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Evaluation of the Proximate properties of the Seed and Physicochemical properties of the Oil of Chinese Fan Palm (*Livistona chinensis*)

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ABSTRACT
The oil of the raw seeds of *Livistona chinensis* (Chinese fan palm) was extracted and its physico-chemical properties evaluated. Also the proximate composition of the pulp, raw seed, blanched (4, 6, and 8 min), cooked (20, 40 and 60 min) and the roasted (110°C for 5, 10 and 15min) seeds were determined. The results obtained showed that the oil had a specific gravity (27°C) of 0.8638g/cm3, smoke point of 140 – 142°C, flash point of 239 – 243°C, iodine value of 35.307mg iodine/g oil, peroxide value of 13.98 MeqO2/kg oil, saponification value of 40.125mg KOH/g oil, free fatty acids value of 22.031% and acid value of 43.828mgKOH/g oil. The raw seed had very high crude fibre content (38.21%) and low carbohydrate content (17.82%). The protein maintained some relative stability and the content did not change significantly during blanching and cooking which could have been as a result of the fact that *L. chinensis* seed has a very hard and tough outer coat (shell) very similar to that of palm kernel shell and it was processed in its whole (unmilled) form which may not have allowed for easy heat transfer and leaching during blanching and cooking. The high free fatty acid value of the oil implies that refining would be required to make them suitable for edible purposes and may be better utilized for industrial purposes.

Key words: proximate composition**,** physico-chemical properties, refining, blanching, roasting

INTRODUCTION
Livistona chinensis commonly known as Chinese Fan palm or Chinese Fountain palm is of the family, Arecaceae (palm family) and belongs to the genus *Livistona* (Naoto *et al*., 2000). It is native to southern Japan, Taiwan and several Islands in the southern China Sea. It is a medium-sized, slow-growing, single-trunked palm tree that reaches about 15.2m tall in its natural habitat but often seen at much shorter heights of 3 – 8m (Forest, 2003). The leaf sheaths are fibrous, fluffy and brown-coloured somewhat like nests of birds. It has oval to round olive-like fruits that change from green to blue-black when ripe (Wagner *et al.*, 1999).

In most developing tropical countries, the food situation is worsening owing to increasing population, shortage of fertile land, high prices of available staples and restrictions on the importation of food (Nwosu, 2011). This has resulted in a high incidence of hunger and malnutrition, a situation in which children and women, especially pregnant and lactating women are most vulnerable (Potter and Hotchkiss, 1995; Nwosu, 2011). Prediction of future rates of population increase and food production emphasizes the seriousness of this problem (FAO, 1990). Okaka *et al.* (1992) and Nwosu (2011) noted that there isno single solution to the problem of food shortages and crisis. In essence, all information on new sources of food will be of value in the food security struggle.

As recommended by Okaka *et al.* (1992) and noted by Nwosu (2011) that although measures are being taken to boost food production by conventional agriculture, a lot of interest is currently being focused on the possibilities of exploiting the vast number of less familiar food plant resources. Many of such plants have been identified but lack of data on their chemical composition has limited the prospects for their broad utilization (Viano *et al.*, 1995). Most reports on some lesser-known and unconventional crops indicate that they could be good sources of nutrients and many have the potentials of broadening the present narrow food base for humans (Nwosu, 2011).

Livistona chinensis (Chinese Fan Palm) tree resembles that of *Cocos nucifera* (coconut), the cross-sectional profile of the seed also resembles that of coconut and both belong to the same family, Arecaceae (Genini *et al.*, 2009).
It is mainly planted for ornamental reasons (Juliana *et al.*, 2003). The seeds have been noted to be astringent, contain phenolic compounds and used traditionally by the Chinese as an anti-cancer agent (Juliana *et al.*, 2003; Gurpreet and Roman, 2008; Singh and Kaur, 2008; Tao *et al.*, 2009). But in areas where this plant is found in Nigeria, their seeds are left to waste after maturity. Also its sparing distribution, astringent nature, high phenolic compounds composition, lack of knowledge and documentation of its chemical composition has restricted its use to traditional medication rather than food.
Application of different processing methods to *Livistona chinensis* (Chinese Fan palm) seed, its seed oil properties' determination, proximate composition determination, and its toxicological evaluation will give some useful information,

which may increase the utilization of Chinese Fan palm seeds and enhance its potential in food formulations. It is envisaged that a more suitable process for the reduction or elimination of any detected anti-nutritional factors may be found for the production of safer Chinese Fan Palm seed products.

