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Original Research Article

Effect of plant materials (botanicals) on Proximate and mineral composition of kola nut (*C. nitida*) at three weeks after curing

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The aim of this work was to determine the effect of different botanicals on proximate, minerals and anti- nutrient composition of kola nut in respect to length of storage at 3 weeks after curing. Different classes of weight, 1-10, 11-20 and 21-40g and colours of *C. nitida* nut were collected from "Ogunmakin market" Ogun state. The nuts in a basket were lined up with different botanicals while justoxin was used as a standard. The nuts of the different sizes and colours were crushed separately into smaller particle sizes using perforated grater for analysis. Nutritive and anti- nutrient evaluation were investigated. Significant difference was obtained for potassium, magnesium and zinc with Potassium having the highest in all the elements analyzed with value 11.69mg/100g dry matter when treated with *T. grandis*, followed by phosphorus with value 5.57mg/100g dry matter when treated with *A. indica* and the least was observed for zinc with value 2.50mg/100g dry matter when treated with justoxin respectively. There was significant increase in all the mineral elements analyzed from the lowest nut weight (smallest size) to the highest nut weight (highest size) with the preponderance of potassium (K). Red nut had the highest in all the mineral elements analyzed except for calcium and was highly significant. Oxalate had the highest value ranged between 1.78mg/100g dry matter to 3.09mg/100g dry matter, followed by trypsin inhibitor ranged between 1.33mg/100g dry matter to 2.06mg/100g dry matter and phytate the least ranged between 1.30mg/100g dry matter to 2.03mg/100g dry matter respectively. All the anti-nutrient analyzed was significantly different from each other at 5% level of probability. Significant difference were obtained for % crude protein, moisture content, organic carbon and organic matter ranged between 3.34 to 3.49 for crude protein, 88.17 to 88.79 for % moisture content, 5.52 to 5.70 for % organic carbon and 9.46 to 9.80 for % organic matter respectively. Result obtained for proximate of different weight showed increased values from the lowest nut weight to highest nut weight. These results reveal that these seeds/nuts contain appreciable amounts of nutrients especially carbohydrates and proteins with good caloric value and low levels of toxicants and should be included in human diets to supplement our daily allowance needed by the body.

Key words: Nutrient, Anti-nutrient, *C. nitida,* mineral, nutritional, nut colour

INTRODUCTION

Cola nitida (Kola nut) also known as cola, goro nut, is an important commercial and economic crop for many West African countries (Lovejoy, 1980). It grows into a tree form and it is cultivated to a large degree in Nigeria, Ghana, Ivory Coast, Brazil and the West Indian Islands (Opeke, 2005). About fifty kola species have been described out of which only seven have edible nuts and only two have been commercially exploited: *Cola acuminata* (Beauvoir) Schott and Endlicher ("abata") and *Cola. nitida* (Ventenat) Schott and Endlicher ("gbanja") (Quarcoo, 1973; Daramola, 1978). The cultivation of *C. nitida* and it is estimated that the country produces 88% of the world's kola nuts (Mokwunye, 2009) with an annual production of 200,000 metric tones mostly from South Western Nigeria. About 90% of the kola nuts produced in Nigeria is consumed in the country while the remaining 10% is exported as sun-dried nuts to other parts of Africa especially neighbouring West African countries (Ogutuga, 1975; Akinbode, 1982) where they are used as stimulants or as sources of colorants for cloth dyeing. *C. acuminata* is frequently used for social and religious ceremonies in Southern and Middle-belt Nigeria while *C. nitida* which is referred to as "the true kola of commerce" has featured in the internal trade of West Africa for a number of centuries (Jaiyeola, 2001). The crop is important because of its nut ("Obi") that has important pharmacological properties (Atawodi et al., 2007) and also contains some active principles found in coffee and cocoa (caffeine, theobromine, kolatin) (Opeke, 2005) which prevents sleep, thirst and hunger and also acts as an anti-depressant (Mokwunye, 2009). Jayeola (2001) reported the possible use of kola nut for the production of soft drinks.

Due to high rate of consumption of Kola nuts in the country both by the young and elderly and considering the medicinal importance and the health implications of its consumption, this work was therefore aimed at investigating the proximate, mineral composition, anti-nutrient of kola nut in relation to their vary levels of maturity with a view to ascertaining if their mineral content could help to replicate the deficiency of some of these minerals in the body in order to meet the human daily dietary intakes of these minerals for effective growth and development.

