Comparative Analysis of Macro Elemental Compositions of the Juice and Seeds of *Morinda Citrifolia* Fruit

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Abstract

Morinda citrifolia fruit has been used mostly as drug supplement in most communities and as such needs to know the elemental compositions is necessary. Base on the analysis the following results were obtained. The seeds and the juice were subjected to analysis using standard methods proposed by Association of Analytical Chemists (AOAC, 2000) and Atomic Absorption Spectrophotometer (AAS). The results in milligrams per 100 grams (mg/100g) on the seeds were: 60.707 ± 0.009 sodium, 31.017 ± 0.015 calcium, 78.054 ± 0.076 magnesium, 107.353 ± 0.095 phosphorus, and 116.641 ± 0.213 potassium while the concentration on the juice were; 37.406 ± 0.008 sodium, 33.552 ± 0.016 calcium, 54.389 ± 0.001 magnesium, 76.074 ± 0.069 phosphorus and 68.246 ± 0.024 potassium respectively. Comparing the result obtained from the analysis on WHO Recommended Dietary Intakes (RDI), phosphorus and potassium was significant in both the seeds and the juices. This was followed by magnesium and sodium, while calcium contained moderate amount in both samples. The results suggest that the plant is a valuable source of essential elements, and is sufficient in addressing macronutrient deficiencies. Therefore, the plant is a good dietary supplement.

Keyword: macro element, comparative, juice, seeds, morinda citrifolia

Introduction

Plants are of great medicinal values, which are of therapeutic benefit in the treatment of diseases in human's history. They contained chemical components, (and these are natural products) which sometime, have pharmacological or biological activity that can be useful in treating various diseases. In this manner, they are the active components that are not only of most traditional medicines but also, many modern medicines (Oruk, A. E et al., 2020). These chemical constituents when isolated from the plants are produced by primary and secondary metabolites. Primary metabolites are very useful to the survival of plants and human beings, while secondary metabolites are not essential for the survival, but they provide organisms that produce them an evolutional advantage (Marlstone et al., 1992).

Metals play important role in the metabolism of the body system and as such, they are vital components of all organisms. They are divided into minerals with multiple functions in every cell, such minerals are sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg) and also essential minerals with limited functions mostly as cofactors for enzymes and they are Zinc (Zn), Iron (Fe), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr), Vanadium (V), Molybdenium (Mo).

Minerals may occur in concentrations of grams per kilogram (Kg) biological mass, while essential elements make-up only milligram (Mg) or microgram (µg) amount per kg. Humans get their daily needed amounts of minerals mainly by food in-take and to a minor extent by drinking water. Though, the body has effective regulating mechanisms, which guarantee mineral homeostasis. However, essential elements always have a narrow range between daily requirement and toxicity. A healthy and well-balanced diet always provides essential elements needed by the body. Unbalanced diets consumption causes deficiencies of essential elements in the body with subsequent development of diseases (Mudgal et al., 2010).

Morinda citrifolia (Noni) are herbs grown mostly in all tropical areas of the world, and it is easily distributed by animals that eat its fruits. This fruit contains over a hundred non digestible seeds in a single fruit and it grows in all types of soil between coastal sides and up to heights of 500-600m (Takahashi & Shoji, 2002).

Morinda citrifolia plays important role in maintaining health and also cure many kinds of diseases. Since 1996, *Morinda citrifolia* products mainly the fruit juice, are available as health food worldwide, the fruit juice and the leaf tea were recently approved by European Union law as a novel food (Pande et al., 2005).

Morinda citrifolia is a shrub of about 5-6 m tall, with grey-brown bark. Its twigs are more or less square in cross-section and broad based at the apex, which measures

up to 2cm wide. The leaves are large and arranged in opposite pairs to each other that reach up to 25cm long by 13cm wide (Morton, 2002).

The fruit is a multiple fruit consisting of fused drupes with each containing seeds. They are green, transitioning through pale-yellow to white or grey, and when ripe, they emit a pungent odour similar to blue cheese. They are irregularly ellipsoid or ovid of 9 x 6cm (Jones, 2008).

However, complete phytochemical compositions of *Morinda citrifolia* have not been fully reported, but about 200 phytochemicals were identified and isolated in *Morinda citrifolia*. These include 5, 7-AC P7– 8. (Malaysian Medicinal Plants book; Krishnaiah et al., 2012).

Some volatile compounds were identified in *Morinda citrifolia* ripe fruit such as organic acid and hexanoic acids, alcohols (3-methyl-3-butene-1-1-ol) esters (methyloctanoate and methyl deconoate) ketones (2-heptanone) and lactones (E)-6-dodeceno-lactone (Krishnaiah et al., 2012).

