Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 7 ~ Issue 1 (2021) pp: 45-55
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Evaluation of Proximate and Heavy Metal Concentrations in Nuts And Vegetable Consumed In Port Harcourt Nigeria

[1]Ideriah, Tubonimi J. K., [2]Konne, Joshua L., [2]Otutubuike, Naomi O. and [2]Orlu, Happiness N.
[1]Institute of Pollution Studies, Rivers State University Nkpolu Oroworukwo, Port Harcourt
[2]Department of Chemistry, Rivers State University Nkpolu Oroworukwo, Port Harcourt

Abstract
Proximate and heavy metal concentrations in Tiger nut, Garden egg and Groundnut were assessed using standard methods of analysis. The results of proximate analysis in Solanum aethiopicum L. showed 86.36 % moisture, 4.38 % protein, 1.56 % lipid, 0.557 % ash, 0.10 % fibre and 7.04 % carbohydrate. Tiger nut contained 50.50 % moisture, 1.050 % ash, 22.70 % carbohydrate, 10.97 % protein, 12.97 % lipid and 18.4 % fibre. Fried groundnut contained 1.60 % moisture, 2.484 % ash, 13.92 % carbohydrate, 32.81 % protein, 48.0 % lipid and 2.11 % fibre. Fresh groundnut contained 5.3 % moisture, 2.05 % ash, 12.13 % carbohydrate, 28.62 % protein, 47.05 % lipid and 3.24 % fibre. The results of heavy metals concentrations showed iron in tiger nut (26.675±0.021 mg/kg), garden egg (62.330±0.0120 mg/kg), fried groundnut (43.125±0.302 mg/kg) and fresh groundnut (29.700±0.012 mg/kg); Manganese concentrations in tiger nut (10.625±0.008 mg/kg), garden egg (13.375±0.013 mg/kg), fried groundnut (15.500±0.342 mg/kg), fresh groundnut (16.200±0.052 mg/kg); Copper concentrations in tiger nut (3.875±0.021 mg/kg), garden egg (11.925±0.210 mg/kg), fresh groundnut (9.200±0.043 mg/kg) and fried groundnut (8.725±0.011 mg/kg) which were within and below the average permissible limits. The concentrations of Pb, Cd, Cr and Ni were below permissible limits. The samples contained valuable nutrients in substantial quantities that can be harnessed for various applications and are not harmful for consumption.
***Key words**: Proximate, Groundnut, Tiger Nut, Garden Egg, Port Harcourt*

Received 03 Jan, 2021; Revised: 14 Jan, 2021; Accepted 16 Jan, 2021 © The author(s) 2021. Published with open access at www.questjournals.org

I. INTRODUCTION

Plants have been a great source of nutrients to human and animals. Humans have relied mostly on plants for nutritional and medicinal needs. Some plant seeds have nutritive and calorific values which make them necessary components of diets (Lawhorn and Carter, 1971). The use of plants by people for treatment of diseases and ailments has being in practice for a long time (Bada, 1997).

Nutritional discoveries of the 1990s showed that frequent eating of nuts greatly lower the risk of heart diseases (Anderson and Gobielle, 2001).Nuts play a significant role in human nutrition especially as sources of vitamins and minerals (Mandul and Mandul 2013., Ory and Henningsen, 1969). Minerals serve as cofactors for many physiological and metabolic functions. Edible oils obtained from groundnut provide a more valuable source of fat, protein, carbohydrate, minerals and some vitamins than any other nut.

Groundnut or peanut is a legume which is widely grown as a food crop, a herbaceous plant of which there are different varieties such as Boro light, Boro Red, Mokwa, Campala, Guta and Ela (Anyasor *et. al.* 2009). It is among the major world oilseeds crops which are rich source of edible oils and provide a more valuable source of fat, protein, carbohydrate, minerals and vitamins. Groundnut have various uses:- adds to good nutritional value, as soup thickener and when cooked, roasted, dried or fried serve as snacks, and sometimes , paste used as mangarine or butter. Moreso, they are less expensive, widely distributed, easily cultivated, consumed and sold by the masses.

Tiger nut tubers appear somewhat long or round in shape with a dimension of 8mm to 16mm. In Nigeria, The Hausa call it “Aya”, Yorubas, “Imumu”, the Igbos, “Ofio”, or “aki Hausa”, where these varieties (yellow, black and brown) are cultivated (Umerie *et. al*., 1997). The cultivation time is April to November (Osagie *et al*., 1986).

The tuber is rich in energy (fat, sugar, protein and starch etc) and also assist in reducing the risk of colon cancer, thrombosis and activate blood, circulation. (Adejuyitan *et. al.*, 2009., Chukwuma *et. al.*, 2010).

African eggplant (Plate C) also called garden egg is a plant genus of family *Solanaceae*. The Hausa call it 'Dauta", Igbo, "Afia" or "ahara", Yoruba, "Igba". *Solanum aethiopicum L.* is one of the most widely cultivated eggplant in Nigeria. They are eaten raw or fried as ingredient for stew, soup and vegetable sauce. They can also be used as treatment for several ailments such as:- asthma, allergic rhinitis, nasal catarrh, skin infections, swollen joint pains and constipation (Bello *et. al.*, 2005).

Nuts are widely consumed for nutritional purposes. Studies have shown that nuts which are utilized as food crops and locally available in Nigeria contain heavy metals and other minerals in addition to phytochemicals and proximate composition (Adejuyitan *et al.*, 2009).