MATERIALS AND METHODS

This research work was carried out in January, 2014 at Cocoa Research Institute of Nigeria, Idi -Ayunre, Ibadan, Oyo State.

Fresh *C. nitida* nut with three different weights and colours purchased from "Ogunmakin" village market, Ogun State were used for this study. The nuts were classified into weight as follows: 1-10g, 11-20g and 21-40g, colours: red, pink and white and the different fresh leaves of *A. cordifolia, T. grandis, A. indica*, plantain leaves were used as treatment and justoxin (chemical, kola preservative) was used as standard. The nuts of the different sizes and colours were crushed separately into smaller particle sizes using perforated grater and stored in a capped container until they were needed for analysis.

Experimental design

Fifteen baskets with different botanicals and classes of nuts were arranged in complete randomized design (CRD) replicated thrice.

Nutritional, Proximate and Anti-nutrients analyses of *Cola. nitida*:

Proximate composition of kola nuts

The nuts were washed, chopped into pieces and dried in oven at 70 ^{0}C for 24h. After drying, the nuts were ground into a fine powder using mortar and pestle and stored in a well labeled air-tight container for analysis. The proximate analyses were carried out according to the Association of Official Analytical Chemists AOAC (2005). Moisture content was determined by oven drying at 105°C for 2 h to a constant weight, ash by igniting kola in a muffle furnace at 550°C, crude protein by multiplying the Kjeldahl nitrogen with a factor of 6.25, fat by the reflux Soxhlet extraction method with petroleum ether and crude fibre by the Weende Method as described in AOAC (2005). Total carbohydrate was obtained by difference.

Mineral composition of kola nuts

The phosphorus content was determined by the Vanado-Molybdate colorimetric method as described in AOAC (2005) and the absorbance read at 470 nm on a Spectronic 20 spectrophotometer. Iron and zinc contents were determined by the bulk 200 atomic absorption spectrophotometer while the sodium and potassium content was read on a Jenway digital flame photometer (AOAC, 2005). Phytates was determined by the method of Early and DeTurk (1944) modified by Thompson and Erdman (1982). Total oxalate was determined by the method described by Ukpabi and Ejidoh (1989) and trypsin inhibitors by the method described by Kakade et al*.* (1974).

Statistical analysis

All data generated were subjected to Analysis of Variance (SAS 1999) software package using completely randomized design. Least significant difference (LSD_5%) test at $p \leq 0.05$ was used to separate the means where significant difference was observed.

RESULTS AND DISCUSSION

The mineral composition (mg/100g dry matter) of *C. nitida* nut at 3 weeks after curing using different botanicals and justoxin as treatment shows that no significant difference were obtained for calcium, sodium, phosphorus, iron and manganese. Significant difference were obtained for potassium, magnesium and zinc with values which ranged from 11.43mg/100g dry matter to 11.69mg/100g dry matter for potassium, 3.65mg/100g dry matter to 3.89mg/100g dry matter for magnesium and 2.50mg/100g dry matter to 2.65mg/100g dry matter for zinc respectively. (Table 1). Potassium had the highest in all the elements analyzed with value 11.69mg/100g dry matter when treated with *T. grandis*, this was followed by

Table 1. Effect of different botanicals on mineral composition (mg/100g dry matter) of *C. nitida* nut at 3 weeks after curing

Treatments	Ca	K	Na	P	Mg	Fe	Zn	Mn
T. grandis	2.90[a]	11.69[a]	3.91[a]	5.56[a]	3.88[a]	3.14[a]	2.60[ab]	3.43[a]
A.indica	2.92[a]	11.59[ab]	3.89[a]	5.57[a]	3.87[a]	3.17[a]	2.65[a]	3.43[a]
A. cordifiolia	2.82[a]	11.48[b]	3.81[a]	5.44[a]	3.89[a]	3.09[a]	2.58[ab]	3.44[a]
Plantain leaves	2.81[a]	11.46[b]	3.79[a]	5.42[a]	3.76[ab]	3.06[a]	2.53[ab]	3.34[a]
Justoxin	2.80[a]	11.43[b]	3.74[a]	5.40[a]	3.65[b]	3.05[a]	2.50[b]	3.32[a]

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test.