Despite the importance of the palm family, *Arecaceae*, and particularly *Livistona chinensis* which has been used traditionally by the Chinese as an anti-cancer agent (Singh and Kaur, 2008), little has been systematically documented about its utilization as food; the proximate composition and the physico-chemical properties of the oil.Furthermore, they are mainly planted for ornamental reasons (Corlett, 2005) and the fruits are not utilized as food but rather left to waste after maturity in many places they are found in Nigeria.

The fruit *of Livistona chinensis* has also been noted by many researchers (Gurpreet and Raman, 2008; Juliana *et al.*, 2003; Singh and Kaur, 2008; Fabiana *et al.*, 2006) to be astringent and contain phenolic compounds which could be part of the reason why it is not utilized as food. This research will seek to find answers to some of the problems of its utilization through appropriate processing.

MATERIALS AND METHODS

Source of raw material.

The fresh fruits of *Livistonia chinensis* was obtained from Amaigbo in Nwangele L.G.A of Imo State, Nigeria.

Equipment and chemicals used.

All equipments and chemicals used are available at National Root Crops Research Institute (NRCRI), Umudike and Federal University of Technology (FUTO), Owerri, Imo State.

Sample preparation.

The pulp of the fruit was removed manually with a knife. The separated seed was dried in an oven (Gallenkamp hot box oven) at 60^0C for 3h. The dried sample was milled and kept in airtight containers. From there, the samples for proximate composition analysis and oil extraction were taken. A completely randomized design and one-way analysis of variance (ANOVA) was used for the experiment.

Plate 1: *Livistona chinensis* (chinese fan palm) fruit.

Plate 2*: Livistona chinensis* (chinese fan palm) seeds

Oil extraction

The Chinese fan palm pulp was manually removed from the fruit and the seed was washed to remove dirt. The seed (2kg) was dried in the sun for 5h. The dried seed was milled and soaked in N-hexane for 24h. The milled and soaked seed was extracted of its oil using the continuous soxhlet extraction technique with an analytical grade N-hexane (boiling point rage 68 – 69^{0}C) for 8h and the N-hexane was recovered during the process. The yield of oil from 2kg of the seed was 54ml.

Blanching, cooking and roasting

Blanching and cooking were done by the procedures described by Nwosu (2011). The fruit was manually removed of its pulp and the seed was taken in its whole form (without milling) for blanching, cooking and roasting treatments. The seed was divided into Nine (9) batches (1, 2, 3, 4, 5, 6, 7, 8 and 9) of 300g each. Batches 1, 2 and 3 were given a hot water (100^{0}C) blanching treatment for 4, 6 and 8 minutes respectively. Batches 4, 5 and 6 were cooked for 20, 40 and 60min respectively. While batches 7, 8 and 9 were roasted at 110^{0}C for 5, 10 and 15min respectively). The samples were left to cool after the treatments. The blanched and cooked samples were dried (Gallenkamp hot box oven) at 60^{0}C for 3h to a moisture content of 35%. The Nine (9) processed batches were all milled, allowed to cool and stored in airtight containers. Samples were taken from the airtight containers for rat feeding (toxicity study), proximate composition and anti-nutritional factors determination.

Proximate analysis

The proximate analysis was carried out according to the methods outlined by the Association of Official Analytical Chemists (A.O.A.C, 1990)

Moisture content

Two grams of the dried ground sample was weighed into a crucible and placed in an oven at a controlled temperature of 105^{0}C. The sample was allowed to dry in the oven to a constant weight.