There is paucity of information on the concentrations of heavy metals in these food crops as most studies are on levels of minerals, proximate and phytochemicals. Since heavy metals are toxic at high concentrations, it is important to carry out this study to evaluate the proximate and heavy metal concentrations in nuts (Groundnut and Tiger nut) and vegetables (Garden egg) consumed in Nigeria in order to fill the gap and create awareness amongst the people.

II. MATERIALS AND METHODS

Sample Materials

Groundnut (Plate A), often called 'The King of Oilseeds', is botanically known as *Arachis hypogaea,* belong to the family *Fabaceae.*

Plate A. Groundnut (*Arachis hypogaea L.*)

Source; kisansuvidha.com

Tiger nut (Plate B) is a grass-like plant of the family *Cyperaceae* (Sedge family).

Plate B. Tiger nut (*Cyperus esculentus*)

Source; thethingswellmake. corn.

Plate C. Garden egg (*solanum aethiopicum L.*)
Source: naijafoodtherapy.com

Collection of Samples
The samples for this research (fried groundnut, fresh groundnut, garden egg, tiger nut) were bought from traders at the mile one market in Port Harcourt, Rivers State.

Sample Preparation
The samples were properly selected and thoroughly washed in water to remove dirt and unwanted particles. The edible parts were cut in pieces and grounded with an electric blender separately, before being used for analysis.

ANALYTICAL METHODS
Proximate Analysis
Proximate analysis also known as Weende analysis is a chemical method of assessing and expressing the nutritional value of a feed. The samples (Fried groundnut, raw groundnut, garden egg and tiger nut) were subjected to proximate analysis to determine the moisture content, ash, crude fibre, crude protein using standard Association of Official Analytical Chemist, AOAC (2003). The method and procedure used are:

1. Determination of Protein by Kjeldahl Method

Stage A. Digestion
In a clean 250 m1 conical flask, 0.l g of the sample was placed and 3 g of digestion catalyst with 20 m1 concentrated sulphuric acid were added and heated to digest. The content changed from black to sky-blue coloration. The digest was cooled to room temperature and diluted to 100ml with distilled water.

Stage B. Distillation
In a distillation flask, was placed 20 m1 diluted digest and the flask was held in place on the electro-thermal heater (hot plate). The distillation flask was attached to liebig condenser connected to a receiver containing l0 ml of 2 % boric acid indicator. 40 mls sodium hydroxide was injected into the digest via a syringe attached to the mono-arm steelhead until the digest became strongly alkaline. The mixture was heated to boiling and the distilled ammonia gas via the condenser into the receiver beaker. The colour of the boric acid changed from purple to greenish as ammonia distillate was introduced into the boric acid.

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3\ (g) + Na_2SO_4 + 2H_2O$
$2NH_3\ (g) + H_3BO_3 \qquad NH_4^+ : H_2BO_3 + H_3BO_3\ (excess)$

The distillate was titrated with standard 0.1N hydrochloric acid solution back to purple from greenish colour. The volume of hydrochloric acid added to effect this change was recorded as titter value.

Calculation

$$\%\ \text{organic nitrogen} = \frac{\text{Liter value} \times 1.4 \times 100 \times 100}{1000 \times 20 \times 0.3} \times \frac{100}{1}$$

Where titter value the volume of HC1 used in titrating the ammonium distillate
1.4 = nitrogen equivalent to the normality of HCI used in the titration
100 = the total volume of digest solution
100 = percentage factor
1000 = Conversion factor from gram to milligram
20 = integral volume of sample analyzed or distilled
0.1 = the weight of sample in gram digested.

2. Determination of Carbohydrate by Cleg Anthrone Method

Exactly 0.lg of the sample was placed into a 25m1 volumetric flask, lml distilled water and 1.3m1 of 62 % perchioric acid were added and shaken for 20 mins to homogenize completely. The flask was made up to 25 m1 mark with stopper and distilled water.

The solution formed was filtered through a glass filter paper or allowed to sediment and decanted. l ml of the filtrate was transferred into a l0 ml test tube and diluted to volume with distilled water. 1ml of working solution was transferred with pipette into a clean test tube and 5 m1 anthrone reagent was added. Also, l ml of distilled water and 5 ml anthrone reagent were mixed. The whole mixture was measured at 630nm in a spectrophotometer using the 1 ml distilled water and the 5 ml anthrone reagent prepared as blanks. Also, 0.l mI glucose solution was prepared and treated as the sample of anthrone reagent. The absorbance of the standard glucose was read and the value of carbohydrate as glucose was calculated using the formula below:

$$\% \text{ CHO as glucose} = \frac{0\ 25 \text{ x absorbance of sample}}{\text{absorbance of glucose}} \times \frac{100}{1}$$

Moisture Content by Air Oven Method

Into a clean dried porcelain evaporating dish was placed 1g of the sample and placed in an oven to maintain a temperature of 105°C for six hours. The evaporation dish was cooled in desiccators to room temperature and re-weighed and recorded.

$$\% \text{ moisture} = \frac{\text{weight of fresh sample - weight of dried sample}}{\text{weight of sample used}} \times \frac{100}{1}$$

Lipid determination by Soxhlet Extraction Method

On a filter paper was placed 2g of the sample and place in a Soxhlet extractor. The extractor was placed into a pre- weighed, dried distillation flask. Then the solvent (acetone) was introduced into the distillation flask via the condenser end attached to the Soxhlet extractor.

