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Analysis of Some Mineral Elements in Major Coconut Cultivars in Nigeria

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Abstract
The mineral content of different cultivars of the endosperm tissues of coconut (*Cocos nucifera Linn*) samples commonly available in some parts of Nigeria were collected and analyzed for Fe, Zn, Ca and Mg by atomic absorption spectrophotometric techniques, while Na and K were determined by Flame photometric techniques. The mineral content of the coconut water ranged from 0.09 ±0.06µg/g Zn to 959.52±52.65µg/g Na while the mineral levels of the coconut meat ranged from 6.14 ± 1.52µg/g Zn to 7809.53 ± 436.41µg/g Na. The concentrations of the minerals were generally higher in the coconut meat than in the coconut water samples. However, hybrid samples from Badagry, especially the larger nuts contained the highest levels of the minerals. The levels of Na, K and Ca suggest that health and nutritional benefits can be derived from consuming coconut water and coconut meat.
Keywords: coconut meat, coconut water, mineral, nutritional benefits

1. Introduction

The coconut (*Cocos nucifera Linn*) is a tropical monocotyledon plant which belong to the order Arecaceae and family Palmae (Rurseglove, 1992). It is widely grown in about 90 tropical regions of the world (Peggy, 2007; FAO, 2004). Coconut is called the fruit of life due to its numerous nutritional and health benefits (Khan et al. 2003; Foale, 2003). The cavity of the endosperm contains watery fluid called coconut water (Janick and Paull, 2008) which is rich in vitamins, amino acids, enzymes, minerals, sugars, cytokins and auxins (George, 1993). The water is biologically pure with a pleasant sweet taste and contains important salts which are of immense health benefits to human (Adams and Bratt, 1992; William and Chew, 1979). Analysis of coconut water shows that it contains 95.5% water, 4% carbohydrates, 0.1% fats, protein and mineral salts (Satyavati, 1987; Jean *et al*. 2009). The fluid has long been a popular drink in different parts of the world, where it is sold fresh or bottled and has been successfully used as an intravenous fluid in emergency situations and in controlling hypertension (Campbell –Falk *et al* 2000; Alleyne *et al.* 2005). A major benefit of coconut water is its ability to rehydrate the body following rigorous exercise probably due to the essential electrolytes it contains. This justifies its wide consumption by athletes and termed as a natural sport drink (Campos *et al.*1996; Magda, 1992). Studies have also shown that coconut water contains folate (Goh and Koren 2008), phytohormones (Wu and Hu, 2009), cytokins and auxins (Robert and Frim, 2009; Haberer and Kieber, 2002) and quite a number of other bioactive compounds which are of medicinal importance and promising potentials in improving human health.

The endosperm is semisolid and jelly-like in young coconut but as the coconut matures, it becomes solid and fibrous, developing into the firmer coconut meat from which coconut oil is extracted. The meat may also be grated and mixed with water to make coconut milk, fried to make coconut snack or used in cooking and as a substitute for cow's milk. Coconut milk is different from coconut water. The later is the natural aqueous fluid contained in the endosperm while the former is the liquid extracted from ground or grated coconut meat using water as solvent. The Coconut meat contains an average of 48.0% -62% moisture, 59% volatile matter, 35.5% oil and 16.5% oil free residue (Nathaniel, 1960; Solangi and Iqbal, 2011). Although coconut meat contains less fat than many oil seeds and nuts such as almonds, it is noted for its high amount of medium chain saturated fat (USDA, 2008). About 90% of the fat found in coconut meat is saturated, a proportion exceeding that of foods such as lard, butter and tallow. Like most nut meats, it contains less sugar and more protein than popular fruits such as banana, apples and oranges; it is relatively high in some mineral such as iron, phosphorous and zinc (Santoso *et al*. 1999).

Despite the numerous benefits of coconut fruit, the street coconut sellers in most parts of Nigeria only sell the coconut meat and discard the coconut water. Most consumers also eat the raw meat or extract it to get coconut milk or coconut oil.