Natural Preservation

Morinda citrifolia as a novel food ingredient under the name of Noni fruit puree, but food industry only picked interest in Tahitian *Morinda citrifolia* due to its leaf, fruit and root antioxidant properties, which are the same as vitamin E. They contain butylated hydroxytoluene (a phenol derivative), which has a natural preservative activity. They are effective in blocking warmed over flavour in formally stewed beef pies. This happens by reducing lipid oxidation, which also helps in colour stability and shelf-life of the final aerobically wrapped pies (Nathan et al., 2012).

Juice

Fresh *M. citrifolia* (Noni) juice is obtained by compressing the fruit immediately after harvesting, while homemade juice is prepared by allowing the fruits to decompose naturally and the commercial juice is made by fruit fermentation (Nelson, 2006 & Brown, 2012). The chemical composition of Noni juice depends majorly upon the method of juice extraction. The physiochemical screening of the fermented Indian Noni fruit indicates its contents of anthraquinones, saponins, and scopoletin, while the bioactive screening of Thai *Morinda citrifolia* fermented fruit juice shows superior vitamins such as vitamins C, B1, B2, B3 and B12. The American *Morinda citrifolia* fruit also shows some concentration of alkaloid, anthraquinones, antioxidant, essential oils, flavonoids, saponins, scopoletin and sugar (Satwadhar, 2011; Brown, 2012).

Natural Source of Medicines

Morinda citrifolia as a natural source for the medicinal production was done by using a bioreactor cultivation technology to produce specific medicinal compounds at a

rate similar or superior to natural grown *Morinda citrifolia*. Result obtained proved that casual root cultures of *Morinda citrifolia* could be used for the commercial production of biotechnology-based chemical such as rubiadin, flavonoids, phenolics and anthraquinones (Baque et al., 2012). However, the aqueous root extract of Indian *Morinda citrifolia* was also used in nanobiotechnology, for the synthesis of ecological noble metal. Gold nanoparticles were prepared by mixing *Morinda citrifolia* root aqueous extract with aqueous solution of chloroauric acid to produce gold nanoparticles. This preparation was predicted to have a higher anticancer activity due to its smaller size (12.17 – 38.26 nm) (Suman et al., 2014).

Anti-microbial and Antiseptic Activity

The anti-microbial activity of Tahitian *Morinda citrifolia* fruit in methanol partitioned with n – butanol extract was assessed in an in-vitro assay on Escherichia oil, Candida albicans and Staphylococcus aureus. Candida albican was the most sensitive to *Morinda citrifolia* antimicrobial activity, while Staphylococcus aureus sensitivity was the lowest. This activity was due to the rich iridoid present in the fruit (West et al., 2012).

Antioxidant Activity

Australian *Morinda citrifolia* fruit juice indicates an anti-oxidant activity of 2.8 and 1.4 times higher when compared to vitamin C and pycnogenol. Its antioxidant activity is the same with that of grape seed powder (Krishnaiah et al., 2015).

Anti-cancer Activity

Morinda citrifolia natural components are mostly reported as a natural anticancer cure where sulphated polysaccharide stops metastasis by destabilising the interaction between glycosaminoglycan and certain protein (Liu et al., 2000). Damnacanthal inhibits the formation of tumours either by interfering with the growth of ras gene activation, or by increasing apoptosis in human colorectal cancer cell lines. Alizarin has an antiangiogenic effect by blocking blood circulation to malignant tumours. Limonene prevents mammary liver and lung cancers by stimulating thymus gland to secrete more T cells which destroys the carcinoma cells. While ursolic acid inhibits the growth of cancerous cells and induces apoptosis by modulating the body immune process (Lv et al., 2011).

Mineral Element

In nutrition, mineral is a chemical element, some are essential for life while most of them are not. Minerals are one of the four groups of essential nutrients; others are vitamins, fatty acids, and amino acid. The five major or macro minerals in human body are calcium (Ca), Phosphorus (P), Potassium (K), Sodium (Na) and Magnesium (Mg). while the remaining ones are called trace or minor minerals, they are Iron (Fe), Chloride (Cl), Cobalt (Co), Cupper (Cu), Zinc (Zn), Manganese (Mn),

Molybdenum (Mo), Iodine (I) and Selenium (Sc) among others. Plants obtain minerals from the soil, when eating the plants, then the minerals move from the plant to human body, this is called food chain (Zoroddu et al., 2019).

Materials and Methods

Samples were obtained from a farmland in Ukana Uwa East and brought for identification by a botanist in Akwa Ibom State Polytechnic, Ikot Osurua. The fruit samples were washed and kept in a polythene bag for five days for proper fermentation before extracting the fermented juice for analysis, while the seeds were sun dried for seven days and were grounded into powder. Both samples were labelled accordingly for further analysis.