The set-up was held in place with a retort stand clamp. Cooled water jet was allowed to flow into the condenser and the heated solvent was refluxed as a result. The lipid in the solvent chamber was extracted in the process ominous refluxing. When the lipid was extracted completely from the sample under test the condenser and the extractor were disconnected and the solvent was evaporated to concentrate the lipid. The flask was then dried to constant weight and re-weighted to obtain the weight of lipid.

$$\% \text{ lipid} = \frac{\text{weight of flask and extract - weight of empty flask}}{\text{weight of sample extracted}} \times \frac{100}{1}$$

Ash determination by Furnace Method

Into a pre-heated and weighed porcelain crucible was placed 1g of the dried sample. The crucible was inserted into a muffle furnace and regulated to a temperature of 630°C for three hours and allowed to cool at room temperature and re-weighed.

$$\% \text{ Ash} = \frac{\text{weight of crucible + Ash sample - weight of crucible}}{\text{weight of sample}} \times \frac{100}{1}$$

Determination of crude fibre by Muslin cloth method
Principle
The feed sample was subjected to acid digestion followed by alkali digestion and the remaining residue was weighed and ashed. The loss of weight after ashing was the crude fibre content of the feed.

Procedure
In a 600 m1 lipless beaker was placed 2 g of feed and 200 m1 of 0.255 N H_2SO_4 and placed on an electric heater. A suitable condensing flask (round bottom) was placed over the beaker. The condensing flask was filled with cold water and the heater was switched on.

Digestion in acid
The beaker was heated to boiling and then 2 g of the substance was transferred to the boiling acid. The acid boils and the feed were digested in the acid for 30 mins.

The content of the beaker was filtered using a linen cloth. After all the acid and acid digested residues were transferred to the linen cloth, the beaker was washed with distilled water and transferred to the filtering funnel till the residue was made acid - free.

This was tested by placing one or two drops of the filtrate on a blue litmus paper; blue implies that the residue was washed free of acid. The filter cloth with the residue was squeezed to remove water and placed over porcelain slab.

Digestion in alkali
The acid digested residue was subjected to alkali digestion. Sodium hydroxide, 200 m1 (0.313N) was poured into a 600 m1 lipless beaker and placed over the heater and a condensing flask was fixed over it. The alkali solution was heated to boiling. Then the condensing flask was removed and the acid digested residue transferred to the boiling alkali. The condensing flask was replaced and boiling continued for 30 mins. Then the condenser was removed and the contents transferred to a filtering funnel. The residue was washed repeatedly with distilled water till it was alkali free.

This was tested by placing one or two drops of the filtrate on a red litmus paper which remained red indicating that the residue was free from alkali. The cloth was squeezed to dry the residue and transferred without any loss to a clean silica crucible. The cold water in the condensing flask was never allowed to be hot at any time.

Drying and Weighing
The crucible was placed in preheated (110°C) hot air oven over night to drive off the moisture completely. After complete drying, the crucible was cooled in desiccators and weighed with the residue. The crucible was heated with electrical Bunsen burner till a whitish ash appeared. The crucible was cooled to room temperature and weighed.

Determination of Heavy Metals by Atomic Absorption Spectrophotometer.
The ashed samples were dissolved in l0 ml concentrated hydrochloric acid and heated on a hot plate. The solution was analyzed for metal ion using atomic absorption spectrophotometer by Buck Scientific Model 2010 VOP.

III. RESULTS AND DISCUSSIONS

The results of proximate analysis and heavy metal concentrations are presented in Tables 1 and 2 respectively and in Figs. 1 - 3.

Table 1 Levels of Proximate Composition in the Samples

S/N	Sample type	Moisture (%)	Ash (%)	Carbohydrate (%)	Protein (%)	Lipid (%)	Fibre (%)
1.	Fried groundnut	1.60	2.484	13.92	32.81	48.0	2,11
2.	Fresh groundnut	5.3	2.05	12.13	28.62	47.05	3.245
3.	Garden egg	86.36	0.557	7.04	4.38	1.56	0.10
4.	Tiger nut	50.50	1.050	22.70	10.97	12.97	18.4

The highest moisture content was measured in garden egg (86.36 %) followed by tiger nut (50.50 %) and the lowest in fried groundnut (1.60 %). The highest carbohydrate value was observed in tiger nut (22.70 %) and the lowest in garden egg (7.04 %). The highest ash value was observed in fried groundnut (2.484 %)

and the lowest in garden egg (0.557 %). The highest protein content was observed in fried groundnut (32.81 %) and the lowest in garden egg (4,48 %).

The highest fibre content was observed in tiger nut (18.4 %) and the lowest in garden egg (0.10 %). The highest lipid content was observed in fried groundnut (48.0 %) and the lowest in garden egg (1.56 %).