This research is aimed at analyzing the levels of sodium, potassium, calcium, iron, zinc and magnesium in the coconut water and meat in five different coconut cultivars commonly available in Nigeria. The results obtained will serve as basis for educating the consumers on the immense health benefits of the coconut water and meat.

2.0 Materials and Methods

2.1 Sample Collection

Five different cultivars of coconut samples were obtained in their dry conditions and the following drupes were randomly selected from four different states in Nigeria.

1. Hybrid dwarf coconut popularly called Badagry hybrid purchased from Abubakar Rimi Market in Kano, Nigeria. [HCWB(water) and HCMB(meat)].
2. Hybrid dwarf Badagry hybrid characterized by its larger size of copra content purchased at Odu – Oba market in Ogbomosho, Nigeria. [HCWBB (water) and HCMBB (meat)].
3. Hybrid dwarf coconut popularly called Ghana hybrid purchased from Yanlemu area of Na'ibaawa in Kano, Nigeria. [HCWG (water) and HCMG (meat)].
4. West Africa Tall known as Ata – hunawa from the local farm, Isunwe in Okene, Nigeria. [TCWO (water) and TCMO (meat)].
5. Hybrid dwarf coconut collected at the GRA in Kontagora, Nigeria. [HCWK(water) and HCMK (meat)].

2.2 Sample Treatment

2,2,1 Collection of Coconut Water

The coconut water was collected by cracking the coconut shell and the water drained directly into a Buchner funnel fitted with a whatman filter paper cat no. 1001.125. The filtrate was transferred into a 250ml screw capped plastic bottles and stored in the refrigerator at 4^{o}C.

2.2.2 Preparation of Coconut Copra (Meat) sample

The coconut meat was collected and oven – dried at 90^{o}C over night, cool and ground into a fine powder using mortar and pestle. The powder was transferred into a plastic container and labeled.

2.2.3 Determination of Mineral in the Coconut Water

Twenty (20) cm^3 of the coconut water sample was measured into dry 250ml beaker and heated to dryness on a sand bath. Ten (10) cm^3 of 1M HNO_3 was then added to the residue and heated to dryness. To the resultant solution, 15cm^3 of deionized water was added and filtered through whatman filter paper No. 1001.125 into 100ml standard bottles and made up to the mark using deionized water. The solution was used for mineral analysis using atomic absorption spectrophotometer (Buck Scientific model 210 VGP) and flame photometer (Jenway model).

2.2.4 Determination of Mineral in the Coconut Meat

1g of the powdered sample was weighed into a cleaned porcelain crucible and subjected to dry ashing in a muffle furnace at 550^{o}C for 5 hours. The ash obtained was dissolved in 3ml of concentrated nitric acid and heated to boiling on a hot plate. The boiling was continued for about an hour with occasional additions of some quantity of distilled water. The digest was filtered into 100ml standard flask and made up to mark with distilled water. This solution was used for the minerals analysis by atomic absorption spectrophotometer (Buck Scientific model 210 VGP) and flame photometer (Jenway model).

3.0 Results and Discussion

The mean concentrations of the minerals in the coconut endosperm tissues (coconut water and coconut meat) of the samples analyzed are shown in Figures 1 and 2. The levels of the minerals in the coconut meat ranged from 6.14±1.52µg/g Zn to 7809±436.41µg/g Na for the five cultivars analyzed. The levels of minerals in the coconut water ranged from 0.09±0.06µg/g Zn to 959.52±52.65µg/g Na for the five cultivars analyzed. The variations in levels of minerals in the endosperm tissues are presented in Figures 3 and 4. The results indicate that coconut meat is richer in mineral content than the coconut water. This result shows a good agreement with the results reported by other researchers (Solangi and Iqbal, 2011; Jean *et al.* 2009; Santoso *et al.* 1996)

