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Physical Chemical Characterization of Vegetable Oil and Defatted Meal of *Garcinia kola Heckel (Guttiferae)* from Benin

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Abstract

In view of forest species development little or less crop, this work has focused on the study of unconventional oils extracted from Garcinia kola. The study was aimed to determine the physical-chemical parameters (acidity, peroxide, iodine and saponification values), the fatty acid profile, of vegetable oils obtained from Garcinia kola Heckel produced in Benin. Analyses showed a lipid potential of Garcinia kola was 28.37%. Quality index obtained: acidity (<1%); saponification (176 mg KOH / g oil); peroxide (<9 O2/kg-oil meq) and iodine (80 mg of iodine g-oil) were in conformity with conventional standards of appreciation of the quality of alimentary oils. The fatty acid profile was dominated by oleic acid (38.35%) followed by linoleic acid (27.15%), palmitic acid (21.80%) and stearic acid (10.93%). Myristic acid (~1.76%), arachidic acid (~1%) and palmitoleic (~0.2%) were poorly represented. The high proportion of unsaturated fatty acids (>70%), largely known in nutrition allowed these vegetable oils to be used as food supplements. This study revealed in defatted meal the predominance of minerals such as nitrogen N (0.59%), potassium K (0.34%), Calcium Ca (0.10%) and as well as total protein (MS ~9%), starch (62.9% DM) and total sugar (12.00% DM) indicating their potential use in animal feed. The unsaponifiables of vegetable oil such as sterols and tocols were quantified to 63 and 4000 mg/100 g edible by LC-MS method which could predict their use in cosmetics.

Keywords: Vegetable oil, defatted meal, fatty acids, unsaponifiables, nutritional uses.

Introduction

Since many years, oleaginous plants arouse an interest revival for renewable energy production. Numerous researches have been focused on extracted vegetable oils transesterification with a view to their transformation in motorfuel[1]. This is the way palm oil tree, soya, rape seed tree and sunflower, assuring for it selves more than 80% of vegetable oils world production, have been charged other usages besides the one of feeding attributed to them[2,3]. It has been nevertheless recognized that obtained vegetable oil of these plants overflow with nutritive substances such as fatty acids vitamins[4,5]. The saturated fatty acids assure an important part of human energy expenditure[6]. Myristic acid has been recognized, for example, for its character inside the cell of which it participates to its survival. It acts like hydrophobia anchor and induces proteins specific subcellular targeting and the interactions which guide them. This has led a particular interest for the present saturated fatty acid and for its alimentary sources i.e. dairy products, because it's endogenous synthesis seems extremely limited[7]. Nowadays, the human incapacity to synthesize some fatty acids has been proved. Among fatty acids, oleic acid was also considered as essential fatty acid particularly during gestation-lactation period[8]. Burr G.O. et.al.[9] have discovered this essentiality notion, showing a linoleic acid deficiency (C18; 2n-6 or w-6) could train some symptoms like the growth late, weight decrease, skin dryness; reproduction desquamation adulteration.

In the objective to find alternative vegetable oils to which generally used in food, people have looked at African oleaginous biodiversity as a very wide field but few are valorized[10]. In Benin, vegetable oil extracted from *Garcinia kola* seeds is one of scientifically unknown agro-resources. However, it's a strongly appreciated seeds by the population, suspecting some of its tonic effects when it has been consumed uncooked or in hydro-alcoholic decoction. Since long time, studies have been conducted on the physical chemistry of seeds on extracts from different organs of the plant[11]. Margins of many diverse traditional uses listed above, the laboratory tests by many studies have isolated various active compounds. Antibiotics, anti-inflammatories, antacids, antispasmodics and anti-hepatotoxic proprieties are present[12].

In the present work, we compared the physical-chemical characteristics of the oil and defatted meal of the seeds with those oils consumption (groundnut oil, palm nuts oil...) for a better technical development and future use in human and/or animals food.

Material and Methods

Vegetable Material: The matter constituting this study was composed of *Garcinia kola* seeds (*Garcinia kola* is essential grown in south of Benin) collected at Benin in Oueme. The wholesome seeds were peeled manually to remove the brown seed coat. The peeled seeds were adequately dried in an oven at 50°C and milled. The milled samples were packaged in sterile screw capped sample bottles and stored at ambient temperature for analysis. The analyses of the seeds had taken into account the following characteristics.