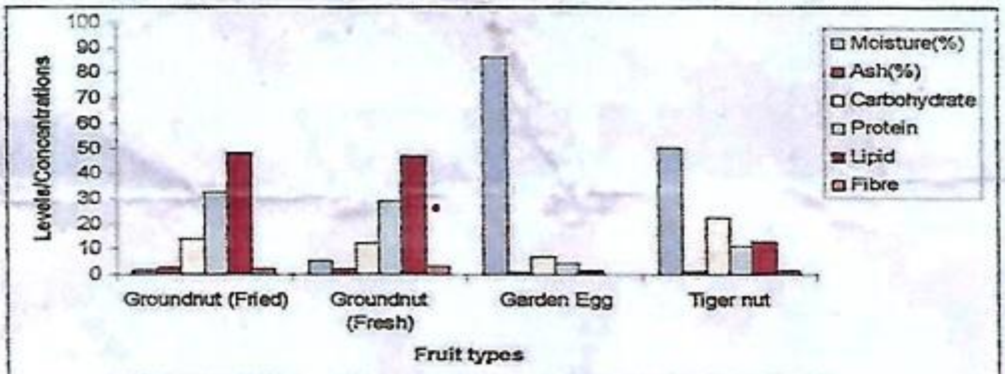

FIG. 2. Variations of Proximate Parameters in Various Fruits

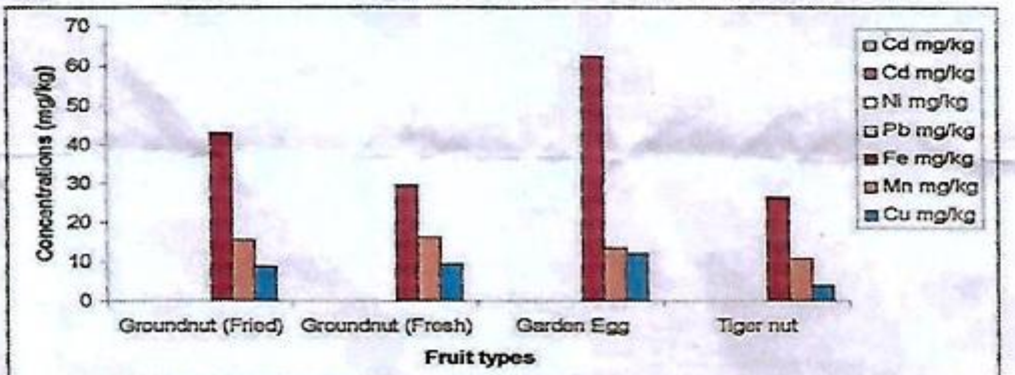

FIG. 3. Variations of Heavy Metals in Various Fruits

Table 2. Concentrations of Heavy Metals in the Samples

S/N	Sample types	Cr (mg/'kg)	Cd (mg/'kg)	Ni(mg'kg)	Pb(mg/kg)	Fe (mg/'kg)	Mn (mg/'kg)	Cu (mg/'kg)
1	Fried groundnut	< 0.001	< 0.001	< 0.001	< 0.001	43.125±0.302	I5.500±0.342	8.725±0.OIl
2	Fresh groundnut	< 0.001	< 0.001	< 0.001	< 0.001	29.700±0.012	16.200±0.052	9.200.±..0043
3 .	Garden egg	-'0.001	<0.00 1	< 0.001	< 0.001	62.330±0.0120	13.375.±0.013	11.925±0.210
4	Tiger nut	< 0.001	< 0.001	< 0.001	< 0.001	26.675±0.021	1 0.625*0.008	3.875±0.021

The results showed very low concentrations of Cr, Cd, Ni and Pb in the samples. The mean concentrations of Fe varied between 26.675 ± 0.021 mg/kg in Tiger nut and 62.330±0.0120 mg/kg in Garden egg. The mean concentrations of Mn ranged from 10.625±0.008 mg/kg in Tiger nut to 16.200 ± 0.052 mg/kg in Fresh groundnut while the concentrations of Cu ranged between 3.875 ± 0.021 mg/kg in Tiger nut and 11.925±0.210 mg/kg in Garden egg. The results showed that tiger nut contained least concentrations of the metals, while garden egg had the highest concentrations of Fe and Cu.

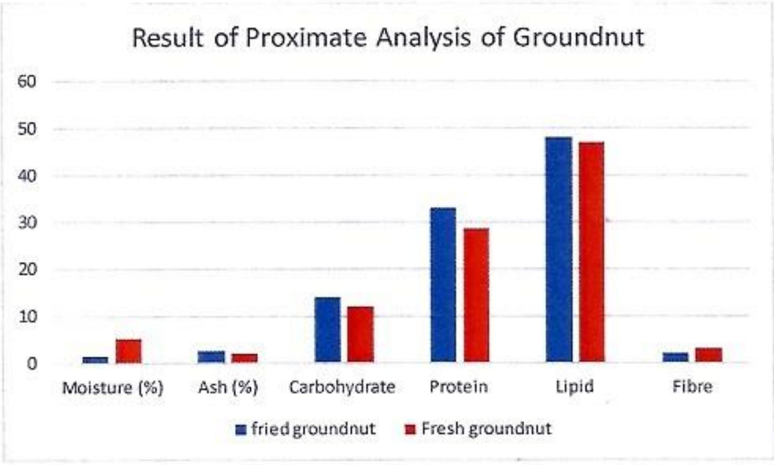

Fig. 1 Proximate composition of groundnut (fresh and fried)

