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# Comparative Analysis of Elemental Composition of Palm Kernel (*Elaeis guineensis*) *and* Coconut (*Cocosnucifera*) Shells

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***Abstract***
*The elemental compositions present in the shells of palm kernel and coconut were determined using atomic absorption spectrophotometer (AAS) and flame photometer after digestion. The concentration of the elements in coconut shell were; calcium (24.00±0.26 mg/kg), iron (27.41±0.21 mg/kg), zinc (17.05±0.26 mg/kg) and magnesium (125.20±0.21 mg/kg) were higher when compared to their compositions in palm kernel shell with calcium (15.00±0.03 mg/kg), iron (14.57±0.03 mg/kg), zinc (10.00±0.26 mg/kg) and magnesium (98.20±0.03 mg/kg). Other element concentrations were; potassium (220.20±0.03 mg/kg), sodium (10.40±0.01 mg/kg) and copper (4.64±0.03 mg/kg) in palm kernel shell were higher as compared to coconut shell with potassium (198.05±0.17 mg/kg), sodium (15.40±0.32 mg/kg) and copper (3.00±0.21 mg/kg). However, lead was below detectable limit. Palm kernel and coconuts shell have similar metals present although in different concentrations. This study revealed that the shells of palm kernel and coconut contains substantial amount of mineral elements which make them suitable alternative cheap sources for these minerals element.*

***Keywords:*** *Biochemical, Cocosnucifera, Composition, Elaeis guineensis, Macro-element, Mineral elements, Shells*

## 1.0 Introduction

The search for cheaper alternative sources of mineral elements has been on the increase as they play active roles in the metabolic active of living organisms and also in other applications. Researchers have established that minerals originate in the earth and cannot be made by living organisms. Plants get these minerals from soil. Most of the minerals in a human diet come from eating plants and animals or from drinking water (Micronutrient Information Center, 2016). The five major minerals in the human body are calcium, phosphorus, potassium, sodium, and magnesium. All of the remaining elements in a human body are called "trace elements". The trace elements that have a specific biochemical function in the human body are sulfur, iron, chlorine, cobalt, copper, zinc, manganese, molybdenum, iodine and selenium (Berdanier *et al*., 2013).

Mineral elements though usually form a small portion of total composition of most plant materials and of total body weight; they are nevertheless of great physiological importance particularly in the body metabolism. Besides several organic compounds, it is now well established that many trace elements play a vital role in general well-being as well as in the cure of diseases (Prasad, 1993). These elements are present at varying concentrations in different parts of the plants, especially in roots, seeds and leaves. It has been established that ashes give us an idea of the mineral matter contained in a plant (Sunggyu, 2005).

Scientists and nutritionists in recent years have started believing in the therapeutic role of metals in human health (Udayakumar and Begum, 2004) as it is believed that minerals are required by living organisms and can help to prevent occurrence of some diseases.

Botanically, the coconut fruit is a drupe not a tree nut. Like other fruits, it has three layers; the exocarp, mesocarp, and endocarp. The exocarp and mesocarp make up the ‘‘husk’’ of the coconut. The mesocarp is composed of a fibre, which has many traditional and commercial uses. The shell has three germination pores (micropyle) or ‘‘eyes’’ that are clearly visible on its outside surface once the husk is removed.

The coconut husk has high amount of lignin and calorific value of 18.62 MJ/kg. The chemical composition of coconut husks consist of cellulose, lignin, pyroligneous acid, gas, charcoal, tar tannin and potassium. Coconut shell is the strongest part covered in coconut fruit. Coconut shell is located in between the flesh and the coconut husk. The shell is naturally created to protect the inner part of the coconut. The shell is use to produce various handicrafts and other applications. Most of the handmade decorative are created by using coconut shell due to their strength. Coconut shell is an agricultural waste and has a high calorific value of 20.8MJ/kg and can be used to produce steam, energy-rich gases, bio-oil, biochar etc. It is to be noted that coconut shell and coconut husk are solid fuels and have peculiarities and problems inherent in this kind of fuel.

