not affect the bioavailability of minerals especially calcium and zinc for absorption.

The oxalate content of *Bombax buonopozense* leaves was found to be 14.55±0.01mg/100g. This value is higher than those reported for *Senna alata* leaf (7.84mg/100g) Abubakar *et al.,* (2015)[25]; *Senna alata* (8.03mg/100g) Abdulwaliyu *et al.,* (2013)[20]; *Chanca piedra*(5.34mg/100g) Gafar *et al.,* (2015)[24]; *Clerodendrum volubile*(3.67mg/100g) Ogunwa *et al.,* (2015); *I. alba* (0.12mg/100g) and *I. batatas* (0.0007mg/100g) Essiett *et al.,* (2014)[26]. The physiological tolerance level of oxalate is 2-5g/day (RDI reports, 2011). Oxalate can bind to calcium present in food thereby rendering calcium unavailable for normal physiological and biomedical roles. Oxalates present in food is insoluble, it may also precipitate around soft tissue such as kidney, causing kidney stones[27],[28].

However, the high anti-nutrients levels in plants can be lowered via some processing methods such as soaking and boiling.

CONCLUSION

The data obtained in this study indicates that the *Bombax buonopozense* leaves contain appreciable amounts of elements which are within the RDI permissible limits for daily consumption and as such the plant could serve as supplements for food and also have the potential to improve the health status of its consumers. The presence of antinutritional factors in appreciably low amounts suggests that the plant can contribute significantly to the nutritional requirement of man.

RECOMMENDATIONS

- The elemental and anti-nutritional compositions of the roots and stem of the plant should also be investigated.
- Extracts from the various plant parts should be tested on various microorganisms with the aim of investigating the medicinal properties of the plant.
- Active ingredients also should be isolated in other to produce drugs with adequate potency.

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