The levels of Na and K are however higher in coconut meats while the waters are rich in Na and Ca when compared to the other minerals (Figure 3). The traditional coconut meat from okene recorded highest level of Na(7809.25± 436.41 µg/g) while high level of K(1375±0.00 µg/g) was observed for hybrid coconut meat from Kontogora. The small size coconut from Badagry contained the highest levels of K(1208.33±288.68 µg/g) in the coconut meat while the large size from the same location contained highest levels of Na(959.52±52.65 µg/g) and Ca(686.67±33.29 µg/g) in the water. The high concentration of Na and appreciable levels of K in the coconut water makes it a suitable electrolyte and can be used in protection against dehydration and maintenance of osmotic pressure in the body. The use of coconut water in dehydration, as a sport drink and in treatment of a number of diseases such as congestive cardiac diseases, diabetes and infectious diseases have been reported (Bruce, 2005; Saat *et al.* 2002; Adam and Bratt, 1992). Sodium also play a role in the normal irritability of muscles and cell permeability (Grim *et al.* 1980) while potassium is a major cation of intracellular fluid involved in protein synthesis. Studies have shown that most high protein foods are rich in both sodium and potassium (Fregley, 1984). Calcium on the other hand, is an indispensable component of the structure of the body; the

bones and teeth owe their hardness and strength to the presence of this mineral element (Arnaud, 1988).
The other minerals which were also found to be in appreciable quantities in both water and meat include, Mg, Fe and Zn (Figure 4). Magnesium is required for processing ATP and for bones and its high level especially in the coconut meat compared to values obtained in literature (Satyavati, 1987). The result of this study also revealed appreciable levels of Iron and Zinc. Iron is a constituent of hemoglobin, myoglobiin, and a number of enzymes and, therefore, is an essential nutrient for humans (Bothwell *et al*., 1979). The absorption of iron is influenced by among other factors, the amount and chemical nature of iron in the ingested food and by a variety of dietary factors that increase or decrease the availability of iron for absorption (Gillooly *et al*. 1983; FAO, 1988). The presence of iron in the coconut analyzed might be connected to the iron – rich mineral in the soil (Osei, 2000). The levels of zinc especially in the coconut meat were higher than that of the literature values, which may be attributed to the natural level of Zinc which is available to the plant in the soil. Zinc, being a constituent of enzymes involved in most major metabolic pathways, is an essential element for plants, animals, and humans (Hambidge *et al.* 1986).
Though there are variations in the levels of the minerals in the coconut waters from all the cultivars investigated but the levels are within the recommended dietary allowances (NRC, 1980b) which suggest that they all have high nutritional values. These results therefore, indicate a desirability of the consumption of the coconut endosperm tissue especially the cultivars investigated in this study for improved nutritional health of individuals.

4.0 Conclusion

The mineral levels such as Na, K, Ca, Mg, Fe, and Zn in the endosperm tissues of coconut fruits of the various cultivars studied are in accordance with literature values with few exceptions and deviations. The levels of potassium in the coconut water though lower than in the meat but high enough to replenish the electrolyte composition in body fluids. It can therefore be used as a first aid treatment for hydration and resuscitation of critically ill patients prior to proper medical attention.
Furthermore, the coconut endosperm tissues could provide the much needed sources of some of the essential minerals and can serve as a good dietary supplement. It is economically affordable and the advantage of its use as a natural resource could be of immense benefit especially in the less developed areas where this fruit is abundant.

