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Extraction and Characterization of Rubber Seed Oil

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Abstract— *The oil extracted from Rubber seeds (RS), using n-hexane yielded 42.967 ± 0.59% oil content. The oil was liquid at room temperature, with brownish yellow colour and with an unpleasant odour. The oil was analyzed for it physico-chemical properties using standard methods. The results from the characterization are as follows; viscosity (0.420 ± 0.16 poise), specific gravity (0.923 ± 0.10), (28.667 ± 0.35(°C) acid value (32.000 mg KOH/g), saponification value (185.333 mg KOH/g.), iodine value (139.703 g I_2/100g), peroxide value (14.300 mequiv O_2/kg oil), free fatty acid (16.096 %), Ester Value (135.330 ± 2.99 mgKOH/g) and heat of combustion (9544.528± 32.14 gcal/g). The high saponification value (185.333 mg KOH/g.) suggests that it will good for soap formulations. The iodine value (139.703 g I_2/100g) classified it as a semi - drying oil. The peroxide value (14.300 mequiv O_2/kg oil) falls above the Standard Organization of Nigeria (SON) recommended peroxide values (10 mequiv O_2/kg oil) for edible oils and its free fatty acid (16.096 %) value being above 5% makes it non-edible oil. The physicochemical of the oil suggest that it exhibit non-edible industrial potentials.*

Keywords— *Rubber seed oil, Characteristics, non-edible.*

I. Introduction

Edible Fats and oils are the third most important macro nutrient required by the body after carbohydrates and proteins (Youdim, 2019). They are rich sources of vitamins and contain two and a half times the energy provided by carbohydrates. In addition, fats and oils also contain essential fatty acids which are not manufactured by the body and as such must be obtained from diets containing fats and oils (Aremu *et al.*, 2015). With some exceptions and in contrast to animal fats, oils are the lipids that contain predominantly these unsaturated (light) fatty acids of two kinds: monounsaturated (oleic acid mainly in extra virgin olive oil) and polyunsaturated (linoleic acid and linolenic acid in oil extracted from oil seeds) (Thomas, 1991). Therefore seed oils are sorted for in various food applications as important contributor to healthy diet; they also provide characteristic flavours and textures to foods as integral diet components (Odoemelam, 2005). Globally, an estimated 40 million tons of fats and oils are consumed by man annually (Dhiman *et al.*, 2009) and the demand is on the increase with the increasing population. As a result, there is shortage in the availability of oils with inflated cost as supplies cannot meet the demands.

Therefore, over the years concerted efforts have been made to find alternative sources of oils to augment the existing ones (Aremu *et al.*, 2015; Ikhuoria and Maliki, 2007) and as much as possible find non-edible oil sources for non-edible industrial uses and vice versa in order to reduce the food- non-food clashes of oils. However effective determination of the potential use of oil extracts demands reliable information about the physiochemical characteristics of the oils. It is on these bases that this study is conducted, to extract oil from seeds of Rubber (*Hevea brasiliensis*) and to also investigate it physiochemical characteristics to provide baseline data on their quality in order to give an indication for their suitable uses.

Rubber tree (*Hevea brasiliensis*), belonging to the family *Euphorbiaceae* is one of the major tree crops in Nigeria. It is cultivated on plantations in the tropics and subtropics, especially in Southeast Asia and western Africa. The milky liquid (latex) that oozes from any wound to the tree bark is the most important part of the plant, which can be coagulated and processed into solid products, such as tires. Latex can also be concentrated for producing dipped goods, such as surgical gloves (Sun, 2004; Pillai and Girish, 2014). The tree produces enormous amount of seeds which presently does not have any major applications.

An estimate of 20 000 tonnes rubber seed can be produced from 200 000 ha of rubber plantations in Nigeria (Nwokolo, 1996) and an estimate of 1.3kg of seeds (800 seeds) can be produced by each tree yields twice a year.

