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Physicochemical and Nutritional Parameters in Palm Wine from Oilpalm Tree (*Elaies guineensis*) and Raffia Palm (*Raphia hookeri*) in South-South Nigeria

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Abstract The levels of proximate and physicochemical parameters in raffia and palm tree wine were assessed using standard methods such as cleg anthrone for carbohydrate, Kjeldahl method for protein, soxthlet extraction for lipid, Air oven for moisture, furnace for Ash and Atomic Absorption Spectrophotometer and Flame Atomic Absorption Spectrometer for the minerals The results in Raffia wine the results showed mean levels of 95.77± 1.45% moisture, 0.12±0.10% Ash, 3.61± 3.03% carbohydrate, 0.21± 0.03% protein, 0.11±0% lipid, 0% fibre, 1.56± 0.02mg/kg P, 2.252± 1.13mg/kg Mn, 15.544±6.13mg/kg Mg, 0.72±0.27mg/kg Zn, 48.60±23.1mg/kg Na, 6.458± 2.79mg/kg Fe, 6.184±2.69mg/kg Ca, 349.714± 66.85mg/kg K, 400.00± 65mg/kg Cl, 0.434± 0.22mg/kg Cu, 0mg/kg Cr, 4.10±0.01pH and 1.09± 0.01g/l Density. The results in Palm tree wine the results showed mean levels of 92.87±1.43% moisture, 0.33±0.08% Ash, 9.67± 3.10% carbohydrate, 0.28± 0.04% protein, 0.11±0.02% lipid, 0% fibre, 1.590±0.01mg/kg P, 0mg/kg Mn, 3.293±6.10mg/kg Mg, 0.174±0.25mg/kg Zn, 1.396±23.6mg/kg Na, 0.872±2.68mg/kg Fe, 0.798±2.56mg/kg Ca, 349.714± 66.85mg/kg K, 216.016±66,48mg/kg Cl, 270.00±63mg/kg Cu, 0mg/kg Cr, 4.10±0.01pH and 1.11± 0.01g/l Density. Palm tree wine had higher contents in the proximate analysis than the raffia wine but the reverse was the case in the mineral values. Palm wine from both raffia and palm tree is acidic The mean levels of the parameters measured in the Raffia and Palm tree wines showed highly significant correlation ($r = 0.9899$). t-test between their means showed significant difference ($p<0.05$). It is recommended that both palm wine should be consumed with great care depending on the health demand of individuals.

Keywords Raffia palm, Palm wine, Palm tree, Tombo, Proximate analysis

Introduction

Palm wine is an alcoholic beverage produced from the fermented sap of palm trees. It is a sweet locally brewed beverage with moderate sugar content of about 10-12%, mainly sucrose. Palm wine is a colourless clean liquid which has the ability to decrease sucrose content on conversion to alcohol.

Palm wine is mostly rooted in West Africa and other parts of the world where the species are found. The name given to this wine varies depending on the country of origin. In Asia, it is called Tody. In Latin America, it is known as Tuba and in Nigeria, it is referred to as Tombo [1].

Chandrasekhark *et al*. [2] reported that palm wine is the fermented sap of various palm trees, especially palmyra, silver date palm and coconut palms. Palm wine can be obtained from the young inflorescence either male or female ones. It is collected by tapping the top of the trunk by felling the palm tree and boring a hole into the trunk. It is a

cloudy whitish beverage with a sweet alcoholic taste and very short shelf life of only one day. The wine is consumed in variety of flavours varying from sweet unfermented to sour fermented and vinegary.

In West Africa, palm wine serves a variety of purposes ranging from traditional naming and marriage ceremonies, child dedications, medicine in the cure of low sperm count and poor sight, energy production, traditional incantation and acting as catalyst for extraction of juice from herbs and roots for medical application.

Interestingly, both government and health professionals have recognized the health benefit of palm wine in the treatment of malnutrition and vitamin deficient diseases. Palm wine is known for its oxidant nature, it is rich in trace elements essential for growth and development as well as general wellbeing of the body especially in lactating women.

Palm wine yeast is capable of degrading hydrocarbon in kerosene and diesel (oil spills). Confirmatory evidence was derived from gas chromatography analysis. It is used in oil spill clean up as well as in single cell protein production using hydrocarbon feed stocks [3].