References

Adam, W. and D.E. Bratt (1992). Young coconut water for home rehydration in children with mild gastroenteritis. *Trop. Geogr. Med.* 44: 149-153.
Alleyne, Y., Roache, S., Thomas, C., Shirley, A. (2005).The Control of Hypertension by Use of Coconut Water and Mauby: Two Tropical Food Drinks. *West Indian Med J.* 54:3-8.
Arnaud, C.D. (1988). Mineral and bone homeostasis In: J.B. Wyngaarden, L.H. Smith, Jr., and F. Plum, eds. Cecil Textbook of Medicine, 18th ed. W.B. Saunders, Philadelphia. . Pp. 1469-1479
Bothwell, T.H., Char hon. R.W., Cook J.D. And Finch, D. A (1979). Iron Metabolism in Man Blackwell Scientific Publication Oxford.
Bruce, Fife. (2005). Coconut Cures: Preventing and Treating Common Health Problems with Coconut. Piccadilly Books Ltd: USA. 256pp
Campbell-Falck, D.; Thomas, T.; Falck, T.M.; Tutuo, N.; Clem, K.(2000). The intravenous use of coconut water. *Am. J. Emerg. Med.* 18: 108–111.
Campos, C.F., Souza, .E.A., Coelho, J.V. and Gloria, M.B.A. 1996. Chemical composition, enzyme activity and affect of enzyme inactivation on flavor quality of green coconut water. J. Food Process. Pres. 20: 487-500.
FAO (Food Agricultural Organization) (2004). Coconut Statistics: World Area, Production and Productivity of Coconut.
FAO(UN)(Food and Agriculture Organization)(2000). Press Release PR 00/51: *Coconut water as energy drink for Joggers and Athletes*- First Patent granted to UN Food Agency.
FAO (Food and Agriculture Organization). (1988). *Requirements of Vitamin A, Iron, Folate, and Vitamin B12.* Report of a Joint FAO/WHO Expert Consultation. FAO Food and Nutrition Series No. 23. Food and Agriculture Organization, Rome. 107 pp.
Foale, M. (2003). *The Coconut Odyssey*: The Bounteous possibilities of the tree of life. Australian Centre for International Agricultural Research (ACIAR) Monograph No. 101, 132p.
Fregley, M.J. (1984). *Sodium and potassium*. In: Nutrition Reviews' Present Knowledge in Nutrition, 5th ed. The Nutrition Foundation. Washington, D.C. Pp. 439-458.
George, E.F. (1993). *Plant propagation by tissue culture*: The Technology, 2nd edn. London Exegetics Ltd. 318-320.
Gillooly, M., T.H. Bothwell, J.D. Torrance, A.P. MacPhail, D.P. Derman, W.R. Bezwoda, W. Mills, and R.W.