Digestion of Samples

1gram of each sample was weighed into different 50 milliliters standard flask as concentrated 10 milliliters of nitric acid and 20 milliliter of HCl solution were added to each digestion flasks. They were heated using heating mantled until the solution with brown fumes changed to yellow colour, which indicate the completion of the digestion. The digested samples were allowed to cold and were diluted with deionised water of 30 milliliters, filtered and the volume of the filtrate were made up to 100cm^3 with deionised water, then the digested samples were stored in the sample bottles. Two different major methods were used for the analysis: (i) Atomic Absorption Spectrophotometer (AAS), (ii) Association of Analytic Chemists (AOAC, 2000).

Results

The results for the comparative analysis of elemental composition of seeds and juice of *Morinda citrifolia* fruit in miligrams per 100 grams are shown in the Tables below:

Table 1.0

Elemental composition of the seeds of Morinda citrifolia

Parameters	Concentration milligrams (mg/g)	World Health Organization Recommended Dietary Intake
Sodium (Na)	60.707 ± 0.009	>2000
Calcium (Ca)	31.017 ± 0.015	1000-1200
Magnesium (Mg)	78.054 ± 0.076	310-420
Phosphorus (P)	107.353 ± 0.095	700
Potassium (K)	116.641 ± 0.213	3500

Data are mean ± Standard deviation of triple determination

Table 2.0

Elemental composition of the juice of Morinda citrifolia

Parameters	Concentration milligrams (mg/g)	World Health Organization Recommended Dietary Intake
Sodium (Na)	37.406 ± 0.008	>2000
Calcium (Ca)	33.552 ± 0.016	1000-1200
Magnesium (Mg)	54.389 ± 0.001	310-420
Phosphorus (P)	76.074 ± 0.069	700
Potassium (K)	68.246 ± 0.024	3500

Data are mean ± Standard deviation of triple determination

Discussion

When comparing the results obtained from both samples; the seeds and the juice from *Morinda citrifolia* fruit, it was found out that some significant changes in their concentration in milligram per 100 grams, when also comparing out results by putting side by side with other results obtained from other researchers and World Health Organisation's recommended dietary intake. The results highlight the nutritional importance of the seeds and the juice of *Morinda citrifolia* fruit.

The sodium content in the seed is 60.707 $\pm$ 0.009 while that of the juice are 37.406 $\pm$ 0.008 and the WHO recommendation is greater than 2000 mg/day. These values show a minimal contribution to the daily limit, making both seeds and the juice suitable for low-sodium diets since they do not exceed the required daily limit. When comparing with result obtained by Singh et al. (2017), its concentration in the juice were a little higher (55.34 mg/100g). The difference may be due to different environmental conditions.

Knowing the importance of sodium in the body and being the principal cation in extracellular fluids, it regulates plasma volume and acid-based balance. It also takes part in the maintenance of Osmotic pressure of the body fluids, while preserving normal irritability of muscles and cell permeability. It activates nerve and muscle function, and is involved in Na^+/K^+ ATPase, maintenance of membrane potentials, transmission of nerve impulses and the absorptive processes of monosaccharides, amino acids, pyrimidines, and bile salts (Hays & Swenson, 2015). Sodium deficiency causes retardation in growth and increased level of sodium in the serum, which is called hypernatraemia and this occurs in cushion's diseases.

Calcium concentration in both samples was 31.017 $\pm$ 0.015 in seeds, which means, it can be consumed in order to maintain a certain level of calcium (33.552 $\pm$ 0.016). These values were lower than the WHO recommendation of 1,000 to 1,200mg/day. Sharma and Gupta's (2020) reports showed that the juice concentration were 35.12mg/100g with a little in the present results. The variation may be as a result of environmental impact, storage, or handling of the fruits.

Calcium functions as a constituent of bones and teeth, as well as the regulation of nerves and muscle. It coagulates the blood, activates the conversion of prothrombin to thrombin and also in milk clothing. It is vital in enzymes activation such as adenosine triphosphatase (ATPase), succinic dehydrogenase, and lipase. A reduced extracellular blood calcium increases the irritability of nerve tissue and very low levels can develop spontaneous discharges of nerve impulse that leads to retany and convulsions (Hays & Swenson, 2015).

Calcium absorption in the body system needs calcium binding proteins and this is regulated by vitamin D, through sunlight, parathyroid hormone and thyrocalcitoniin. Thyrocalcitonin brings down plasma calcium and phosphorus levels, while parathyroid hormone helps in increasing them. Dietary calcium is absorbed only in the upper small intestine by the duodenum and the amount absorbed is based on the source. Calcium-phosphorus ratio, intestinal pH, lactose intake and dietary levels of calcium, phosphorus, vitamin D, Iron, aluminium, manganese and fat, which is based on the assumption that greater the needs, the more efficient the absorption.