Oil palm (*Elaeisguineensis*) is a crop with distinct group of monocotyledon. Hutchinson grouped *Elaeisguuineensis* with cocos, corozo and other genera of the palmae family, in the order palmates, under the tribe Cocoineae. The palm gets its characteristics appearance due to the irregular set of the leaflets on the leaf. The fruit is a drupe, borne on a large compact bunch. The fruit pulp which provides palm oil surrounds a nut, the shell of which enclose the palm kernel. Palm kernel is the edible seed of the oil palm fruit. The fruits yields two distinct oils; palm oil derived from the outer parts of the fruit and palm kernel oil derived from the kernel.

Palm kernel shell is the fraction left after the nut has been removed after crushing in the palm oil mill. Palm kernel shells are fibrous materials and can easily handle in bulk directly from the product line to the end use. Large and small shell fractions are mixed with dust-like fraction and small fibres. Palm kernel shells contain residues of palm oil, which accounts for its slightly higher heating value than average lignocellulosic biomass. Compared to other residues from the industry, it is a good quality biomass, easy crushing and limited biological activity due to low moisture content.

This study was to investigate and compare mineral elements composition of the shells of palm kernel and coconut in order to ascertain theirs best suitable usefulness.

## 2.0 Materials and Method

### 2.1 Sample Collection and Preparation

The palm kernel shells were collected from a palm oil mill and coconut fruits were purchased from Ekpoma Market, Esan West LGA, Edo State, Nigeria. The coconut was broken and then the kernel

was separated from the shell after the water was removed. The palm kernel and coconut shells were crushed with grinding machine (for shells) to reduce them to smaller size and then sieved to get fine particles. The powdered obtained were secured in air tight bottle. Analytical grade reagents were used for the analysis and all container were thoroughly washed with dilute nitric acid before rinsing with de-ionize water so as to elimination any metal contamination.

### 2.2 Methods of analyses

#### 2.2.1 Mineral analysis

Mineral analysis was determined as report by Okonkwo and Ozoude (2015). The levels of Ca, Mg, K, Na, Cu, (Macro-element), Fe, Zn (Micro-element) and Pb (Heavy-element) in the shells of the palm kernel and coconut nuts were quantified by procedure of James (1995). The samples for the determination of the element was subjected to acid digestion using concentrated perchloric acid and hydrochloric acid and subsequently the different elements were determined using appropriate methods as described by James (1995). Calcium and magnesium content of the samples were determined by complexiometric titration. Sodium and potassium were determined by flame photometry method. Lead was analysed using Atomic Absorption spectrophotometer (Jackson, 1973). The mineral concentration was expressed as mg/kg.

#### 2.2.2 Statistical analysis

All the measurements were replicated three times and the data are presented as mean ± SD.

### 3.0 Result and Discussion

Results of the mineral elements determined showed that the shells have these elements in varied concentrations as presented in Table 1 and are graphically represented in figure 1.

**Table 1: Concentration of some metals present in PKS and CS.**

| Elements | lm kernel shell (mg/kg) | oconut shell (mg/kg) |
|---|---|---|
| lagnesium | 98.20 ± 0.03 | 125.20 ± 0.21 |
| Copper | 4.64 ± 0.03 | 3.00 ± 0.21 |
| Zinc | 10.00 ± 0.26 | 17.05 ± 0.26 |
| otassium | 220.20 ± 0.03 | 198.05 ± 0.17 |
| Sodium | 10.40 ± 0.01 | 15.40 ± 0.32 |
| Iron | 14.57 ± 0.03 | 27.41 ± 0.21 |
| Calcium | 15.00 ± 0.03 | 24.00 ± 0.26 |
| Lead | BDL | BDL |

**Key: BDL (Below Detectable Limit)**

Metal concentrations in plants vary with plant species (Alloway *et al*., 1990) and also cultivation location. In the palm kernel and coconut shells analyzed, magnesium contents was 98.20±0.03mg/kg and 125.20±0.21mg/kg respectively, which was higher than 50.96mg/kg and 46.14mg/kg in palm kernel shell and coconut shell reported by Akpakpan *et al*. (2012). Ekebafe *et al*. (2010) reported 0.673mg/kg for magnesium in rubber seed shell which was lower than the values for this study. For the transfer of energy and normal functioning of the nervous system in the body, magnesium is an important element needed, and it is also an important element for plants for photosynthesis. Magnesium plays a significant role in carbohydrate metabolism, nucleic acids and binding agents of cell walls (Sunday *et al*., 2016).