The percentage moisture content was then expressed as the percentage of the original weight of the sample. The experiment was carried out in triplicates the percentage moisture was thus calculated:

$$\text{Percentage moisture} = \frac{W2 - W3}{W2 - W1} \times 100$$

Where W1 = Mass of dried crucible

W2 = Mass of dry crucible+ Sample before drying

W3 = Mass of dry crucible + Sample after drying

Ash content

Two grams of the dried sample was measured into a crucible and placed in the muffle furnace at 550^{0}C until it was burnt to ash. The crucible and content were then allowed to cool in a desiccator and weighed. This was done repeatedly until a constant weight of the ash was obtained.

The percentage ash content was then expressed as percentage of the original weight of the sample on dry basis. The experiment was done in triplicates. Percentage ash content was thus calculated:

$$\% \text{ Ash} = \frac{W2 - W3}{W1} \times 100$$

Where W1 = Weight of sample analyzed

W2 = Weight of empty crucible

W3 = Weight of crucible + Ash

Crude fat content

Ten grams of the dried ground sample was weighed and wrapped with a clean filter paper and placed into the thimble in a soxhlet extractor. A round bottom flask was cleaned, weighed and 120ml of food grade hexane added. The flask was connected to the sample holder of the soxhlet extractor and heated slowly on a mantle for 6h. Refluxed hexane was recovered and the flask containing the lipid was dried in the moisture extractor in the oven at 60^{0}C for few minutes to remove any residual solvent. After drying, the flask containing the oil was cooled in a desiccator and reweighed.

By difference, the mass was determined and expressed as the percentage of the fat thus:

$$\text{Percentage (\%) Crude fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Crude fibre content

Two grams (2g) of the defatted dried sample was transferred into a 100ml flask, followed by addition of 200ml of 1.25% sulphuric acid. The flask was then placed in a digest apparatus on a pre-adjusted hot plate and boiled for 30min with rotation of the flask periodically to prevent solid from adhering to the bottom of the flask. At the end of 30min, the mixture was allowed to stand for one minute, and filtered immediately through the Buchner funnel lined with a muslin cloth. The insoluble matter was washed into the flask for alkali digestion using 0.3M sodium hydroxide. The digest was boiled for 30min and was allowed to cool for 1min and then filtered using a muslin cloth as before. The residue was then washed successively with 0.1MHCl and finally with boiling water until it was free of acid. It was then washed twice with alcohol and thrice with ether. The residue or insoluble matter was then transferred into a crucible and dried at 105^{0}C in an oven to a constant weight, cooled and weighed. It was then ashed at 550^{0}C, cooled and weighed. The difference in weight after ashing was then calculated as the fibre content of the sample and was expressed as a percentage of the original weight. The percentage crude fibre content was this calculated:

$$\% \text{ Crude Fibre} = \frac{W2 - W3}{W1} \times 100$$

Where W1 = Weight of sample

W2 = Weight of sample and crucible after drying at 105^{0}C

W3 = Weight of sample (as ash) and crucible after ashing

Crude protein content
0.6g of the dried ground sample was weighed into an already dried kjeldahl flask. A few drops of water was added to the sample to moisten it, using a burette, 3ml of conc. H_2SO_4 acid was added into the flask followed by the addition of 0.5g of $CuSO_4$. The content of the flask was then digested in a fume cupboard with occasional stirring until a clear solution was obtained. The flask was allowed to cool and a small quantity of distilled H_2O added. The digest was then transferred into 100ml volumetric flask and the initial volume recorded. The mixture was shaken thoroughly to obtain a homogenous solution.

The mixture was now ready for distillation. The distillation apparatus was steamed for 30min as to get rid of traces of alkali left in the flask. With the aid of a pipette, 10ml of the digest was added to the micro distillation apparatus using a funnel. 10ml of 50% NaOH solution was put in the funnel with measuring cylinder, with stopper glass rod in place. A water condenser set was connected with a 100ml conical flask used as a receiver which contained 10ml of 4% boric acid and two (2) drops of mixed indicator (bromocressol green/methyl red). The drop end of the condenser was immersed well into the boric acid. The stopper glass rod was gradually removed to allow the NaOH solution to thoroughly mix with the sample digest solution. The funnel was filled with distilled H2O and the steam generator was closed at the top and steam passed into the distillation set. NH3 was liberated and was distilled into 10ml 4% boric acid for 15 min. 50ml of the distillate of blue/green colour was collected and the drip end of the condenser was washed with distilled water into the 100ml conical flask containing the distillate. The distillate was then titrated against 0.1N hydrochloric acid till it changed to pink colour.