Charlton. (1983). The effects of organic acids, phytates, and polyphenols on the absorption of iron from vegetables. *Br. J. Nutr.* 49(3):331-42.
Goh, Y.I.and Koren, G. (2008). Folic acid in pregnancy and fetal outcomes. *J. Obstet Gynaecol.*, 28: 3–13.
Grim, C.E., F.C. Luft, J.Z. Miller, G.R. Meneely, H.D. Battarbee, C.G. Hames, and L.K. Dahl. (1980). Racial differences in blood pressure in Evans County, Georgia: relationship to sodium and potassium intake and plasma renin activity. *J. Chronic Dis.* 33:87-94.
Haberer, G. and Kieber, J.J.(2002). Cytokinins. New insights into a classic phytohormone. *Plant Physiol.*128: 354–362.
Hallberg, L. (1981). Bioavailability of dietary iron in man. Annu. Rev. Nutr. 1:123147
Hambidge**,** K.M., C.E. Casey**.** and N.F. Krebs. (1986). Zinc**.** In: W. Mertz, ed. Trace Elements in Human andAnimal Nutrition, Vol. 2. 5th ed. Academic Press, Orlando, Fla. Pp. 1-137.
Janick, J. and Paull, R.E. (2008). *The Encyclopedia of Fruit & Nuts*; CAB International: Wallingford, UK. Pp. 112.
Jean W. H., Yong, Liya Ge, Yan Fei Ng and Swee Ngin Tan. (2009). The Chemical Composition and Biological Properties of Coconut (*Cocos nucifera* L.) Water. *Molecules* 14: 5144-5164; doi:10.3390/molecules14125144
Khan, M. Nasiruddin, M.U. Rehman and K.W. Khurram. (2003). A study of chemical composition of *Cocos nucifera* L. (Coconut) water and its usefulness as rehyderation fluid. *Pak. J. Bot*. 35(5): 925-930.
Madga, R.R., (1992). Coco-Soft Drink. Health Beverage from Coconut Water. *Food Marketing Tech*. 6.22-23.
Nathanael, W.R.N. (1960). The Sugar of the Coconut Water. Ceylone *Coconut Quarterly*. 3 (4): 193-9.
NRC (National Research Council). (1980b). *Recommended Dietary Allowances*, 9th Revised Ed.
Committeee on Dietary Allowances, Food and Nutrition Board, Division of Biological Sciences, Assembly of Life Sciences. National Academy of Sciences, Washington, D.C. 185 pp.
Osie, A. V. (2000). New School Chemistry. Africana- Fep Publishers Ltd, Nigeria. pp 301-355.
Peggy, T.F., (2007). *Coconut History.* History, New-York Times Company, USA. Pp. 26-38.39.
Robert, H.S. and Friml, J. (2009). Auxin and other signals on the move in plants. *Nat. Chem. Biol.* 5: 325–332.
Rurseglove, J.W., (1992). *Tropical Crops: Monocotyledons*. Longman Singapore Publishers, New York, 76-89, 180-224,440-479.
Saat, M. Singh R., Sirisinghe, R.G., Nawawi, M. (2002). Dehydration after Exercise with Fresh Young Coconut Water. *J. Physio Anthropol. Appl. Human Science*. 21:93-104.
Santoso, U.; Kubo, K.; Ota, T.; Tadokoro, T.; Maekawa, A. (1996). Nutrient composition of kopyor coconuts (*Cocos nucifera* L.). *Food Chem.* 57: 299–304.
Solangi, A.H. and Iqbal, M.Z. (2011)**.** Chemical composition of meat (kernel) and nut water of major coconut (*cocos nucifera* l.) cultivars at coastal area of Pakistan. *Pak. J. Bot*., 43(1): 357-363.
Satyavati, K.G. (1987). *Biochemical Analysis of Coconut Water*. Coconut Development Board India. 18: 399-408.
United States Department of Agriculture (USDA) (2008). *National Nutrient Database for Standard Reference, 2008. Nuts, coconut water* [Online]. Available: http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl/, accessed on 23 February, 2013.
William, C.N. and Chew, W.Y. (1979). *Origin and Uses of Coconut*. Longman Group Ltd. London. Pp. 188-199.
Wu, Y.; Hu, B. (2009) Simultaneous determination of several phytohormones in natural coconut juice by hollow fiber-based liquid-liquid-liquid microextraction-high performance liquid chromatography *J. Chromatogr. A 1216*, 7657–7663.

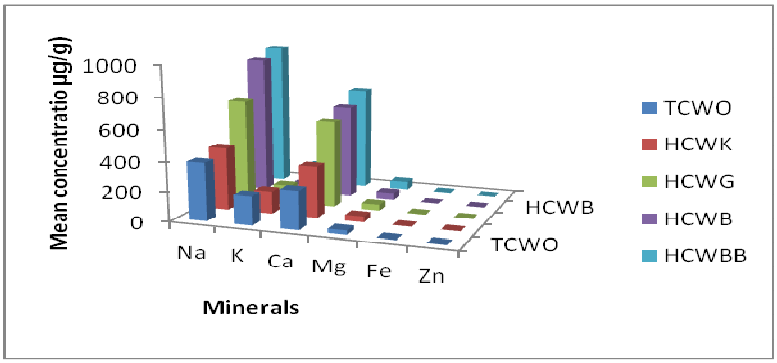

Figure 1: Mean concentrations of the mineral in the coconut water (µg/g)from different areas in Nigeria