Table 2. Effect of different botanicals on mineral composition (mg/100g dry matter) of *C nitida* nut at different

Nuts sizes(g)	K	Ca	Na	P	Mg	Fe	Zn	Mn
21-40	12.71[a]	3.39[a]	4.80[a]	6.45[a]	4.71[a]	3.82[a]	3.16[a]	4.01[a]
11-20	12.01[b]	2.98[b]	4.07[b]	5.67[b]	4.11[b]	3.25[b]	2.64[b]	3.63[b]
1-10	9.88[c]	2.17[c]	2.62[c]	4.31[c]	2.62[c]	2.23[c]	1.92[c]	2.48[c]

Means followed by the same letters are not significantly different at 5% level of probability using Duncan Multiple Range Test.

Table 3. Effect of different botanicals on mineral composition (mg/100g dry matter) of *C. nitida* nuts at different colours

Nut colours	Ca	K	Na	P	Mg	Fe	Zn	Mn
Pink	3.09[a]	11.86[b]	3.23[b]	5.56[b]	3.60[b]	3.10[b]	2.36[b]	3.21[b]
Red	2.86[b]	12.12[a]	4.66[a]	6.06[a]	4.62[a]	3.27[a]	3.05[a]	3.88[a]
White	2.59[c]	10.61[c]	3.60[c]	4.81[c]	3.21[c]	2.92[c]	2.32[c]	3.02[c]

Means followed by the same letters are not significantly different at 5% level of probability using Duncan Multiple Range Test.

phosphorus with value 5.57mg/100g dry matter when treated with *A. indica* and the least was observed for zinc with value 2.50mg/100g dry matter when treated with justoxin respectively. (Table 1) Table 2 shows a common trend of increasing quantities of different weights. The most abundant mineral element obtained was potassium which ranged from 9.88mg/100g dry matter to 12.71mg/100g dry matter, this was followed by phosphorus which ranged from 4.31mg/100g dry matter to 6.45mg/100g dry matter and the least was observed for zinc ranged between 1.92mg/100g dry matter to 3.16mg/100g dry matter respectively. Other mineral elements ranged between 2.17mg/100g dry matter to 3.39mg/100g dry matter for calcium, 2.62mg/100g dry matter to 4.80mg/100g dry matter for sodium, 2.62mg/100g dry matter to 4.71mg/100g dry matter for magnesium, 2.23mg/100g dry matter to 3.83mg/100g dry matter for iron and 2.48mg/100g dry matter to 4.01mg/100g dry matter for manganese respectively. All the minerals analyzed were significantly different from each other at 5% level of probability. Table 3 shows that red nut had the highest in all the mineral elements analyzed except for calcium and was highly significant. This was followed by pink nuts values except for sodium where the pink nut had the least and the least was observed for white nut except for sodium.

The pink nut value had the highest in calcium; this was followed by red nut and the white nut, the least (Table 3). These values are calcium, 2.59mg/100g dry matter white nut to 3.09mg/100g dry matter for pink nut; potassium, 10.61mg/100g dry matter for white nut to 12.12mg/100g dry matter for red nut; sodium, 3.23mg/100g dry matter pink nut to 4.66mg/100g dry matter for red nut; phosphorus, 4.81mg/100g dry matter for white nut to 6.06mg/100g dry matter for red nut; magnesium, 3.21mg/100g dry matter for white nut to 4.62mg/100g dry matter for red nut; iron, 2.92mg/100g dry matter for white nuts to 3.27mg/100g dry matter for red nut; zinc, 2.32mg/100g dry matter for white nut to 3.05mg/100g dry matter for red nut and manganese, 3.02mg/100g dry matter for white nut to 3.88mg/100g dry matter for red nut respectively (Table 3). The result obtained from this study compared favorably with that reported by other Workers (Jayeola, 2001). Similar distribution of mineral elements was observed in *V .volvacea* and *P. tuber-regium* (Kuforiji, 2005). Similar result was obtained by earlier workers (Ugioro et al., 2012; Fasidi and Kadiri, 1990; Kadiri and Fasidi, 1990a). The preponderance of potassium may be due to the absorption and accumulation of this element on the matured nuts. The implication of the above findings of increasing mineral elements with maturity is that most mature *C.nitida* nuts is the most nutritious and is therefore the ideal stage recommended for human consumption.

Table 4 shows the effect of plant botanicals on anti-nutrient composition of *C. nitida* nut at 3 weeks after

Table 4. Effect different botanicals on of anti- nutrient composition (mg/100g dry matter) of *C. nitida* nut at 3 weeks after curing

Treatment	Trypsin inhibitor	Oxalate	Phytate
T. grandis	1.78[a]	2.65[a]	1.74[a]
A.indica	1.76[a]	2.57[a]	1.74[a]
A. cordifiolia	1.77a	2.55[a]	1.76[a]
Plantain leaves	1.75a	2.52[a]	1.72[a]
Justoxin	1.71[a]	2.39[b]	1.65a

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test.