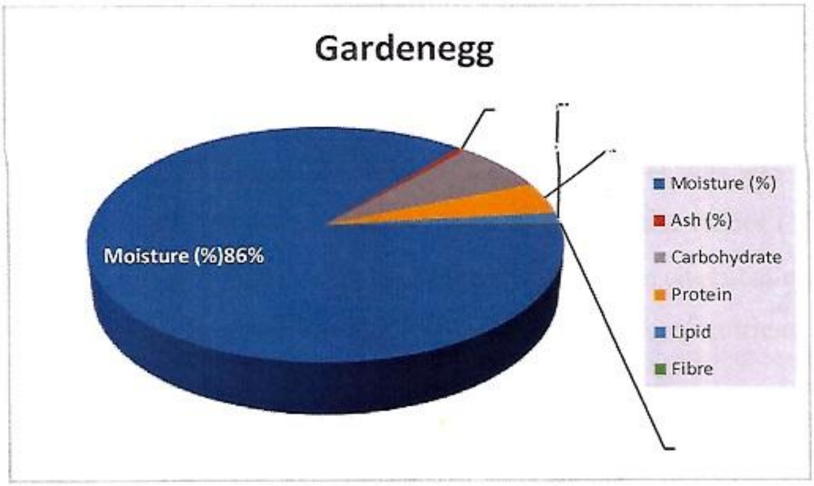

Fig. 2 Proximate composition of Garden Egg

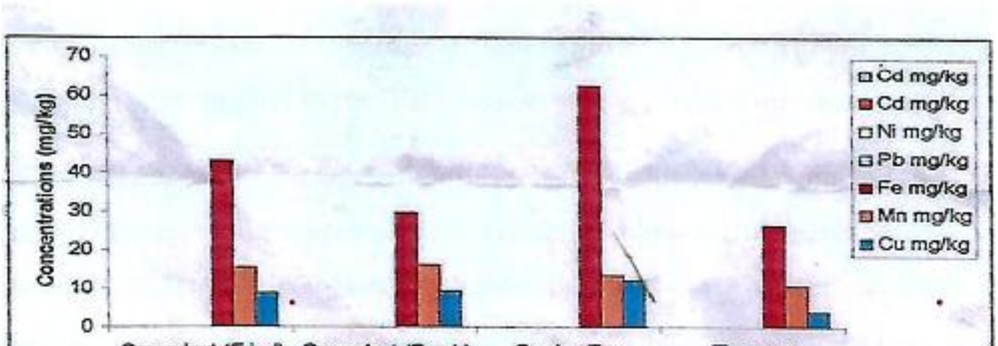

Fig. 3. Variations of heavy metals concentrations in the samples.

Groundnut

The crude protein content of fried groundnut (32.81 %) was higher than that in fresh groundnut (28.62 %) which agrees with the values (19.7% - 31.3 %) reported by Musa *et al.* (2010) in their study on the proximate composition of selected groundnut varieties. The result confirmed that groundnut is rich in its protein content which makes it suitable for consumption and also helps in body development such as repair of worn-out tissues (Ayoola *et al.,* 2012). Atasie *et. al.* (2009) in their analysis reported that the crude protein percentage decreases when the groundnut seeds are subjected to heat treatment.

The carbohydrate value in fresh groundnut (12.13 %) was less than that in fried groundnut (13.92 %). This observation agrees with the values (25.30 % -26.50 %) reported by Ayoola *et. al.* (2012) in their study on the chemical evaluation of food value of groundnut; which makes it a suitable source of nutrient.

The moisture content of fried groundnut (1.60 %) was less than that in the fresh groundnut (5.3 %). This observation is in line with the values (1.07%-7.48 %) reported by Ayoola *et. al.* (2012) in their study on the chemical evaluation of food value of groundnut. This makes its shelf-life to be long and contributes to the stability of groundnut to prevent rancidity of the oil (Ayoola *et. al.*, 2012).

The lipid content of fried groundnut (48.0 %) was higher than that in fresh groundnut (47.05 %), which agrees with the values (40.60 % - 46.10 %) reported by Ayoola *et. al.* (2012). This makes it a suitable source of nutrient that can improve the energy density of man and promote fat soluble vitamin absorption (Atasie *et. al.,* 2009).

The crude fibre of fried groundnut (2.11 %) was less than that of fresh groundnut (3.245 %). This is in agreement with the values (2.91 %-3.09 %) recorded by Bhanu *et al.* (2013) in their study on the comparative physico-chemical, proximate and mineral analysis on raw and roasted groundnut. Crude fibre indicates the ability of groundnut to maintain internal extension for normal peristaltic movement of the intestinal tract and aids digestibility in humans (Atasie *et. al.,* 2009). Diets low in fibre are undesirable as they could cause constipation and such diets have been associated with diseases of colon like piles, appendicitis and cancer (Bhanu *et. al.,* 2013).

The ash content in the samples was found to be 2.484 % in fried groundnut and 2.05 % in fresh groundnut. According to Pomeranz and Clifto (1981), ash content of seeds should be in the range of 1.5 - 3.5 % for suitable consumption. Thus, the value obtained in this study falls within this range and is therefore suitable for consumption.

The fried groundnut is a rich source of protein and lipid with moderate amount of carbohydrate than the fresh groundnut. t-test showed no significant difference (P>0.05) between the proximate values of fried and fresh groundnuts. t-Test showed no significant difference (P>0.05) between the proximate values for groundnut(fresh and fried) and garden egg. t-test showed no significant difference (P>0.05) between proximate values for fried groundnut and tiger nut.