Values represent Mean ± Standard deviation

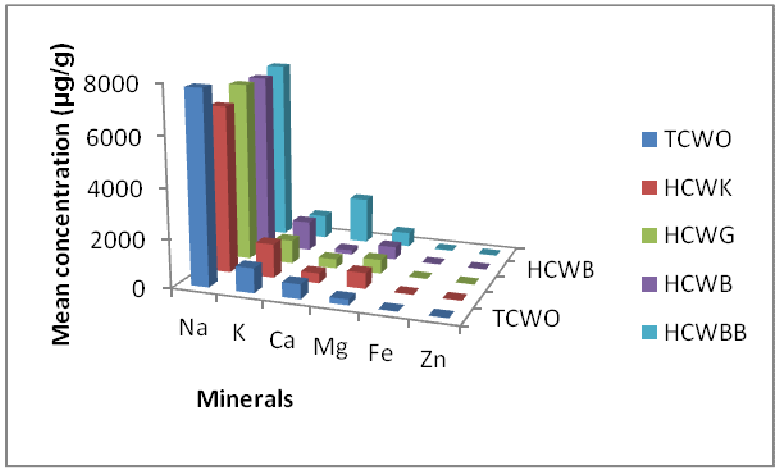

Figure 2: Mean concentrations of the mineral in the coconut meat (µg/g)from different areas in Nigeria
Values represent Mean ± Standard deviation

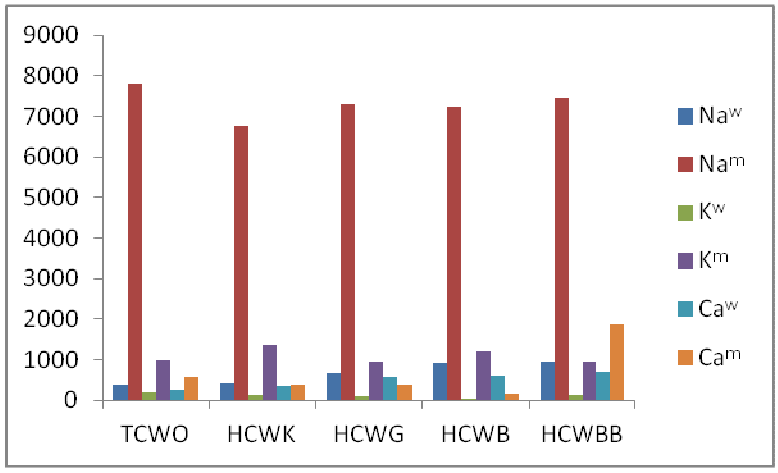

Figure 3: Mean concentrations of major minerals in coconut water and meat (µg/g) based on cultivars
Values represent Mean ± Standard deviation
Superscript w= coconut water, Superscript m= coconut meat

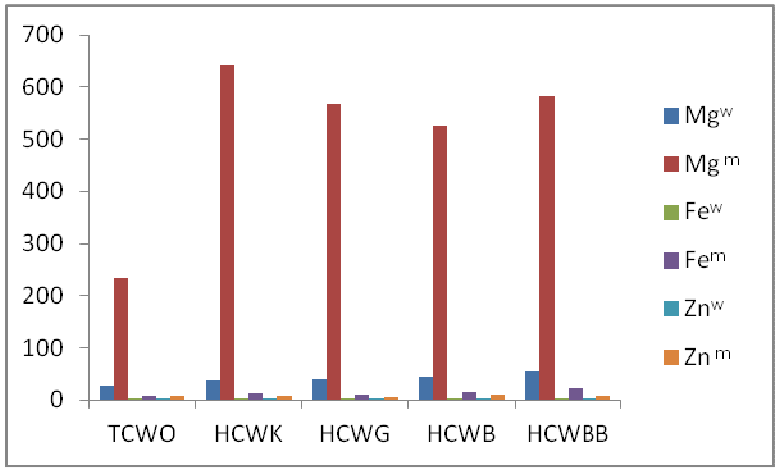

Figure 4: Mean concentrations of other minerals in coconut water and meat (µg/g) based on cultivars
Values represent Mean ± Standard deviation
Superscript w= coconut water, Superscript m= coconut meat

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