Table 5. Effect of different botanicals on anti-nutrient composition (mg/100g dry matter) of *C.nitida* nut at different weight

Nuts weight (g)	Trypsin inhibitor	Oxalate	Phytate
21-40	2.06[a]	3.09[a]	2.03[a]
11-20	1.87[b]	2.74[b]	1.83[b]
1-10	1.33[c]	1.78[c]	1.30[c]

Means followed by the same letters are not significantly different at 5% level of probability using Duncan Multiple Range Test.

Table 6. Effect of different botanicals on anti-nutrient composition (mg/100g dry matter) of cured *C. nitida* nuts at different colours

Nuts colours	Trypsin inhibitor	Oxalate	Phytate
Pink	1.45[b]	2.88[a]	1.51[c]
Red	2.35[a]	2.76[b]	2.10[a]
White	1.46[b]	1.97[c]	1.54[b]

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test

curing. The result indicated that no significant difference was obtained for trypsin inhibitor and phytate. Significant different was observed for oxalate which ranged between 2.39 to 2.65. In all the parameters tested, oxalate had the highest (2.65) in when treated with *T. grandis*, followed by trypsin inhibitor (1.78) when treated with *T. grandis* and the least phytate (1.65) when treated with justoxin (Table 4).

The result in (Table 5) shows the various quantities of increasing order of values from the lowest nut weight to the highest nut weight of *C. nitida* nuts at 3 weeks after curing using different botanicals as treatment. Oxalate had the highest value which ranged between 1.78mg/100g dry matter to 3.09mg/100g dry matter, followed by trypsin inhibitor which ranged between 1.33mg/100g dry matter to 2.06mg/100g dry matter and phytate the least which ranged between 1.30mg/100g dry matter to 2.03mg/100g dry matter respectively. All the anti-nutrient analyzed was significantly different from each other using 5% level of probability.

Table 6 shows the anti- nutrient composition of cured *C. nitida* nuts at different colours. Red nut had the highest in trypsin inhibitor and phytate and is highly significant when compared to pink and white nuts. This was followed by pink nut and white nut the least. The pink nut had the highest value in oxalate and was significant when compared to red and white nuts. The range of values are; pink value, 1.45mg/100g dry matter for trypsin inhibitor to 2.88mg/100g dry matter for oxalate, red nut; 2.10mg/100g dry matter for phytate to 2.76mg/100g dry matter for oxalate and white nut, 1.46mg/100g dry matter for trypsin inhibitor to 1.97mg/100g dry matter for oxalate respectively (Table 6)

In Table 7, no significant difference were obtained for percentage crude fibre, crude fat, ash content and carbohydrate. however, significant difference were obtained for % crude protein, moisture content, organic carbon and organic matter with values ranged between 3.34 to 3.49 for crude protein, 88.17 to 88.79 for % moisture content, 5.52 to 5.70 for organic carbon and 9.46 to 9.80 for organic matter respectively. In all the parameters analyzed, % moisture content had the highest with value 88.79, followed by carbohydrate with value 85.74 and the least was observed in crude fat with value 2.37 respectively.

The result of proximate analysis of the different weight of *Cola nitida* nut treated with botanicals at 3 weeks after curing (Table 8) showed that they have comparable proximate properties. The crude protein of the different weight of *Cola nitida* showed a common trend of increase

Table 7. Effect of proximate composition of *C.nitida* nut using different botanicals at 3 weeks after curing

Treatments	% crude protein	% crude fibre	% crude fat	Ash content	% moisture	Organic carbon	Organic matter	carbohydrate
T. grandis	3.49[a]	5.65[a]	2.37[a]	3.19[a]	88.58[b]	5.70[a]	9.80[a]	85.57[a]
A.indica	3.48[a]	5.68[a]	2.42[a]	3.15[a]	89.79[a]	5.68[ab]	9.78[a]	85.37[a]
A.cordifolia	3.48[a]	5.47[a]	2.39[a]	3.12[a]	88.17[b]	5.62[ab]	9.70[ab]	85.57[a]
Plantain leaves	3.33[b]	5.47[a]	2.38[a]	3.11[a]	88.59[ab]	5.59[ab]	9.60[ab]	85.64[a]
Justoxin	3.34[b]	5.44[a]	2.37[a]	3.09[a]	88.81[ab]	5.52[b]	9.46[b]	85.74[a]