A reagent blank was run as a control and the protein content was then calculated by multiplying Nitrogen obtained with the factor of 6.25, expressed on dry basis. The experiment was carried out in triplicates. The formula for % crude protein is given below:

% Protein = % N2 x 6.25

$$\% N2 = \frac{100}{W} \times \frac{N}{1000} \times 14 \times \frac{Vt}{Va}$$

Where W = Weight of sample
N = Normality of titrant
Vt = Total digest volume
Va = Volume of digest analyzed
T = Sample titre value
B = Blank titre value

Carbohydrate content
Carbohydrate content was determined by the difference method. This was done by summing up the % moisture, % protein, % fat, % ash and % crude fibre contents and then subtracting their sum from 100. It was also expressed in percentage (%).

OIL PROPERTY DETERMINATION
These experiments were carried out in accordance with the methods described by A.O.A.C. (1990).

Free fatty acids
0.320g of the oil sample was weighed into 250ml conical flask; 25ml of freshly neutralized hot alcohol was added. The mix was boiled on a heating mantle. The content was then titrated with 0.2N NaOH solution using phenolphthalein indicator until the pink colour returned. The volume of the alkali used was recorded and free fatty acid was calculated. The free fatty acids content was done in triplicate. The free fatty acids were thus calculated:
% FFA (as oleic) = ml alkali x N of alkali x 28.2mg
Sample weight

Acid value
The acid value was calculated from the free fatty acid (as oleic) values multiplied by 1.99. It was thus calculated:
Acid value= % Free fatty acid (as oleic) x 1.99

Peroxide value
0.206g of the oil sample was weighed out into a 250ml conical flask 30ml of acetic acid-chloroform solution (with the ratio 3:2 by volume) was added to it. 1.5ml of saturated potassium iodide was then added, the solution was occasionally shaken for 6min. 30ml of distilled water was then added. The solution was titrated with 0.002M sodiumthiosulphate solution using starch indicator until the blue colour disappeared. The peroxide value was done in triplicate and was thus calculated:
Peroxide Value (Meq/kg oil) = (S – B) x N x 1000
Sample weight
Where S = Sample titrate value
B = Blank titre value
N = Normality of Na2S2O3 solution

Saponification value
0.755g of oil sample was weighed into a conical flask. 25ml of 0.5KOH was added. A blank experiment was also carried out at the same time with the oil sample. Air condenser was fitted to the two flasks. The two experimental flasks were boiled steadily until saponification was completed as indicated by the absence of an oily matter and the appearance of a clear solution. The flasks were then cooled and the excess KOH was titrated with 0.5N HCl, using phenolphthalein indicator. The saponification value was then calculated. The saponification value was done in triplicate. The saponification value was thus calculated:

$$\text{Saponification value} = \frac{(b - a) \times N \times 56.1}{\text{Weight of sample (g)}}$$

Where b = blank titre value

a = sample titre value
N = Normality of the HCl
56.1 = the molecular weight of KOH

Iodine value
The oil sample (0.412g) was weighed into 50ml conical flask; 10ml of Wij's solution was added. 5ml of carbon tetrachloride was added, a stopper was fitted on top of the conical flask to avoid evaporation and absorption of CO_2 from the air. The sample was kept in the dark for 60min. 10ml of 10% potassium iodine solution was then added. 50ml starch was added to obtain a blue black colour. 0.2N sodium thiosulphate was then used to titrate the sample back to a colourless solution. A blank sample experiment was also carried out along with the oil sample experiment. The iodine value was calculated. The iodine value was done in triplicate. It was thus calculated:

$$\text{Iodine value} = \frac{(b - a) \times 12.69 \times N}{\text{Weight of sample}}$$

Where b = blank titre value
a = sample titre value
N = Normality of sodium thiosulphate solution ($Na_2S_2O_3$)

Smoke point
30ml of the oil sample was placed into a 50ml conical flask. A thermometer was inserted in a bored rubber cork and was clamped in such a way that the thermometer was suspended in the oil. The whole set up was heated on a heating mantle until smoke appeared. The temperature at which the smoke started appearing was recorded as the smoke point. The smoke point was done in triplicates.