Palm sap is the white, semi-translucent, sugary sap obtained by trapping the stalk of the immature inflorescent of palm trees, the upper stem or by tapping the felled trees. The principal sap bearing palms are *Borassus spp, Phoenix sylvestris, Phoenix dactylifera* (date palm), *Caryota urens*, *Arenga pinnata*, *Juboea spectabilis* (Chilean molasses palm), *Raphia spp* (raffia palms), *Cocos nucifera* (coconut palm) and *Elaeis guineensis* (African oil palm) [4]. Obahiagbon [5] reported that *Raffia* palm is among the eleven indigenous genera of the palms found in Nigeira. The palms include: *Borassus, Elaeis, Hyphaene, Phoenix, Raphia, Ancistrophyllum, Calamus, Eremospatha, Oncocalamus, Podococcus, Sclerosperma*.

In the tropics palm sap is drunk as such (fresh or pasteurized and bottled), evaporated for palm syrup and sugar or fermented to alcohol and vinegar. Palm sap is also aq source of yeast for bread making.

Fred *et. al*. [6] reported that the palm syrup from both sources were rich in carbohydrates and potassium and modest amounts of calcium and iron. They added that the syrup from both sources have potential for utilization as nutritious food ingredient. Raffia palm wine is used in almost all African tribes in particular during births, traditional rites, weddings, funerals. It is used in the treatment of venereal diseases, measles, and typhoid and is a significant contribution in the treatment of impotence. It is used in milk production in lactating women [7-8] and rich in sugars, proteins, carbohydrate, alcohol, minerals, vitamins and some micro-organisms [9-11].

Like other alcoholic beverages, these wines (fresh) can only be preserved for 24 hours after which they sour (fermentation begins), which is not too attractive to consumers [12-13].

This research is therefore purely based on the assessment of nutritional and mineral values of palm wine from oil palm tree (*Elaies Guineensis*) and raffia palm (*Raphia Hookeri*) consumed in Ogoniland in Rivers State, Nigeria.

Materials and Methods

Study Area

Samples were collected from Palm wine tapped from Raffia Palm at Yeghe in Ghokana local Government Area and Oil Palm Tree at Kpong in Khana local Government Area all in Ogoni land of Rivers State. The sampling areas lie between Longitude 4° 70′ 31.04″ N and Latitude 7° 34′ 67.15″ E. The area has mean annual rainfall of 2438.4mm, mean temperature of 28.2°C. The areas have soils of the mangrove swamp forest (Tidal flats) dominated by *raffia hookeri* vegetation [14].

Moisture (Air Oven Method)

Weigh 1g of sample into a clean dried porcelain evaporating dish. The porcelain dish with the sample was placed in an oven to maintain a temperature of 105^0C for six hours. The dish was brought out and allowed to cool at room temperature and was reweighed heating and weighing were done until a constant weight was obtained. The moisture content was calculated using the formula below.

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

Ash (By Furnace Method)

Measure 100ml of sample into an evaporating porcelain crucible. The crucible was inserted into a muffle furnace with temperature of 630^0C for six hours because of the volume and sugar base. The crucible was brought out and allowed to cool and the weight at that point was taking. Calculate the Ash value as follows:

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

Carbohydrate (By Cleg Anthrone Method)

This method is also known as the hydrolysis of sugar. 0.1ml of sample was measured into a clean volumetric flask, 1ml of distilled water was added and 1.3ml 62% perchloric acid was added and shaking for a period of 20mins for acid hydrolysis to take place and monosaccharide liberated to polysaccharide. Distilled water was then added to mark up to the mark, shaken and then allowed to stand for homogeneity.

Pipette 0.1ml of the prepared solution from the volumetric flask into a clean test tube. 0.9ml distilled water was added to the test tube to make up to 1ml. This was labeled as **Sample**

Glucose.

A standard glucose concentration was prepared by dissolving 0.1g analytical glucose into 100ml distilled water, 10ml of glucose solution was taken into a volumetric flask and made up to100ml with distilled water. This was labeled as **Working Glucose.**

Then 1ml of the working glucose solution was pipette into a test tube and labeled **Standard glucose.**

Measure 1ml of distilled water into a clean test tube and label **Blank Test.**

Add 5ml of Anthrone reagent to all the solutions prepared. All solution turned greenish except the blank. The absorbance of the solution was and read recorded using a spectrophotometer at 620nm, the blank was used to calibrate the equipment.

The formula below was used for the calculation.

$$\% \text{ Carbohydrate as glucose} = \frac{25 \text{ x absorbance of sample}}{\text{Absorbance of standard glucos} \times 1}$$

Protein (By Kjeldahl Method)

Proximate analysis for protein undergoes three stages.

1) **Digestion**

Pipette 5ml of test sample into a conical flask that the weight was zero on an analytical balance to get 1g of sample. 20ml concentrated sulphuric acid was added which turns solution black. The black solution was heated in a fume cupboard until it turned sky blue, allowed to cool and was carefully made up to 100ml with distilled water.