Garden Egg (*Solanum aethiopicum L.*)

The results of proximate analysis of *Solanum aethiopicum L.* fruit (garden egg) showed moisture content value of 86.36 % which is in line with the value of 85.58 % reported by Sam *et. al*. (2012). The moisture of any food is an index of its water activity and is used as a measure of stability and susceptibility to microbial contamination (Haruna *et. al.*, 2016). This indicates that the fruit has a short shelf-life due to its high moisture content and also the reason why it is classified as a perishable food (Haruna *et. al.*, 2016). The high moisture content also makes the eggplant to be of high nutritional value to people suffering from dehydration (Elleta *et. al.,* 2017).

The protein content (4.38 %) obtained in the *Solanum aethiopicum L* fruit, is similar to an earlier report 4.58±0.40 % by Agoreyo *et. al.* (2012). This result indicates that *Solanum aethiopicum* fruit was not very high in its protein content. Also, Plant foods that provide more than 12% of its caloric value from protein are considered to be a good source of protein. The low level of protein obtained in this study implies that the *Solanum aethiipicum* fruit is not considered to be a good source of protein.

The ash content of the *Solanum aethiopicum* fruit obtained in this study was 0.551 % which is slightly below the value 0.73±0.03 % reported by Elleta *et. al.* (2017). The ash content which represents the total amount of minerals present makes the fruit a good source of mineral and an essential element for proper functioning of tissues and act as second messenger in some biochemical cascade mechanism (Agoreyo *et. al.*, 2012).

The carbohydrate content (7.04 %) obtained in *Solanurn. aethiopicum* fruit was lower than the value (11.77±1.55 %) reported by Agoreyo *et. al.* (2012). Low carbohydrate and glucose levels make the *Solanum. aethiopicum* fruit useful for weight loss and diabetics (Elleta *et. al.*, 2017).

The level of Lipid, 1.56 % in this study was low, which agreed with the value (1.65±0.62 %) reported by Agoreyo *et. al.* (2012). Generally, eggplants have been reported to reduce LDL/HDL ratio and increase HDL/LDL ratio in hypercholesterolemic rabbits (Igwe *et. al.* 2013). They are ideal fruits for individuals with increased serum lipid levels, high blood pressure and other ischemic heart diseases (Igwe *et. al*.. 2013).

The crude fibre content of Solanum. aethiopicum fruit (0.10 %) was less than the value (1.78±0.13 %) reported by Agorevo *et. al*. (2012). Consumption of fruit with high crude fibre content may contribute to a reduction in the incidence of certain diseases like colon cancer, coronary heart diseases, diabetes, high blood pressure, obesity and other digestive disorders (Agoreyo *et. al*., 2012). Increased crude fibre consumption also increase fecal bulk and rate of intestinal transit and have prebiotic effects (Igboh *et. al*., 2009). The crude fibre value obtained in this study satisfies these requirements.

In general, garden egg contains high moisture content with low amount of carbohydrate, protein, ash, lipid and fibre.

Tiger Nut

The results showed moisture content (50.50 %), ash (1.05 %), carbohydrate (22.70 %), protein (10.94 %), lipid (12.97 %) and fibre (18.4 %).

The moisture content (50.50 %) obtained in tiger nut was higher than the value (43.84 %) reported by (Ogunlade *et. al.*, 2015) in their study on the chemical compositions, antioxidant capacity of tiger nut. This disparity could be due to climate conditions.

The ash content value of 1.05 % confirms to the value 1.25 - 1.85 % reported by Imam *et. al.* (2013). Thus, it is a suitable source of nutrients for consumers.

The lipid content value of 12.97 % was lower than the value 24.8 ± 0.06 % recorded by Samson and Safiya (2013) in their study on the assessment of the nutritional and antinutritional components of tiger nut residues and higher than the value 7.40±0.0.55 % reported by Imam *et. al.* (2013). This disparity could be due to difference in varieties and climate conditions.

The fibre content in the sample was found to be (18.4 %), which agrees with the value (18.4±0.77 %) recorded by Samson and Safiya (2013). The high fibre content makes it suitable for consumption to some pathologic stages i.e diabetic mellitus, obesity and coronary heart disease (Adejuyitan *et. al.*, 2009; Chukwuma *et al*., 2010).

The carbohydrate content of tiger nut (22.70 %) was lower than the value (30.58 %) reported by Ogundale *et. al.* (2015) for fresh tiger nut tuber. The high carbohydrate content reveals that tiger nut is a good source of energy and the residue can be used as a good source of feed formulation in animal production (Samson and Safiya, 2013).

The protein value in tiger nut (10.94 %) was higher than the value (9.70 %) reported by Gambo *et. al.* (2014) in their study on the composition, products, uses and health benefits of tiger nut. In general, tiger nut is a rich source of fibre, moisture and carbohydrate.

The nutrient values in the samples followed the trend: Tiger nut >Fried groundnut
>Fresh groundnut >Garden egg.

Heavy Metals

The importance of minerals in consumable food plants cannot be over emphasized. The heavy metals form an essential part of enzyme necessary for immune competence.