Flash point
After noting the smoke point (from 3.7.6), the temperature at which the oil started flashing (when flame was applied) without supporting combustion was noted and recorded as the flash point.

Specific gravity
A 50ml measuring cylinder was dried and weighed; oil sample was poured into it up to the 50ml graduation mark. Marked, weighed and result recorded.
Similarly distilled water was poured up to 50ml graduation mark in another already weighed cylinder re-weighed and the result recorded. The specific gravity was done in triplicate. The specific gravity was this calculated:

$$\text{Specific gravity} = \frac{\text{Weight of Xml of oil}}{\text{Weight of Xml of water}}$$

Where X is the specific volume of sample used.

RESULTS AND DISCUSSION

Physicochemical properties of *livistonia chinensis* seed oil
Some of the physicochemical properties of *L. chinensis* seed oil are shown in Table 1.
The oil content of *Livistona chinensis* seed is 2.86% and is therefore taken not to be an oil seed. *Livistona chinensis* seed oil has a straw colour (yellowish-brown) and is liquid at room temperature ($27^0C \pm 2^0C$).
The specific gravity at 27^0C was determined to be 0.8638g/cm3. This value is lower than the values recorded by codex standards (1999) for crude vegetable oils like Arachis oil (0.912 – 0.920g/cm3), coconut oil (0.908 – 0.921 g/cm3), cotton seed oil (0.918 – 0.926 g/cm3), maize oil (0.917 – 0.925 g/cm3), palm oil (0.891 – 0.899 g/cm3), palm kernel oil (0.899 – 0.914 g/cm3), soya bean (0.919 – 0.925 g/cm3), etc. It is in essence less dense than these oils. Specific gravity is a measure of the heaviness of a substance compared to water (Onwuka, 2005). The oil by implication will readily float in water since its specific gravity (0.8638 g/cm3) is less than one (1) and it is less dense than water.

Table 1: Physico-chemical properties of *Livistona chinensis* seed oil.

PHYSICOCHEMICAL PARAMETER	VALUE
Oil content (%)	2.86
Colour	Straw Colour (Yellowish-brown)
State (at room temp)	Liquid
Specific gravity (27^0C) (g/cm3)	0.8638
Smoke point (^0C)	140 – 142
Flash point (^0C)	239 – 243
Iodine value (mg iodine/g oil)	35.307
Peroxide value (MeqO2/kg oil)	13.98
Saponification value (mg KOH/g Oil)	40.125
Free fatty acids (FFA) (%)	22.031%
Acid value (mg KOH/g Oil)	43.828

The smoke and flash points of the oil are 140 – 142^{0}C and 239^{0}C – 243^{0}C respectively. The smoke and flash points are measures of the thermal stability of oils. The smoke point (140 – 142^{0}C) and flash point (239 – 243^{0}C) of *L. chinensis* seed oil are lower than the smoke point (221 – 260^{0}C) and flash point (302 – 338^{0}C) of refined corn oil respectively (Potter and Hotchkiss, 1995). In essence, the oil is regarded as being less thermally stable than that of refined corn oil and cannot withstand very high frying and roasting temperatures and very high thermal processing. As such it could be recommended in food for mild frying.

Chemical properties of *Livistona chinensis* seed oil

The acid value and free fatty acid (FFA) value of *L. chinensis* seed oil are 43.828mg KOH/g oil and 22.031% respectively. Both values are relatively very high when compared to codex standards (codex standards, 1999) for crude vegetable oils which recommends an acid value of 4.0mgKOH/g oil for cold pressed and virgin oils, 10.0mgKOH/g oil for virgin palm oils and free fatty acid values of 0.0 – 3.0%. The free fatty acids can stimulate off-flavour development in the oil (Oderinde *et al*., 2009). The high free fatty acid value of the oil implies that refining would be required to make them suitable for edible purposes and may be better utilized for industrial purposes.