2) **Distillation**

The distillation apparatus was set up for distillation, 20ml of diluted digest into the conical flask, 20ml of boric acid was added in the receiver beaker and 2 drops of indicator was added. Caustic soda was injected into it until the color of the digest turns alkaline (dirty brown), the solution was heated while water was allowed to run through the Liebig condenser to cool the pressure. Since protein is made of ammonia, ammonia sulphate is liberated and ionization takes place, as ammonia distillate was introduced in to the boric acid, the color of the boric acid changes from purple to greenish.

3) **Titration**

The distillate was titrated with standard 0.1N hydrochloric acid solution until colour changed from green to purple. The volume of hydrochloric acid added to effect this change was recorded as titer value.

Below is the formula used.

$$\% \text{ Organic Nitrogen} = \frac{\text{titer value} \times 1.4 \times 100 \times 100}{1000 \times 20 \times 0.1}$$

where:

Titer value = The volume of HCl used in titrating the ammonium distillate (0.25cm)

1.4 = Nitrogen equivalent to the normality of HCl used in the titration 0.1M.

100 = The total volume of digest dilution.

100 = Percentage factor
1000 = Conversion factor from gram to milligram.
20 = Integral volume of digest analyzed or distilled.
0.1 = The weight of sample in gram digested

Lipid (By Soxhlet Extraction Method)

Insert 2g of sample into a filter paper and was placed into a soxhlet extractor, which was then 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 refluxed as a result. The lipid in the solvent chamber was extracted in the process of continuous refluxing. When the lipid was observably completely extracted from the sample under test, the condenser and the extractor wer disconnected and the solvent was evaporated to concentrate the lipid. The flask was then dried in the air oven to constant weight and re-weighed to obtain the weight of lipid. The formula below is used for the calculation.

$$\% \text{ Lipid} = \frac{\text{Weight of flask and extraction} - \text{weight of empty flask}}{\text{weight of sample extracted.}} \times \frac{100}{1}$$

Fibre (By Acid And Alkaline Hydrolysis)

Measure 10ml of test sample into a digestion flask, 25ml of 1.25% of sulphoric acid was added and heated for 30 minutes under reflux, filter through fibre filter paper, then wash with distilled water and digest again, the residue with 25ml of 1.25% NaOH solution in the same time and treatment as with time and filter after 30 minutes digestion and washed with distilled ethanol until there is no trace of alkaline in the water after filtration. The residue was introduced into a clean dried crucible and was dried at 105^0C to a constant weight. The dried residue was heated in the furnace at the temperature of 630^0C for three hours.

Mineral Values

The mineral values of these parameters listed below were analyzed using two methods.

i. Atomic Absorption spectrophotometer (AAS).
ii. Flame Atomic Absorption spectrometer (FAAS).

i) The following minerals were analyzed using the AAS: Manganese, Zinc, Iron, Chlorine, Copper and Phosphorus.
ii) The minerals that were analyzed by FAAS are: Chromium, Magnesium, Sodium, Calcium and Potassium.

Method

Sample was digested as was described and the solution was made up to 50ml with distilled water.
Different Wavelengths were selected for different minerals, air and gas pressure was adjusted. Slit width and other vital settings employed were programmed and regulate.
Equipment was calibrated by aspirating standard graph of these minerals one after the other and was plotted and then sample solution was aspirated into the Atomic Absorption Spectrophotometer chamber. The concentration of the minerals was determined, the aspirator tubing was occasionally flushed with distilled water.

Results and Discussion

The results of physicochemical parameters and nutrient values measured in the local wine samples are presented in Tables 1 – 2 and Figs. 1 – 4.

Table 1: Percentage of Proximate Content in Palm Wine Samples

S/N	Parameters	Raffia wine (%)	Palm Tree wine (%)
1	Moisture	95.77± 1.45	92.87±1.43
2	Ash	0.12±0.10	0.33±0.08
3	Carbohydrate	3.61± 3.03	9.67± 3.10
4	Protein	0.21± 0.03	0.28± 0.04
5	Lipid	0.11±0	0.11±0.02
6	Fibre	0± 0	0±0