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test

Table 8. Effect of proximate composition of *Cola nitida* nuts at different weights at 3 weeks after curing

Nuts weight(g)	% crude protein	% crude fibre	% crude fat	Moisture content	Organic carbon	Organic matter	Ash content	carbohydrate
21-40	4.00[a]	6.78[a]	2.74[a]	91.47[a]	6.48[a]	11.15[a]	3.63[a]	89.04[a]
11-20	3.61b	5.87[b]	2.51[b]	90.31[b]	5.87[b]	10.11[b]	3.43[b]	84.62[b]
1-10	2.66c	3.98[c]	1.91[c]	84.59[c]	4.51[c]	7.73[c]	2.34[c]	83.07[c]

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test.

Table 9. Effect of botanicals on proximate composition of *C.nitida* nut of different colours at 3 weeks after curing

Nut colours	% crude protein	% crude fibre	% crude fat	Moisture content	Organic carbon	Organic matter	Ash content	carbohydrate
Pink	3.55[a]	5.10[c]	2.08[c]	89.54[b]	5.90[a]	10.17[a]	2.90[c]	86.36[a]
Red	3.29[c]	5.94[a]	2.77[a]	86.44[c]	5.45[c]	9.36[c]	3.56[a]	84.43[c]
White	3.43[b]	5.58[b]	2.13[b]	90.39[a]	5.50[b]	9.46[b]	2.94[b]	85.94[b]

Means followed by the same letters are not significantly different at 5% level of probability using Duncan Multiple Range Test.

ranged from the highest nut weight with value 2.66 to 4.00 and is highly significant when compared to the medium and lowest weight nuts. Similar result were obtained for other proximate parameters ranged between 3.98 to 6.78 for crude fibre, 1.91 to 2.74 for crude fat, 2.34 to 3.63 for ash content, 84.59 to 91.47 for % moisture content, 4.51 to 6.48 for organic carbon, 7.73 to 11.15 for organic matter and 83.07 to 89.04 for carbohydrate respectively.

Means followed by the same letters are not significantly different at 5% probability level using Duncan Multiple Range Test.

Table 9 shows that pink nut had the highest value in crude protein 3.55, organic matter 10.17, organic carbon 5.90 and carbohydrate 86.36 respectively and is highly significant when compared to the red nut with value 3.29 for crude protein, 86.44 for moisture content, 5.45 for organic carbon, 9.36 for organic matter and 84.43 for carbohydrate and white nut with value 3.43 for crude protein, 5.50 for organic carbon, 9.46 for organic matter and 85.94 for carbohydrate respectively. This was simply followed by white nut and red nut the least. Similarly, red nut had the highest in crude fibre 5.94, crude fat 2.77 and ash content 3.56 which is highly significant when compared to pink and white nuts. This was simply followed by white nut with value 5.58 for crude fibre, 2.13, crude fat and 2.94, ash content and pink nut the least with value of 5.10 for crude fibre, 2.08 crude fat and 2.90, ash content. The white colour had the highest in % moisture content of 90.39 which is highly significant from the pink with value 89.54 and red with value 86.44, 89.84 respectively. The nutrient composition of kola nut differs relatively from what has been reported by other workers. Jaiyeola (2001) had earlier reported 8.90% protein, 0.92% fat and 2.40% ash in the fresh nut of kola and Ogutuga (1975) also reported a protein content of 8.0%. All these are quite different from what had been reported in this study with the exception of ash content. The varying composition reported by various workers might be due to the fact that nutrient compositions of these snacks vary with season, environment and/or condition or time of evaluation. This result has confirmed that *C. nitida* has a higher percentage of carbohydrate (88.4%) than *Sorghum bicolor* L. stem flour (44.52%) as reported by Adetuyi and Akpambang (2005) and can be used as a source of carbohydrate. They also provide readily accessible fuel for physical performance and regulate nerve tissue (Whitney and Rolfes, 2005). The samples shows a considerable amount of protein, 3.95 for big, 3.53 for medium and 2.66 for small even though is low compared to the protein level in some commonly consumed oil seed in Nigeria like rapeseed (25%) and sun flower (28.7%) as reported by Jackson(2000). *C.nitida* can therefore be used as a source of protein. Other gross components are present in considerable amount. Crude fiber content of 6.63 for big, 6.14 for medium and 4.39 for small shows that they contain little amount of cellulose, hemicelluloses and lignin which aid digestion.