The peroxide value was determined to be 13.98 Meq O2/kg oil. This value is lower than the maximum value (15 Meq O2/kg oil) stipulated for cold pressed or virgin oils (Codex standard, 1999). The peroxide value is a measure of the degree of oxidation (Potter and Hotchkiss, 1995) and its value is below the stipulated Codex standard value. The oil is therefore considered to be relatively stable.

The saponification value obtained (40.125mgKOH/g oil) was very low compared to the Codex standard (1999) saponification values for crude vegetable oils like Arachis oil (187 – 196mgKOH/g oil), cotton oil (248 – 265mgKOH/g oil), cotton seed oil (189 – 198mgKOH/g oil), maize oil (187 – 195mgKOH/g oil), palm oil (190 – 209mgKOH/g oil), palm kernel oil (230 – 254mgKOH/g oil), soya bean oil (189 – 195mgKOH/g oil), sun flower seed oil (188 – 194mgKOH/g oil). Saponification value is a measure of both free and combined acids and is inversely proportional to the mean molecular weight of the fatty acids in the glycerides present (Onwuka, 2005). The very low saponification value of the oil indicates that its fatty acids have a high mean molecular weight and it will be suitable for the production of soaps and candles.

The iodine value was determined to be 35.307 mg iodine/g oil. The iodine value is low when compared to the range of many crude vegetable oils recorded by codex standard (1999) like Arachis oil (86 – 107mg iodine/g oil), cotton seed oil (100 – 123mg iodine/g oil), maize oil (103 –135mg iodine/g oil), mustard seed oil (92 – 125mg iodine/g oil), palm oil (50 – 55mg iodine/g oil), rice bran oil (90 – 115mg iodine/g oil), sesame seed oil (104 – 120mg iodine/g oil), Soya bean oil (124 – 139mg iodine/g oil). While coconut and palm kernel oils have much lower iodine values of 6.3 – 10.6mg iodine/g oil and 14.1 – 21.0mg iodine/g oil respectively than *L. chinensis* (Chinese Fan palm) seed oil. Iodine value is a measure of the level of unsaturation of oil (Onwuka, 2005) and the low iodine value (35.307 mg iodine/g oil) indicates low level of unsaturation and the presence of saturated fatty acid. This places the oil in the non-drying group and it could be utilized for cooking and may find application as a raw material in industries for the manufacture of vegetable oil-based ice-cream (Oderinde *et al.*, 2009).

Effect of blanching, cooking and roasting on the proximate composition of *Livistona chinensis* seed

The effect of blanching, cooking and roasting on the proximate composition of *L. chinensis* seed is presented in Table 2.

Results of the moisture content (Table 2) show that the blanching, cooking and roasting processes had significant effect on the moisture content of *L. chinensis* seed. The dry heat treatment (roasting) significantly reduced the moisture content while the wet heat treatments (blanching and cooking) significantly increased the moisture content of *L. chinensis* seed. The 60min cooking had the most significant increasing effect on the moisture content raising it from its raw seed value of 35.35% to 41.45% while the 15 minutes roasting had the most significant reducing effect on the moisture content reducing it from its raw seed value of 35.35% to 25.44%. The pulp had 11.14% moisture content (dry basis) and no treatment was given to it. *Livistona chinensis* raw seed with a crude protein content of 4.44% (Table 2) is much lower than that of *Zea mays* (9 – 10%),*Oryza sativa* (6.8 – 8.0%) and *Triticum valgare* (8 – 10%) (Okaka, 1997).Blanching and cooking had no significant effect on the crude protein content except for 60 minutes cooking while 5,10 and 15min roasting all had significant increasing effect on the crude protein content of *L. chinensis* respectively. This is in agreement with the research carried out by Jimoh *et al*.(2011) Which indicated a decrease in the crude protein content of sesame seed when cooked for 30min and an increase in the crude protein content when roasted for 30min. The crude protein levels in the treatments were 4.42%, 4.41% and 4.40% for 4, 6 and 8min blanching respectively, 4.38%, 4.36% and 4.32% for 20, 40 and 60min respectively and 4.63%, 4.95% and 5.22% for 5, 10 and 15min roasting respectively. The pulp had a crude protein value of 9.04% and no treatment was given to it. The protein maintained some relative stability and the content did not change significantly during blanching and cooking which could have been as a result of the fact that *L. chinensis* seed has a very hard and tough outer coat (shell) very similar to that of palm kernel shell and it was processed in its whole (unmilled) form which may not have allowed for easy heat transfer and leaching during blanching and cooking.