Table 2: Concentrations of Physicochemical Parameters in Palm Wine Samples

S/N	Parameters	Wavelength(nm)	Raffia wine	Palm Tree wine
1	P (mg/kg)	229	1.56± 0.02	1.590±0.01
2	Mn (mg/kg)	279	2.252± 1.13	0±0
3	Mg (mg/kg)	285.2	15.544± 6.13	3.293±6.10
4	Zn (mg/kg)	213.8	0.72±0.27	0.174±0.25
5	Na (mg/kg)	589	48.60±23.1	1.396±23.6
6	Fe (mg/kg)	248.3	6.458± 2.79	0.872±2.68
7	Ca (mg/kg)	422.7	6.184±2.69	0.798±2.56
8	K (mg/kg)	766	349.714± 66.85	216.016±66,48
9	Cl (mg/kg)	359.8	400.00± 65	270.00±63
10	Cu (mg/kg)	292.2	0.434± 0.22	0±0
11	Cr (mg/kg)	357.9	0± 0	0±0
12	pH	-	4.10±0.01	4.10±0.01
13	Density (g/l)	-	1.09± 0.01	1.11±0.01

In Table 1 the mean moisture content of the raffia wine in this study was 95.774± 1.45%, while that of palm wine was 92.87±1.43%. Mintah *et al*., [13] reported that the moisture content of these wines determines the shelf life of the sap. The higher the moisture content of a sap, the shorter the shelf-life, thus moisture content is an important measure of sap quality. The reduced water content in palm tree wine (Fig. 4) could be as a result of substrate (palm tree) degradation such as conversion of ethanol to sugar as reported by Matthew *et al* [15]. The lower water content of Palm wine indicates that Palm wine has a longer shelf-life than raffia wine.

The higher Ash content of the palm tree wine (0.33%) shows that it has high sugar level than raffia palm wine (0.120%).

Carbohydrate content of palm tree wine (9.67%) was higher than that of raffia palm wine (3.61%). The difference between both wines indicates the higher sugar content in palm tree wine than raffia palm wine. The carbohydrate content of palm wine is simple sugar which is used up by microorganisms during substrate degradation [15].

The protein level of palm tree wine (0.28%) is also higher than that in the raffia palm wine, (0.21%), which indicates that palm tree wine is richer in protein than raffia palm wine.

The lipid similar contents of palm tree wine and raffia palm wine (0.11%) indicates that both wines are of same strength in lipid content.

Table 2 and Figs. 1 – 3 show the levels and comparison of the physicochemical parameters. The pH of both wines was same, 4.1 indicating that fresh palm wine is acidic and therefore could pose health concern. Palm tree wine was slightly more dense (1.11g/l) than raffia palm wine (1.09g/l). In this study Chromium was generally not found in both wines while Mn and Cu were not found Palm tree wine. With the exception of Phosphorus, the levels of all the mineral elements (chemical parameters) measured in the raffia palm wine were higher than those in the palm tree wine. This observation could mean that the palm wine from raffia is of higher quality than that of palm tree. On the contrary, the higher levels of heavy metals such as Mn, Mg, Zn and Fe as well as the high concentrations of Na, K and Cl could be sources of health concern.

The mean levels of the parameters measured in the Raffia and Palm tree wines showed highly significant correlation ($r = 0.9899$). t-test between their means showed significant difference ($p<0.05$). This shows similar source of the parameters. In particular the mean levels of Mn, Mg, Na, Fe, Ca, K, Cl, Cu and moisture showed significant difference ($p<0.05$) while the mean levels of P, Zn, Cr, pH, Density, Ash, Carbohydrate, Protein, Lipid and Fibre showed no significant difference ($p>0.05$).