Oil Extraction: Oil extraction has been done with Soxhlet using Hexane at 69 °C under atmospheric pressure, according to French Standard Protocol (NFT 60-201) (AFNOR, 1993). Each extraction operation had last for 6 hours.

Oils Quality Index: Oils acidity has been determined by the standard NFT 60- 204 (AFNOR, 1993). The peroxide and saponification oils index have been determined according to French standards NFT60-220 and NFT60-206 respectively, whereas iodine index has been assessed according to WINKLER method (AFNOR 1993).

Weighting Composition in Fatty Acids: To determine fatty acids composition, 1 µl of hexanic solution composed of methylic esters, has been injected in GC apparatus, Agilent 6890HP series (Agilent USA), equipped with a column of type Innowax (Agilent USA) about 30 nm length, 0.32 mm of internal diameter with a film of 0.25 µm thickness. The injector has been used in split mode, with a ratio 1/80 and at temperature of 250°C. Helium was the vector gas with a flow rate of 1.5 ml/min. The ionization flame detector has been set up at 270°C, hydrogen flow was 35 ml/min and one of air at 350 mL/min. Oven temperature programmed as: 150°C during 3 minutes, increasing of 3°C/min till 220°C (26.3 min) and degree till the end (35.3 min). Peaks identification has been achieved by retention times of methylic esters of known fatty acids oils, sun flower and palm oils injected in the same operative conditions. In order to verify the results reproducibility, each sample has been analyzed triplicate in the same operative conditions. The result has been expressed in percentage of non corrected fatty acids areas.

Oils Mineral Elements Proportioning: Mineral elements (N, P, Ca, Mg, Na) have been dosed after oil mineralization according to the dry way procedure, by ICP (Inductive Couplage Plasma) with a Varia-Vista apparatus at a wavelength λ = 214.914 nm for phosphorus and at λ= 589.592 nm for sodium. The spectrometer Varia- Vista was equipped with a detector CCD (Coupled Charge Device). The measurement has been done realizing stallionage which respects the analyzed medium conditions (matrix acidity). The calculations have been done by interpolation in relation with stallionage range. Analytical results validation has been carried out by internal reference samples analysis, named proves, in which the mineral elements content known. The total nitrogen content determination has been done by DUMAS method.

Cellulose and Lignocelluloses Measurement: The crude cellulose measurement and parietal fibres sequential determination have been carried out according to AFNOR Standard, NF V 03-040 and Van Soest protocols, standardized AFNOR, NF V 18-122 (1990). The interest of these methods is to isolate different parietal fractions permitting to predict foods energetic value. This method is a general application for simple and composed foods. The successive treatments with neutral and acidic detergents, then with sulphuric acid at 72% lead to three residues obtention named: Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL). NDF, ADF and ADL are respectively Total Insoluble Fibers estimation, lignocellulosic and lignin complex.

Results and Discussion

The density of an oil increases with the average length of fatty acid chains[13]. The Oil of *Garcinia kola* has low is 0.7114g/ ml compared to oil consumer density. The refractive index increases with the average length and unsaturation of the fatty acid chains. The extracted oil has a high refractive index is 1.4763.

Garcinia kola contents in vegetable oils is in the magnitude line as the one of soya and cotton grains (20-30%) (table-1) (CAC, 1993). These seeds of Garcinia kola oils compositions were superior to those (21.18%) of Garcinia Mangostana seeds harvested in Nigeria and extracted using a mixture of solvents (n-hexane)[14] but of the same lower than that of groundnut (45-50 %)[15,16]. The oil content makes it possible to extract oil by simple pressure. However, this method would not be useful for the extraction of this oil because of its use in traditional medicine makes its cost and very limited availability. Nevertheless for pharmaceutical properties, this oil may be extracted by maceration in organic solvents[17,18]. *Garcinia kola* seeds oils obtained by hexane assistance have shown quality parameters in concordance with standards of CAC (1993). This justifies the percentages of free oleics acids and peroxide index in accordance with standards (acidity index <4% and peroxide one <10 meq O2 / Kgoil This slow *Garcinia kola* oil peroxidation under light could be justified by its iodine index superior than those of palm and groundnut oils[19]. The iodine index, in fact, gives information to the olefinic links presence, which protect oil adulteration by air oxygen. We also notice quality index of the Garcinia kola of oils were very near as saponification index testifies it (176 mg KOH/g-oil) for which the value predisposes oil for potential uses in cosmetics, notably for soap preparation.