Blanching and roasting had no significant effect on the ash content while cooking had a significant decreasing effect on the ash content, although 20 and 40min cooking had the same effect on the ash content. The raw *L. chinensis* seed had an ash content of 1.31% while the ash content in the treatments were

1.31%, 1.28% and 1.27% for 4, 6 and 8min blanching respectively,1.12%,1.06% and 0.82% for 20,40 and 60min cooking respectively, 4.63%, 4.95% and 5.22% for 5, 10 and 15min roasting respectively. The pulp had an ash content of 6.92% and no treatment was given to it.

The oil content of the raw seed of *Livistona chinensis* is 2.86% (Table 2). The oil content at the different levels of processing as represented in Table 2 are 2.86%, 2.70% and 2.32% for 4, 6 and 8min blanching respectively, 1.91%,1.52% and 1.30% for 20, 40 and 60min cooking respectively, 2.64%, 2.71% and 2.51% for 5,10 and 15min roasting at 110°C respectively while the pulp contains 2.38% oil. This oil content of the raw seed of *L. chinensis* (2.86%) is higher than that of Rice (2%) and wheat (1 – 2%) but is comparable to that of Millet (2 – 4.5%) and is lower than that of maize (3 – 5%) and Guinea Corn (3%). The oil content of 2.86% for the raw *L. chinensis* seed indicates that it is not an oil seed unlike soya bean that has up to 23.1% fat content (Potter and Hotchkiss, 1995). The oil content decreased generally with increased processing time (Table 2) especially with that of the wet heat treatment (blanching and cooking) which could possibly be as a result of leaching of the oil into the treatment water as pointed out by Okaka *et al.* (1992).

Table 2: Effect of blanching, cooking and roasting on the proximate composition of *Livistona chinensis* seed

Sample	Moisture (%) (Dry weight basis)	Crude protein (%)	Ash (%)	Crude fat (%)	Crude fibre (%)	Carbohydrate (%)
Raw Seed	35.35^{g} ± 0.05	4.44^{e} ± 0.04	1.31^{b} ± 0.01	2.86^{a} ± 0.01	38.21^{b} ± 0.21	17.83^{e} ± 0.03
4min blanched	35.45^{f} ± 0.40	4.42^{ef} ± 0.07	1.31^{b} ± 0.01	2.86^{a} ± 0.02	38.21^{b} ± 0.10	17.34^{f} ± 0.04
6min blanched	35.86^{e} ± 0.25	4.41^{ef} ± 0.01	1.28^{b} ± 0.02	2.70^{b} ± 0.01	37.14^{d} ± 0.08	17.79^{e} ± 0.08
8min blanched	37.15^{d} ± 0.15	4.40^{ef} ± 0.03	1.27^{b} ± 0.02	2.32^{f} ± 0.00	37.54^{c} + 0.20	17.32^{f} + 0.01
20min cooked	39.06^{c} ± 0.06	4.38^{ef} ± 0.08	1.12^{c} ± 0.03	1.91^{g} ± 0.00	37.50^{c} ± 0.00	16.03^{g} ± 0.09
40min cooked	39.83^{b} ± 0.20	4.36^{ef} ± 0.05	1.06^{c} ± 0.02	1.52^{h} ±0.01	36.02^{f} ± 0.00	17.21^{f} ± 0.05
60min cooked	41.45^{a} ±0.05	4.32^{f} ± 0.01	0.82^{d} ± 0.01	1.30^{i} ± 0.01	35.92^{f} ± 0.50	16.19^{g} ±0.05
5min Roasted	30.42^{h} ± 0.22	4.63^{d} ± 0.15	1.34^{b} ± 0.02	2.64^{c} ± 0.02	38.59^{a} ±0.19	22.38^{d} ± 0.03
10min roasted	27.22^{i} ± 0.01	4.95^{c} ± 0.04	1.35^{b} ± 0.01	2.71^{b} ± 0.00	37.27^{cd} ± 0.10	26.50^{c} ± 0.08
15min roasted	25.44^{j} ± 0.03	5.22^{b} ± 0.02	1.38^{b} ± 0.02	2.51^{d} ± 0.01	37.91^{b} ± 0.00	27.54^{b} ± 0.04
Pulp	11.14^{k} ± 0.02	9.04^{a} ± 0.03	6.92^{a} ± 0.01	2.38^{e} ± 0.01	36.66^{e} ± 0.00	33.69^{a} ± 0.05
LSD	0.36	0.10	0.12	0.02	0.32	0.17