In the light of this, studies have shown that these seeds contain appreciable amount of oils with nutritional value that could be used to augment the dwindling supply of oil and fats and also provide a useful supplement to animal feeds. Also, several studies on the extraction and characterization of rubber seeds oil have been conducted (Aigbodion *et al.*, 2001; Asuquo *et al.*, 2012; Kaur *et al.*, 2016). The results obtained suggest that the oils display a large variation in properties which is influenced by environmental factors, seasonal variations, the factory operational conditions, oil extraction methods/ solvents, genetic and ecological variations, therefore the swaying need to periodically get specific data for specific location. It is also on these bases that this study is conducted, to extract oil from seeds of Rubber (*Hevea brasiliensis*) and to also investigate it physiochemical characteristics to provide baseline data on their quality in order to give an indication for their suitable uses.

II. Materials and Methods

2.1 Samples Collection and Oil extraction.

Rubber seeds were collected from the Plantation of Rubber Research Institute of Nigeria (RRIN) Iyanomo, Benin City, Edo State, Nigeria. The rubber seeds were cracked (shelled), washed clean with distilled water, chopped into small pieces and dried in an oven at 50°C until there was no significant

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change in their weight. After cooling, the seeds were milled into powder with a blender and stored in air-tight polythene bags before use. 50g of the milled seeds were loaded into a thimble and placed in the refluxing unit of the Soxhlet apparatus with 300ml of n-hexane as extraction solvent. The extract was de-solventized with the rotary evaporator to obtain the seed oil.

2.2 Physicochemical Characteristics

The Physicochemical characteristic of the oil was carried out. The colours and smell of the oil was determined by visual observation and use of the sense of smell while melting points was by the capillary method. Relative viscosity was determined by the use of Oswald U-tube viscometer. The percentage yield was obtained as ratio of the weight of oil extracted to the weight of sample, multiplied by 100. The saponification value (SV), acid value (AV) and iodine value (IV) was determined using the official method of analysis (AOAC, 1995). Peroxide value was determined using the AOCS Surplus method Cd 8-53. Unsaponifiable matter was determined using the separation method. Ester value (EV), heat of combustion (HC) and free fatty acid (FFA) values were determined by mathematical expression; EV= SV- AV; HC = 11380 – IV – 9.15(SV); FFA = 0.503(AV) (Akinola *et al*. 2010; Aremu *et al*., 2015).

2.3. Statistical analysis

The mean of the data was compared using SPSS (Statistical package for Social Scientist).

III. Results and Discussion

TABLE 1. Physical Properties of the Rubber seed oil sample

Characteristics	Values
State	Liquid
Colour	Brownish Yellow
Odour	Unpleasant
Viscosity (Poise)	0.420 ± 0.16
Specific gravity at 29°C	0.923 ± 0.10
Melting point (MP) (°C)	28.667 ± 0.35
% Yield (%)	42.967 ± 0.59

Results are expressed as mean of triplicate determinations

The Physical characteristics of the oil sample are presented in Table 1. The extract was liquid at room temperature, signifying that it can be classified a oil. This also gives an indication that the oils have some level of unsaturation. The colour of rubber seed oil (RSO) was brownish yellow which is different from the dark brown reported by some authors (Asuquo *et al.,* 2012; Abubakar *et al.,* 2014; Ebewele *et al.,* 2010) and golden yellow (Pearson, 1976). Elsewhere, yellow colour was reported (Joseph *et al.,* 2004), while pale yellow was also reported (Salimon *et al.,* 2012). The colour of oils is attributed pigmented materials such as gossypol, carotinoids, chlorophyll and various resins present in the crude oil (Gumuskese and Cakaloz, 1992). The properties of crude oils can also be determined by several factors, which include; it's crude colour, the extraction procedures and the color of the oil after extraction. Nevertheless, refining procedures of degumming and decolourisation can significantly improve the appearance (Asuquo *et al.,* 2012). The physical appearance and odour of rubber seed oil makes it undesirable as edible oil.

Oil quality and its content are the key determinants of the viability of an oil source. In this study, the percent oil content of Rubber seed (RS) was 42.967 ± 0.59% was within the rang classified as oil bearing viz; 28 - 33.6% for palm oil (Akubugwo and Ugbogu, 2007; Ezeoha *et al.,* 2017); 31.7 – 57.0% for groundnuts (Yol *et al.,* 2017); 50.1% for peanuts (Bishi *et al.,* 2015); 15.85 – 19.45% for soybean (Anwar *et al.,* 2016) and 31.28 – 42.37% for coconut (Adeyanju *et al.,* 2016).