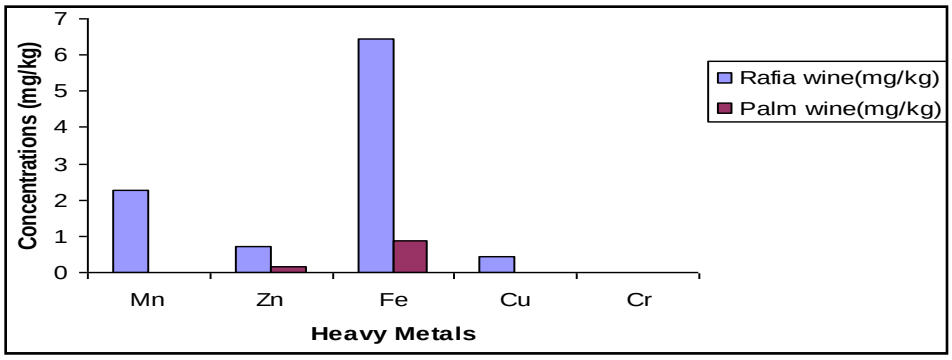

Figure 1: Concentration of Heavy Metals in Rafia and Palm Tree wines

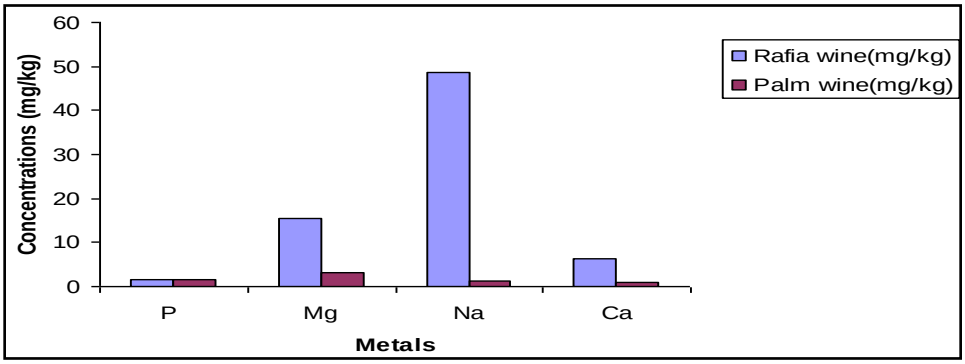

Figure 2: Variations in Concentrations of Metals in Rafia and Palm Tree wines

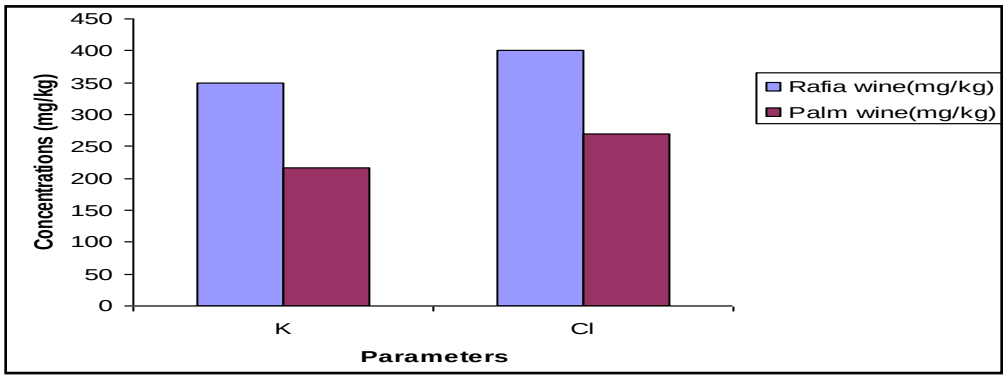

Figure 3: Variations in Concentrations of Potassium and Chlorine in Rafia and Palm Tree wines

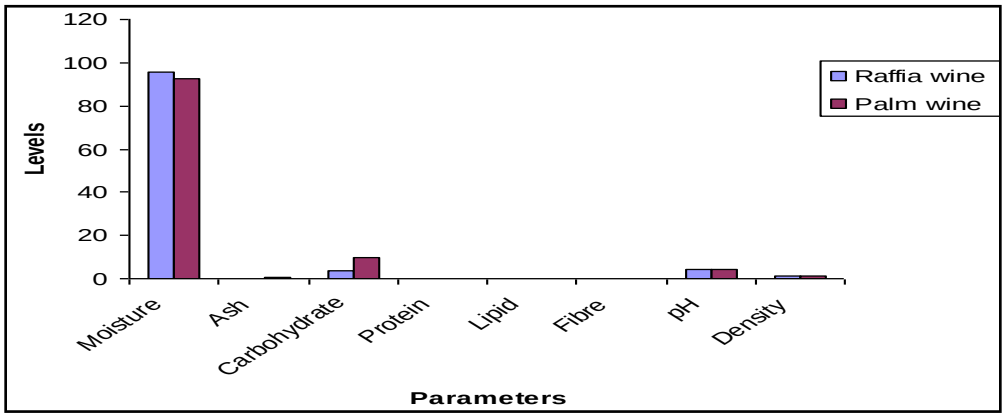

Figure 4: Variations in Levels of Parameters in Rafia and Palm Tree wines

Conclusion and Recommendation

This study has shown that palm wine from both raffia and palm tree is acidic and contain nutrients such as: carbohydrate, moisture, lipid, protein, ash and some minerals such as phosphorus, manganese, magnesium, magnesium, zinc, sodium, iron, calcium, potassium, chloride and copper. Also palm tree wine is higher in proximate values than the raffia palm wine while raffia palm wine is higher in mineral values than palm tree wine.

It is recommended that both palm wine should be consumed with great care depending on the health demand of individuals. Also further study should be carried out to ascertain the levels of the parameters in fresh and fermented palm wine from both raffia palm and palm tree as well as the species of palm tree.

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