NOTE: Means with different superscripts in the same column are significantly different at $P<0.05$
LSD = Least significant difference.

Livistona chinensis seed has a very high crude fibre content of 38.21% as shown in Table 2. There was significant decrease in the crude fibre content during the blanching, cooking and roasting except for 4 minutes blanching and 15min roasting that both had no significant effect on it. Its fibre content of 38.21% (Table 2) is higher than that of many cereals like Guinea corn (2%), maize (2 – 3%), Millet (2%), Rice (0.2%), Wheat (1.5 – 2.5%) (Okaka, 1997) and is also higher than that of many legumes like soya bean (2.2%), Lupin (1.5%), Faba bean (1.4%), Pean bean (1.7%), lima bean (2.1%) and lentil (1.1%) (Potter and Hotchkiss, 1995). This level of crude fibre is an indication that the seed of *L. chinensis* can serve as a good roughage source for animals.

The carbohydrate content of raw *L. chinensis* seed (17.83%) and its values at different stages of processing are shown in Table 2. The treatments had significant effects on the carbohydrate content except for 6min blanching. The carbohydrate content at the different levels of processing are 17.34%, 17.79% and 17.32% for 4, 6 and 8min blanching, 16.03%, 17.21% and 16.19% for 20, 40 and 60min cooking respectively, 22.38%, 26.50% and 27.54% for 5, 10 and 15min roasting respectively. The pulp had a carbohydrate content of 33.69% and no treatment was given to it. The carbohydrate content (17.83%) of raw *L. chinensis* seed is lower than that of most cereals like Guinea Corn (68 – 80%), maize (65 – 84%), millet (75 – 85%), Rice (80%) and wheat (65 – 75%) (Okaka, 1997). Its value (17.83%) is also lower than that of most legumes like bambara groundnut (65%), broad bean (56.9%) Chick peas (60.9%), Cowpea (61.0%), groundnut (21.0%), Jack bean (61.0%), Lentils (65%), Peas (60%), Soya beans (32%), etc (Okaka, 1997). Its value is nevertheless higher than that of some nuts like walnuts (15.6%), fibre (17.7%), Pecans (13.0%) etc (Potter and Hotchkiss, 1995).

CONCLUSION

The findings from the physicochemical properties of the oil from *Livistona chinensis* (Chinese Fan Palm) seed revealed that it has low oil content. The findings also show that the oil has low thermal stability, oxidatively stable, high level of free fatty acids and saturated fatty acids. These suggest that the oil will not be suitable for edible purposes (unless refined) but will rather be better for industrial purposes.

It was discovered that raw *L. chinensis* seed has a relatively low crude protein, fat and carbohydrate content but with a relatively high ash and very high crude fibre content. It is therefore concluded that it can serve as a good source of fibre and roughage for animals. The study also showed that heat processing improves the ash content and crude protein content of *L. chinensis* seed just like many other raw foods that are heat processed before consumption.

RECOMMENDATION

Livistona chinensis seed should not be explored for high level of industrial oil since it contains very low oil content. *L. chinensis* seed is recommended for use as a high source of fibre/roughage in animal feed formulations.

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