The melting point of rubber seed oil (RSO) was 28.667 ± 0.35 was low. Low melting point for oils has been associated with unsaturated oils (Ikhuoria and Maliki, 2007). The relative viscosity value (0.420 ± 0.16) was high suggesting that it will not be useful any many edible application such as in frying and cooking oils, in the production of mayonnaise etc.

The specific gravity value (0.923 ± 0.10^c) is similar to values documented by Asuquo *et al.,* 2012, Ebewele *et al.,* (2010) and Kaur *et al.,* (2016) for RSO. These values are comparable to the specific gravities of other edible vegetable oils (Negash, *et al*., 2019) and within the 0.919-0.925 levels advised by FAO/WHO. The highest specific gravity obtained for RSO could be attributed to the presence of high content of linoleic acid. Previous studies have associated high specific gravity levels to presence of linoleic acid (Mengistie *et al.,* 2018).

TABLE 2. Chemical Properties of the Rubber seed oil sample

Characteristics	Values
Acid Value (AV mg KOH/g)	32.000 ± 0.81
Saponification Value (SV mg KOH/g)	185.333 ±3.51
Iodine Value (IV g I_2/100g)	139.703 ± 1.48
Peroxide Value (PV meqO_2/Kg)	14.300 ±0.43
Unsaponifiable Matter (USM %)	9.297 ± 0.61
Free Fatty Acid (FFA %)	16.096 ± 0.41
Ester Value (EV mgKOH/g)	135.330 ± 2.99
Heat of Combustion (HC) gcal/g	9544.528± 32.14

Results are expressed as mean of triplicate determinations

Acid value is a measure of the amount of free fatty acids present in fat and oils. It gives an indication of the deterioration, rancidity, or edibility of the oil. High acid levels imply that the oil will require an excess polyol for its polycondesation reaction. The acid value obtained for RSO (32.600 ± 0.81^{c} mg KOH/g) in this study was very high compared to the 1.68 mgKOH/g recorded by (Asuquo *et al.,* 2012) but lower than values obtained by (Abubakar *et al.,* 2014) and (Ebewele *et al*., 2010) who recorded 34.0 and 37.96 mg KOH/g respectively in similar studies for RSO. High acid value may be due to hydrolytic reaction during processing or due to enzymatic action in the RSO. However, alkali refining can be used to achieve the desired acid content (Aigbodion *et al.,* 2001; Nawar, 1996). The acid value of RSO suggests that it cannot be used in any edible applications.

The saponification value gives an indication of the molecular weight of the fatty acid contained in the oil. It also gives an indication of the purity status of the oil or whether the oil is adulterated (Akubugwo and Ugbogu, 2007). High saponification values suggest that the oil has little impurities.

In this study the saponification value recorded for RSO (185.333 ±3.51 [c] mg KOH/g oil) was high but lower than the 193.61 mg KOH/g and 226.02 mg KOH/g recorded respectively by (Asuquo *et al.,* 2012) and (Ebewele *et al.,* 2010) but higher then than the 179.6 mg KOH/g oil recorded by (Abubakar *et al.,* 2014) in similar studies for RSO. The difference in values may be due to genetic and ecological variations as the values fall within the range reported in literatures. The high saponification value obtained suggests that the oils could be good for soap making.

The iodine value is a measure of the degree of unsaturation of oils. High iodine value is attributed to high unsaturation. It is the amount of iodine in grams that will saturate 100 grams of the oil or fat. Saturated oils and fats have zero iodine value because they cannot take up any iodine. Iodine value is also the measure of the drying property of oils. It is used as a basis for the classification of fats and oils into drying (with iodine value higher than 150 g I_2/100g), semi-drying and non-drying (with iodine value of the range 100 - 150 g I_2/100g) and non-drying (with iodine value lower than 100 g I_2/100g) oils (Aremu *et al.,* 2015; Asuquo *et al.,* 2012). This information determines the ability of oils to form solid film on exposure to air. Iodine value for RSO was high (139.703 ± 1.48 [c] g I_2/100g), indicating that it has higher unsaturated fatty acids. The iodine value recorded for RSO in this study was significantly higher than the 118.8 g I_2/100g reported by (Kaur, 2010) for RSO in a related study. The high iodine values of RSO suggest that the oil can be classified as a semi-drying oil (iodine value of 100-150 g I_2/100g) (Asuquo *et al.,* 2012) thus can be used in alkyd resin production and other formulations such as liquid soap and shoe polish.