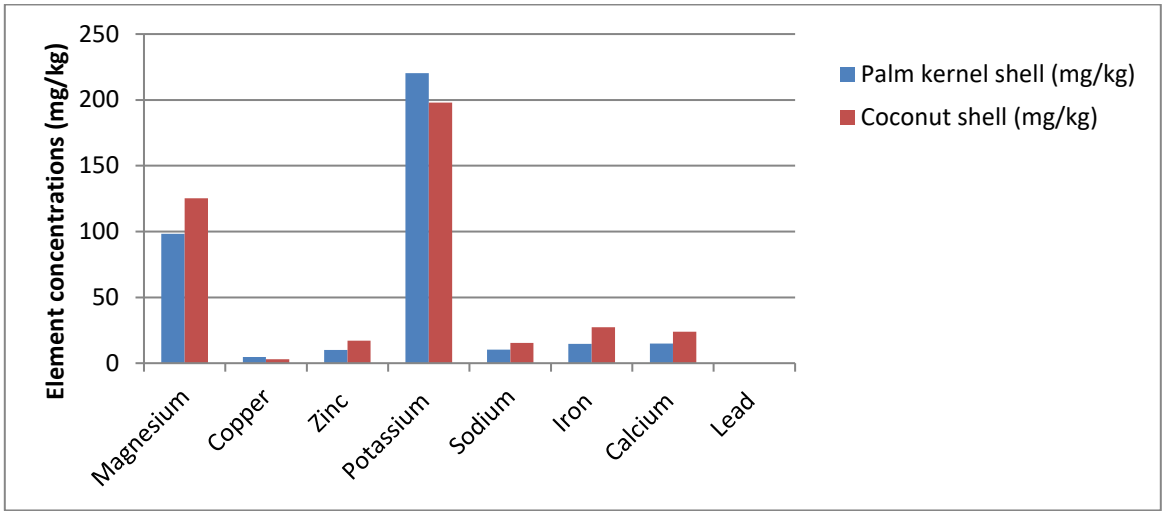


**Figure 1: Elemental composition of the palm kernel and coconut shells**

The amount of copper present in palm kernel shell (4.64±0.03mg/kg) was higher than that obtained in coconut shell (3.00±0.21mg/kg). However, Akpakpan *et al*. (2012) reported 4.54mg/kg for palm kernel shell and 7.01mg/kg for coconut shell. Chinthani and Mevan, (2015) reported that the value of copper in coconut shell was 0.28mg/kg which was lower than that obtained for coconut shell from this study. Copper is an essential micro-nutrient necessary for the haematologic and neurologic systems (Tan *et al*., 2006). It is necessary for the growth and formation of bone, formation of myelin sheaths in the nervous systems, helps in the incorporation of iron in haemoglobin, assists in the absorption of iron from the gastrointestinal tract (GIT) and in the transfer of iron from tissues to the plasma (Malhotra, 1998; Murray *et al*., 2000).

The values of zinc were 10.00±0.26mg/kg and 17.05±0.26mg/kg respectively for palm kernel shell and coconut shell respectively, with coconut shell having the highest value. Akpakpan *et al*, (2012) reported zinc concentration of 8.61mg/kg for palm kernel shell which was higher than 3.02mg/kg reported for coconut shell. Ogundiran *et al*. (2011) reported 726±1.16mg/kg for cashew nut shell. Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms (Erum and Ahmad, 2010). Nevertheless, higher concentrations of zinc can be toxic to the organism. However zinc deficiency might result in significant reduction in crop yields and quality.