Magnesium found in both the seeds and juice and their concentrations are 78.054 $\pm$ 0.076 and 54.389 $\pm$ 0.001, while the WHO recommendation is between 310 – 420 mg/day (Jones & Carter, 2021).

Magnesium concentration in the seeds alone is 80.5mg/100g, which indicate a little difference in this analysis. Magnesium is an active component in enzyme systems which thymine pyrophosphate is a cofactor. Oxidative phosphorylation is greatly reduced in the absence of magnesium. It is an essential activator in phosphate-transferring enzymes, myokinase, diphophopyridine nucleotide kinase and creatine kinase. It also activates pyruvic acid carboxylase, pyruvic acid oxidase and the condensing enzymes for the reactions in the citric acid cycle. Magnesium is also in bones, teeth among others (Murray et al., 2020).

Health condition of a digestive system and the kidneys plays a role in influencing magnesium status in the body. One-third to one and a half of dietary magnesium are absorbed into the body in the intestine and transported through the blood to cells and tissues. Gastrointestinal disorders can reduce absorption and as such, Crohn's disease may develop. The disorders can deplete the body storage of magnesium, which may lead to magnesium deficiency in the body.

Phosphorus contents in both the seeds and the juice are 107.353±0.95 and 76.074±0.069 respectively, while WHO's recommendation is 700mg/day. Comparing with previous work done by Johnson et al. (2020), it was found that 105.20mg/100g are in the seeds; a little bit higher than the current result. This may be as a result of environmental factors. The presence of phosphorus in a large quantity shows that *M. citrifolia* is a good source of phosphorus. It functions as a constituent of bones, teeth, adenosine triphosphate (ATP), phosphorylate metabolic intermediates and nucleic acid. It is involved in buffering action (Phosphate buffers), in the formation of high energy compounds (example, adenosine triphosphate - ATP) and in the synthesis of phospholipids and phosphoproteins.

Its involvement is in every form of energy exchange inside living cells in the formation or breaking of high energy bonds that links oxides of phosphorus to carbon or to carbon-nitrogen compound (Hays & Swenson, 2015; Malhotra, 2018; Murray et al., 2020). Vitamin D may be involved in the control of phosphorus absorption and serum levels that is regulated by the kidney re absorption. Much availability of phosphorus in the soil stimulates early growth and speed up maturity in the plants. Phosphorus is an important macro nutrient because it plays a part in energy transfer in both plants and other living organisms.

Potassium contents are 116.641 $\pm$ 0.213 in the seeds while 68.246 $\pm$ 0.024 were found in the juice and the WHO recommended daily intake is 3,500 mg/day. In Lee et al. (2018) work, it is shown that the concentration in the seeds was 12g and in the juice, 70.45 mg/100g. The difference in both results may be as a result of some factors, such as soil potassium, water availability, post-harvest treatment or processing techniques. Potassium is the main cation in the intracellular fluid. It also functions in acid-base balance it regulates osmotic pressure, conduction of nerve impulse, muscle contraction, cell membrane function and Na^+/K^+-ATPase. It is needed during glycogenesis, it plays a role in basic cellular enzymatic reaction, as well as regulates aldosterone metabolism.

Potassium deficiency affects the collecting tubules of the kidneys, which results in the inability to concentrate urine, and it also causes alterations of gastric secretions and intestinal motility (Streeten & Williams, 2012). Potassium is critically useful in maintaining electrolyte balance in the body.

Conclusion

The research highlights the nutritional potential of *Morinda citrifolia* fruits in both the seeds and the juice by comparing their elemental compositions. The results obtained indicated that, the seeds contained higher levels of sodium, calcium magnesium, phosphorus and potassium, while the juice concentration is low. When the results of this study are compared with World Health Organization's (WHO), Recommended Dietary Intake (RDI), the parameters are moderate, which shows that the noni fruit can be used as dietary supplement. The findings also highlight the importance of the seeds that are sometimes, discarded as waste products.

Recommendations

Sequel to the above results obtained from comparative analysis of both juice and seeds of *Morinda citrifolia*, it is suggested as follows:

- Since the plant contains five essential macro elements (as enumerated earlier) that could handle macro nutrients deficiencies, making the plant a potential

dietary supplement based on World Health Organization's (WHO), Recommended Dietary Intake (RDI) is a right step in the right direction.

- Proper characterisation analysis should be carried out on the plant. This should involve the government and pharmaceutical industries for clinical purposes.

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