Tiger Nut

The mean concentrations of Iron (26.675+0.021 mg/kg) and Manganese (10.625±0.008 mg/kg) were found to be below and within the permissible limits (40-500 mg/kg) and (50-1000 mg/kg) respectively RSMENR (2002). Iron is required for blood formulation and its deficiency can cause nutritional disorder. It is vital in the formation of Hemoglobin and myoglobin, which function in oxygen-transport. Manganese is part of the enzyme involved in urea formation, pyruvate metabolism and the galactotransferase of connective tissue biosynthesis (Chandra and Govind, 1994). Copper concentration was above the permissible limit (0.20 mg/kg) reported by FAQ (1985) and are toxic to consumers when present at higher concentration.

Garden Egg

The concentrations of Fe (62.330+0.0120 mg/kg) was found to be within limit (40-500 mg/kg) and Mn (13.375+0.013 mg/kg) below limit (50-1000 mg/kg) reported by RSMENR (2002). The concentration of Cu (11.925±0.210 mg/kg) was above the limit reported by FAQ (1985). Toxic metals such as (Cr, Cd, Pb and Ni) were not detected in the sample, being below the detection limit (0.001 mg/kg) of the method.

Groundnut

The concentration of Fe in fried groundnut was (43.125+0.303 mg/kg) which is within the permissible limit (40-500 mg/kg) reported by RSMENR (2002), but that of fresh groundnut, 29.700+0012 mg/kg was below the permissible limit (40- 500 mg/kg) reported by RSMENR (2002) and therefore not harmful for consumption.

Concentrations of manganese in fresh and fried groundnut were 16.200+0.052mg/kg and 15.500±0.342 mg/kg respectively, and are below permissible limits (50-1000 mg/kg) reported by RSMENR (2002). The concentration of copper for both fresh and fried groundnut 92.00±0.043 mg/kg and 8.725+0.011 mg/kg respectively, were above the permissible limit by FAQ (1985) and can be harmful to consumers. Toxic metals such as Cr, Cd, Ni and Pb were not detected in the samples. The presence of metals such as (Fe and Mn) in both fresh and fried groundnut shows the ability to retain its nutrient contents regardless of its state (fresh or fried) and can be used as supplements for malnutrition problems.

The trend of the metals followed the order: Fe >Mn > Cu in all the samples. The concentration of Fe in the samples followed the trend: Garden egg > Fried groundnut> Fresh groundnut> Tiger nut. The concentration of Mn followed the trend: Fresh groundnut > Fried groundnut > Garden egg > Tiger nut. The concentration of Cu followed the trend: Garden egg > Fresh groundnut> Fried groundnut> Tiger nut. Tiger nut contained least concentrations of the metals.

The concentrations of the metals in the samples varied. However, t-test showed significant difference ($P<0.05$) between Fe concentration in fried and fresh groundnut. Similarly, t-test showed no significant difference ($P>0.05$) between Fe concentration in fresh groundnut and garden egg.

Iron, manganese and copper are essential trace elements needed in humans to survive; diets low in these metals may cause a deficiency. Likewise, an overdose of supplements containing these metals causes severe poisoning (www.health.state.mn.us., www.lenntech.com and www.healthline.com).

IV. CONCLUSION

From the results obtained in this study, it was concluded that the samples under study are only contaminated and not polluted with respect to iron and manganese which were within and below permissible limit respectively. The concentrations of copper were found to exceed limit and therefore pose health concern to consumers. Also Groundnut is a rich source of protein and lipid with moderate amount of carbohydrate, tiger nut is a rich source of fibre, moisture and carbohydrate, while garden egg contains high moisture content with low amount of carbohydrate, protein, ash, lipid and fibre.

REFERENCES

[1]. A.O.A.C. (2003). Official Method of analysis. 15th edn, Association of Official Analytical Chemist, Benjamin Franklin Station, Washington D.C., U.S.A. pp 200-210.

[2]. Adejuyitan J. A., Otunola E. T., Akande E.A., Bolarinwa I.F, and Oladokun F. M. (2009). Some Physicochemical Properties of flour obtained fermentation of tiger nut sourced from a market in Ogbomoso, Nigeria. Aft I Fd. Sci.3: 51-55.

[3]. Agoreyo, B.O., Obansa, E.S., and Obanor, E.O. (2012). Comparative Nutritional and Phytochemical Analysis of two Varieties of Solanum melongena. Sci. worldJ. 7:5-8.

[4]. Anderson, K. J. and Gobielle, A. (2001). Walnut polyphenol inhibits in vitro human plasma low density lipoprotein (LDL) oxidation. J. Nutri. 131:2837-2844.

[5]. Anyasor, G.N., Ogunwenmo, K.O., Oyelana, O.A., Ajayi, D and Dangana J. (2009). Chemical Analysis of Groundnut (Arachis hypogaeaL.) oil. Park. I Nutri. 8(3):269-272.

[6]. Atasie, M.N., Akinhanmi, T.F., and Ojiodu, C.C., (2009). Proximate Analysis and Physico-chemical properties of Groundnut (Arachis hypogaea L.), Pak. I Nutri. 8: 194-197.

[7]. Bada, S. O. (1997). Preliminary Information on the ecology of Chrosophyllumalbidun G. Don is Work and central African proceeding of National workshop on the potentials of star Apple in Nigeria, Pp 16.25.

[8]. Bello, S.O., Muhammed, B.Y., Gammaniel, K.S., Abdu, A.I.. Ahmed, H., and Njoku, C.H (2005). Preliminary Evaluation of the Toxicity and some Pharmacological properties of the aqueous crude extract of Solanum melongena. *Res. J. Agri. Bio. Sci.* 1(1):1-9.