The saponification number was an indirect measure of the average molecular weight of the fatty substances contained in fatty acids analyzed. Garcinia kola Oil has a lower than those obtained for common vegetable oils such as soy-bean Benin (189-195mgKOH/g-huile), groundnut (187-196 mg KOH/g oil) and cotton (189-195 mg KOH / g -oil[20] , but similar to that of *Garcinia mangostana* oil[14](134mgKOH/g-oil).

Table-1
Physico-Chemical Parameters

Chemical Quality Parameters	Garcinia kola *	Garciniakola Nigeria[a]	Garcinia mangostana Nigeria[b]
Oil conent (%-MS)	28.37± 1.45	45.3	21.18 ± 6.18
Acidity (%-oleic)	2.24 ± 0.08	-	2.29 ± 0.08
saponification index (mg KOH/ g-oil)	176.35±0.24	-	134 ± 2.14
iodine index (mg iodine / g-oil)	80±1.46	-	53.64 ± 0.15
peroxide index (meqO2/kg-oil)	8.93±0.03	-	3.27 ± 0.12
Unsaponifiable(%)	4.25		-
phospholipids	0.73	-	5.9
K(PPm)	<50	-	-
Na(PPm)	48.5	-	-
Ca(PPm)	243	-	-
Mg(PPm)	101	-	-

[a]Essien et al., 1995 ; [b]Ajayi et al., 2007, *this study.

The peroxide number of the linked active oxygen in the organic chain of a fat (lipids, free fatty acids, monoglycerides, diglycerides and triglycerides), were used to evaluate the degree of oxidation of unsaturated fatty acids fat. Our results presented in table-1 below show that the value of this index within the limit 15 set the standard for vegetable oils[20].

Garcinia kola Oil has much higher iodine. This value obtained reflects the unsaturated character of the oil. It was superior to that of *Garcinia mangostana*[14], but smallar than the soybean (105-123) and sunflower (110-143) and greater than that of peanut (85-90) and cotton (100-105). The high value of the iodine number shows that the oil would not be protected against oxidation and measures should be taken during storage.

The fatty acid composition of the oil was determined by gas chromatography. The results obtained are shown in table-2. These results give the percentage composition of the total fatty acids of the oil analyzed. From these results, it was noted that the oil contains the most common fatty acids predominantly oleic acid C18:1, followed by linoleic acid C18:2 and palmitic acid C16:0 was noted a small amount of stearic acid C18:0 and a lower percentage of myristic acid . The palmitic acid content of *Garcinia kola* of Benin was higher than that of Garcinia kola of Nigeria and less than Garcinia mangostana Nigeria. By against the linoleic acid was lower than Garcinia kola of Nigeria and greater than Garcinia mangostana Nigeria. *Garcinia kola* Oil studied has a profile comparable to that of Jatropha curcas[21,22]. Comparing the fatty acid composition of the *Garcinia kola* oil with that of conventional oils indicates that this plant is rich in oleic acid (C18:1), linoleic (C18:2) and palmitic (C16:0). The differences in fatty acids composition could be due to, on one hand, to the extractive methods of storing and vegetable oils characterization, and on other hand to the edaphic conditions of these tubers culture zones.

The minerals of the defatted meal of *Garcinia kola* were presented in table-3. Values were in Triplicate Mean ± Standard Deviation. The study of this table showed that defatted meal of *Garcinia kola* was low in total minerals percentage (1.30%) that was, however higher than the one obtained from the sample of Nigeria[12] which was only 0.47 %. The composition of individual minerals was marked by the predominance of nitrogen (0.59%) and potassium (0.34%). It was also noted that the sample of Nigeria got higher than the percentage one studied meal which was only 95ppm in sodium (852ppm). Globally, phosphorus, nitrogen and calcium were the main minerals of these defatted meals. However their proportions were still weak comparatively to those of oleaginous in general (soya, rape seed, cotton, groundnut, palm oil walnut); according to these results, the contents in N, P, K apart the one in phosphorus, were weak comparing to these reported in the literature[23]. Those data were sufficiently weak to permit the defatted meals use in order to replace the chemical fertilizers in agriculture[24]. But their mineral elements composition and in organic matters allow their use in animals feeding.