The peroxide value gives an indication of the quality and stability of oil. It is used to determine the extent to which oil can go rancid as a result of storage, heating or oxidation. Rancid oils have peroxide values of 10- 20 mequiv O_2/kg oil and the Standard Organization of Nigeria (SON) recommended peroxide values for edible oils is 10 mequiv O_2/kg oil (Onoji *et al.,* 2016). Peroxide value for RSO (14.300 ±0.43 mequiv O_2/kg oil) was and fall above SON recommended limits for edible oils. Although peroxide value can be significantly reduced by the refining process (Bell and Gillattm, 1994), its colour, odour and acid value still makes it undesirable as edible oil. On the other hand, the high peroxide value also suggests that the oil can resist deterioration during storage (Mohammed and Hamza 2008).

The unsaponifiable matter (sterols, phospholipids, waxes, terpanes etc.) of the oil was low (9.297 ± 0.61 %). This further confirms the oil will good in soap formulation.

The free fatty acid is an index for determining the quality of oils. The lower the free acid content, the more desirable is the oil as edible oil (Bell and Gillattm, 1994). It is recommended that edible oil should have free fatty acid values of less than 5% (Ikhuoria and Maliki, 2007) as such oils has lower tendency to go rancid (Roger *et al.,* 2010). The free fatty acid value (16.096 ± 0.41 %) recorded for RSO compared with the 18.98% and 17.00% recorded respectively by (Ebewele *et al.,* 2010) and (Abubakar *et al.*, 2014) for RSO in similar studies. However, the value was significantly higher than 0.84% and significantly lower than 41.64% reported by (Asuquo *et al.,*2012) and (Kaur *et al.,* 2016) respectively. High acid and free fatty acids values of RSO have been associated to its high degree of unsaturation (Eka *et al.*, 2010; Kaur *et al.,* 2016). Elsewhere, higher free fatty acid values in oils has been associated to increased hydrolytic activities in the presence of moisture, catalysed by some enzymes, acids, bases and heat (Ikhuoria and Maliki, 2007). The free fatty acids values for RSO being higher than 5% makes it undesirable as edible oils.

The ester value is the number of milligrams of potassium hydroxide required to saponify the esters present in 1g of the oil. In this study, ester value for RSO was 135.330 ± 2.99 mgKOH/g. The ester value obtained lower than many vegetable oils such as castor oil (174.09 mgKOH/g), avocado pear oil (172.8 mgKOH/g) (Ikhuoria and Maliki, 2007), groundnut oil (173.90 mgKOH/g) (Musa *et al.,* 2012) and soybeans oil (188.02 mgKOH/g) (Akanni *et al.,* 2005). Heat of combustion value for RSO (9544.500± 32.14 [a] gcal/g) fall within 8904.25 gcal/g and 11303.35 gcal/g range reported in literature (Aremu *et al.,* 2014).

IV. Conclusion

Results obtained from study the showed that RSO was brownish yellow, had pleasant odour and percent oil content of the seed (42.967 ± 0.59%) it is viable source. The extract was at room temperature and with low melting point signifying that it can be classified as oils with some levels of unsaturation. The results suggest that the oil has many non-edible and industrial attributes.

The acid values, saponification values, iodine values, peroxide values and free fatty acid values of RSO suggest that RSO have high degree of unsaturation, can be classified as semi-drying oil, it would require an excess polyol for its polycondesation reaction, prone to rancidity. Its high peroxide value (14.300 ±0.43 [c] mequiv O_2/kg oil) being higher than SON recommended limits for edible oils and also, its free fatty acid (16.096 ± 0.41 [c] %) value being above 5% makes it not desirable as edible oils. Therefore RSO should be developed for industrial applications such as in the production of alkyd resins and other formulations such as liquid soaps and shoe polish.

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