[9]. Bhanu, S.K., Sadagopan, R.S., Raguru, P.V., Kalapati, M.V., and Mabbu, P., (2013). Comparative Physiochemical, Proximate and Mineral analysis on raw and roasted seeds of groundnut. Comm. Fl. Sci. 3(3-4): 25-29.

[10]. Chandra R. and Govind S. (1994). Effect of urea and ethrel on growth, flowering and fruiting in guava under intensive planting system. *Indian Journal of Horticulture.* 51 (4) 340 – 345.

[11]. Chukwuma E.R; Obioma N; and Cristopher 0. (2010). The phytochemical composition and some biochemical effects of Nigeria tiger nut (cyperus esculentus L.) tuber. Pak. I Nutri. 9 (7):709-15.

[12]. Elleta, O. A. A., Orimolade, B.O., Olujwaniyi, O.O., and Dosumu, O.O. (2017). Evaluation of Proximate and Antioxidant Activities of Ethiopian Eggplant (*Solanum aethiopicum L.*) and Gboma Eggplant (*Solanum mccrocarpon L.*). Int. Appi. Sci. Environ. Manage. Vol.21(5):967-972.

[13]. FAQ, (1985). Water quality for irrigation for agriculture. Irrigation Drainage paper 29:1-130.

[14]. Gambo, A. and Da'u, A. (2014). Tiger nut (Cyperus esculentus): Composition, Products, Uses and Health benefits. Bayero I Fur Appi. Sci. 7(1): 56-61.

[15]. Haruna, S.S., Ahmed, O., and Abdullahi, S.K., (2016). Phytochemical, Proximate and Mineral Analyses of Solanum incanum fruit. Intl. J. Chem. Materi. Environ. Res. 3(1): 8-13.

[16]. Igboh M.N., Ikewuchi, C.J., and Ikewuchi, C.C. (2009). Chemical profile of Chormolaena odoratal. Pak. I Nutri. 8(5):521-524.

[17]. Igwe, S.A., Akunyili, D.N, and Ogbogu, C. (2013). Effects Solanum melongena on some Visual Functions of Visually active igbos of Nigeria. I Ethnopharmacol. 86:135-138.

[18]. Imam, T. S., Aliyu, F. G. and Umar. H.F. (2013). Preliminary phytochemical screening, elemental and proximate composition of two varieties of Cyperus esculentus. L. Nigeria. I Appi. Sci. 21(4) 247-251.

[19]. Lawhorn, T. and Carter U. (1971). The International Diary Food Association: Microbiological and Nutritional foods from meat, fish and diary products. Pp 30-32.

[20]. Mandal, S. and Mandal, A. (2013). Nutritional Profile of *Arachis hypogaea, L.* 1st International Conference on: Recent Advances in Chemical Sciences (ICRACS- 2013), Arya PG College, Panipth, Haryana.

[21]. Musa, A.K., Kalejaiye, D.M., Ismaila, I.E and Oyerinde, A.A. (2010). Proximate Composition of Selected Groundnut Varieties and their Susceptibility to Trogodermagranarium everts attack. I Stor Prod. Postharvest. 1:13-17.

[22]. Ogunlade, I., Adeyemi B. A., & Aluko O. G. (2015).Chemical compositions, antioxidant capacity of tigernut (cyperus esculentus) and potential health benefits. *European Scientific Journal*, Special edition. 217-224.

[23]. Ory, R. L. and Henningsen, K. W. (1969). Enzymes associated with protein bodies isolated from ungerminated barley seeds. Plant Physiol. 44: 1488- 1498.

[24]. Osagie, A.U., Okoye, W.I., Oluwayose, B.O and Dawodu, O.A (1986). Chemical quality parameters and fatty acid position of oils of underexploited tropical seeds. Nig. I Appi. Sd.; 4:151-162.

[25]. Pomeranz, Y and Clifto, D. (1981). FoodAnalysis Theory and Practices In: Melon EE (ed) Chemical Food Analysis Practical Manual Chemistry. Avi Publishing Company, Westport, C.T

[26]. RSMENR (2002). (Rivers State Ministry of Environment and Natural Resources) Interim Guidelines and Standards on Environmental Pollution Control and Management in Rivers State.

[27]. Sam, S.M., Udosen, I.R., and Mensah, S.I., (2012). Determination of Proximate, Minerals, Vitamin and Anti-nutrient composition of *Solanum verbascjfolium L.* mt. I Adv. Res. Tech. Vol.1(2): ISSN. 2278-7763.

[28]. Samson, B.W., and Safiya, S., (2013). Assessment on Nutritional and Anti- nutritional Components of Tiger Nut Residues. mt. I Sci. Res. (IJSR). Vol. 4(6): 342-344.

[29]. Umerie, S.C., Okafor, E.P. and Uka, A. J. (1997). Evaluation of Tubers and Oil of Tiger Nuts. Biores. Tech. 61: 171-173.

[30]. www. health line, corn www.health . state.mn .us www.lenntech .com

[31]. Ayoola, P.B. and Adeyeye, A. and Onawumi, O.O. (2012). Chemical evaluation of food value of groundnut (Arachi hypogaea) seeds. *American Journal of Food and Nutrition*, 2 (3). pp. 55-57.