Potassium had the highest concentration of 220.20±0.03mg/kg in palm kernel shell, while coconut shell recorded 198.05±0.17mg/kg. Akpakpan *et al*. (2012) reported similar trends of results. Chinthani and Mevan, (2015) reported that the concentration of potassium in coconut shell is 26.13mg/kg which is lower the concentration of potassium in coconut from this study. Ekebafe *et al*. (2010) reported 0.01mg/kg for potassium concentration in rubber seed shell. In plants, potassium regulates the opening and closing of the stomata in photosynthesis. Potassium is an essential nutrient used to maintain fluid and electrolyte balance in the body. It is required mineral for the function of several organs, including the heart, kidneys, brain and muscular tissues. Potassium also plays an important role in keeping the body hydrated and works with sodium to support cellular function with your body's sodium-potassium pump (Adrogue and Madias, 2014).

Sodium recorded 10.40±0.01mg/kg for palm kernel shell and 15.40±0.32mg/kg for coconut shell. Comparatively, sodium concentration was found to be higher in coconut shell than palm kernel shell.

The minimum physiological requirement for sodium is between 115 and 500 mg per day depending on sweating due to physical activity, and whether the person is adapted to the climate (National Research Council, 1989). The Adequate Intake for sodium is 1.2 to 1.5 grams per day the minimum amount that promotes hypertension (Geleijnse, *et al*., 2004).

Iron concentrations recorded in shells of palm kernel and coconut were 14.57±0.03mg/kg and 27.41±0.21mg/kg respectively with coconut shell recording the highest concentration. Iron is required for making haemoglobin and it is a prooxidant which is also needed by microorganisms for proliferation (Galan *et al*., 2005). Iron in ferrous form is more soluble and is readily absorbed than the ferric form. Deficiency disease or symptoms include anaemia, (hypochromic, microcytic). Iron deficiency has been reported to have a role in brain development and in the pathophysiology of restless legs syndrome (Tan *et al*., 2006). Also, iron deficiency is associated with alterations in many metabolic processes that may impact brain functioning, among whom are neurotransmitter metabolism, protein synthesis, organogenesis etc (Beard, 2001).

The amount of calcium analyzed in palm kernel shell 15.00±0.03mg/kg was lower when compared to that amount recorded in the coconut shell 24.00±0.26mg/kg. Chinthani and Mevan, (2015) reported 8.35mg/kg value of calcium in coconut shell while Ekebafe *et al*. (2010) reported 0.32mg/kg in rubber seed shell with both values lower than the values obtained in this study. Calcium aid the release of neuro transmitters, regulates heartbeat, and contraction of muscles. Calcium plays a very important role in plant growth and nutrition. Calcium is essential in blood clothing muscle contraction and in certain enzymes in metabolic processes. Calcium is one of the mineral believed to be an important factor governing fruit storage quality (Igwenyi, *et al*., 2014). Calcium is the main constituent of the skeleton and is important for regulating many vital cellular activities such as nerve and muscle function, hormonal actions, blood clotting and cellular mortality. Calcium is essential for healthy bones, teeth and blood.

Lead was not detected in both shells. However, lead is not an essential element. It is well known to be toxic and its effects have been more extensively reviewed than the effects of other trace metals. Lead can cause serious injury to the brain, nervous system, red blood cells, and kidneys (Baldwin and Marshall, 1999). Exposure to lead can result in a wide range of biological effects depending on the level and duration of exposure. Various effects occur over a broad range of doses, with the developing young and infants being more sensitive than adults.

## 4.0 Conclusion

The study revealed that the shells of palm kernel and coconut contain macro and micro elements which are essential for life development in both plant and man. However, these elements vary in concentrations but are present in amount that can be utilized purposefully.

It can thus be concluded that the shells of palm kernel and coconut are good sources of these essential elements which therefore makes these agricultural waste materials suitable cheap and ready alternative for these element outside other uses.

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