Conclusion

This study showed that cured *C. nitida* nut contain high percentage of carbohydrate which makes it a good source of human energy. It also contain moderately amount of minerals, proximate needed for growth and development and metabolic activities by man, development of bones, regulation of acid base balance and osmotic regulation of the body fluids and the transmissions of nerve impulses. This work has shown that *C. nitida* has a good medicinal value for the management of certain health conditions like hypercholesterolemia.

Competing interests

The authors declare that they have no competing interests

REFERENCES

AOAC (2005). Official Methods of Analysis 18th ed. Association of Official Analytical Chemists, USA.

Adetuyi AO, Akpambang OE (2005). The nutritional value of sorgum bicolor stem flour used for infusion drinks in Nigeria. Pak. J. Sci. Ind. Res. 49: 276-276.

Akinbode A (1982). Kola nut production and trade in Nigeria. Nigeria Institute for Social and Economic Research. Ibadan, pp. 76-78.

Atawodi S, Fundstein EO, Haubner BP, Spiegelhalder R, Bartsch BH, Owen RW (2007). Content of polyphenolic compounds in the Nigerian stimulants *Cola nitida ssp alba*, *Cola nitida ssp. rubra* A. Chev, and *Cola acuminata* Schott and Endell and their antioxidant capacity. J. Agric. Food Chem. 55: 9824-9828.

Daramola AM (1978). Insect Pests of *Cola* in Nigeria. Cocoa Res. Institute Niger. Res. Bull. 3: 1-33.

Fasidi IO, Kadiri M (1990). Changes in nutrient contents of *Termitomyces robustus* (Beeli) Hein and *Lentinus subnudus* Berk during sporophore development. Acta Bot. Hungarica 36: 167-172.

Jackson AA (2000). Advances in Experimental Medicine and Biology. Plenum Press, New York.

Jayeola CO (2001). Preliminary studies on the use of kolanuts (*Cola nitida*) for soft drink production. J. Food Technol. Afr. 6(1): 25-26.

Kadiri M, Fasidi IO (1990a). Variation in chemical composition of *Chlorophyllum molybditus* (Mayevex, for Manses and *Pleurotus tuber-reguim* (fries) during fruitbody development. Nigeria J. Sci. 24:86-88

Kakade MC, Racks JJ, McGhee JE, Puski G (1974). Determination of trypsin inhibitor activity of Soy Products: A collaborative analysis of an improved procedure. Cereal chemistry, 51: 376- 382.

Kuforiji OO 2005. Utilization of agro- industrial wastes for the cultivation of Pleurotus tuber- regium and Volvariella volvacea. Ph.D Thesis, Department of Botany, University of Ibadan, Ibadan, Nigeria

Lovejoy PE (1980). Kola in the history of West Africa (La kola dans l'histoire de l'Afrique occidentale

Macrae R, Robinson RK, Sadler MJ (1997) Encyclopedia of Food Science and Food Technology and Nutrition Academic Press Ltd. 3:2163-2175.

Mokwunye FC (2009). Functional characterization of kola nut powder for beverage production. M.Sc. dissertation. University of Agriculture, Abeokuta. Nigeria, pp. 1-69.

Ogutuga DBA, (1975). Chemical composition and potential commercial uses of kola nut. *Cola nitida*, Vent (Schott and Endicher). Ghana J. Agric. Sci. 8: 121-125..

Opeke LK (2005). Tropical commodity tree crops. Spectrum Books. Sunshine House: Ibadan.

Quarcoo T (1973). A handbook on kola. Cocoa Research Institute of Nigeria. Ibadan, p. 90.

Statistical Analysis System (SAS) (1999). Statistical methods, SAS Institute Inc. cary North Carolina

Thompson DB, Erdman JW (1982): Phytic Acid Determination in Soybeans. J. Food Sci., 47: 513- 516.

Ugioro O, Kadiri M, Fadimu YO (2012). Effect of compost on mycelia growth and fructification, mineral elements and proximate composition of *Pleurotus pulmonarius* (fries) singer; at various fruit body stages. Agrosearch J. Agric. Food and Development. 12(2):205-214.

Ukpabi UJ, Ejidoh JI (1989). Effect of Deep Oil Frying on Oxalates Contents and Degree of Itching of Cocoyam. In: Experimental Procedures for Food and Water Analysis, Odo, F.O. and C.N Istiwu (Eds.). Computer Edge Publishers, London, pp: 84-88.

Whitney EN, Rolfes SR, (2005). Understanding Nutrition. 10th Edn., Thomson/Wadsworth Publishing Company, Belmont, CA, pp: 132-137.