Table-2
Fatty Acids Composition of *Garcinia kola* Oils

Acids	Garcinia kola *	Garcinia kola Nigeria[a]	Garcinia mangostana Nigeria[b]
Myristic (C14:0)	1.76 ± 0.02	0.18	-
Palmitic (C16:0)	21.80 ± 0.31	8.73	39.5
Stéaric(C18:0)	10.93 ± 0.10	6.15	1.33
Oleic (C18:1, n-9)	38.35 ± 0.08	30.76	34.2
Linoleic (C18:2, n-9,12)	27.15 ± 0.03	40.53	1.03
Other	0	1.36 (linolenic acid)	14.01

[a]Essien *et al*., 1995 ; [b]Ajayi *et al*., 2007, *this study

Table-3
Mineral composition of defatted meal

Parameters	Garcinia kola *	Garcinia kola Nigeria[a]	Garcinia mangostana Nigéria[b]
Total mineral	1.30 ± 0.10	0.47 ± 0.09	1.99 ± 0.30
N (%)	0.59 ± 0.10	0.09 ± 0.00	-
P (%)	0.09 ± 0.00	0.002 ± 0.001	-
K (%)	0.34 ± 0.00	0.10 ± 0.01	0.07
Mg (%)	0.07 ± 0.00	0.02 ± 0.00	0.09
Ca (%)	0.10 ± 0.00	0.22 ± 0.00	0.05
Na (ppm)	95.0 ± 2.00	852 ± 0.71	26

[a] Adesuyi *et al*., 2012 ; b Ajayi *et al*., 2007, *this study

Table-4 assembled the data on organic matters of defatted meals extracted from *Garcinia kola studied and those from Nigeria.* These results expressed their potential use for digestion and inconstituents for motor fuel of second generation. The sample showed a considerable defatted meal of proteins (3.69%) even though it was low compared to the protein level in some commonly consumed oil seed in Benin like rapeseed (25%) and Sunflower (28.7%) [25]. *Garcinia kola* can still be used as a source of Protein. This value was greater than for a naturalized species in Nigeria[23]. Protein and starch were in the normal range compared to those published by FAO in 1995 (protein: 2% to 15 % starch: 60% -75%).

The other gross components were present in minute quantities. Crude fiber content (4.5%) showed that the sample contained little defatted meal of Cellulose, Hemi-cellulose and Lignin. However, the high proportion of starch and total sugars suggested strong operating value of these seeds in agro-business opportunities. These defatted meals rich in nutritive elements could, however, constitute a lingo cellulosic raw material for motor fuel of second generation[26]. The high content in starch and total sugars was indicative for digestive character of the *Garcinia kola* defatted meals studied and tubers utilization for milk extraction[27].

The result of this research has confirmed that *Garcinia kola* got a higher percentage of carbohydrate (table-4) than *Sorghum bicolour*. L stem flour[28] and could be used as a source of energy. They also provide readily accessible fuel for physical performance and regulate nerve tissue.

Table-4
Proximate composition of defatted meal

Parameters (g/100g-Dry malter)	Garcinia kola*	Garcinia kola Nigeria[a]	Garcinia mangostana Nigeria[b]
Organic Matter	98.70±0.00	90.16 ± 0.23	50.07
Proteins	3.69 ± 0.50	1.86 ± 0.15	6.57
Crude fibers	4.50 ± 0.10	1.23 ± 0.15	13.7
Lignins	-	-	-
Lignocellulose	5.00 ± 0.10	-	-
Hemicellulose	19.80 ± 0.10	-	-
Starch	62.90 ± 0.40	-	-
Total Sugar	12.00 ± 0.20	-	-

[a] Adesuyi *et al*., 2012 ; b Ajayi *et al*., 2007, *This study

Conclusion

Present research work has permitted chemical characterization of oil and defatted meals of consumed *Garcinia kola* acclimated in Benin. Quality index evaluation and the composition in fatty acids dominated by oleic acid have permitted to appreciate the vegetable oil quality and to propose it as table oil. The extracted defatted meals, through their composition in mineral elements and in organic materials, can be destined to livestock feeding or to an intermediate product of biscuit factory. Their saponification index is high in average of 176 mg KOH/g-oil conferred to them a probable use in soap factory.

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