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Article

Extraction and Characterization of Rubber Seed Oil

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Abstract: Physicochemical properties of rubber seed oil (RSO) were investigated using standard techniques in order to obtain specific data for the oil. The oil was characterized for the following parameters: saponification value (193.61), ester value (191.93), viscosity (10.32 poise), refractive index (1.46), iodine value (134.51), acid value (1.68), unsaponificable matter (0.7%), melting point (45-48%), specific gravity (0.92), peroxide value (14.4), color (dark brown), moisture content (8.6%) and pH (6). The observed values of the parameters are in agreement with values obtained for RSO from other places and other similar oils. The characteristic features of RSO from this study shows that RSO can be exploited in the production of environmentally friendly solvent-borne and water reducible coatings and in other industries.

Keywords: rubber seed oil; physicochemical properties; extraction; characterization.

1. Introduction

Worldwide, natural vegetable oils and fats are increasingly becoming important in nutrition and commerce because they are sources of dietary energy, antioxidants, dioxides and raw materials for the manufacture of industrial products. They are used in food, cosmetic, pharmaceuticals and chemical industries. Vegetable oils account for 80% of the world's natural oils and fat supply [1]. With increasing awareness of the importance of vegetable oils in the food, pharmaceutical and cosmetic industries, there is need to search for indigenous plant species that can provide such oils and characterize them.

The rubber tree (*Hevea brasiliensis*) is exploited in Nigeria mainly for latex in view of its economic importance. The auxiliary products, namely, wood and the seeds are mostly neglected [2]. Of these two products, the seeds have the greatest potential and are in abundance in the country [3]. The yield of seeds per annum in the plantations is estimated to be from 100 to 150 kg/ha [4]. However, this yield is influenced by factors such as abnormal leaf and phytophora diseases, species and weather [5]. The seeds have been found to be rich in oil. Its content in the dried kernel varies from 35 to 45%. It is semi-drying and consists of 17-22% saturated fatty acids and 17-82% unsaturated fatty acids, and is comparable to drying oils commonly used in surface coating [6]. Rubber seed oil (RSO) has been found to have potential applications in many areas amongst which are in the production of biodiesel as fuel for compression engines [7,8], foaming agent in latex foam, in the synthesis of alkyd resin used in paints and coatings [6] and several other uses [9]. RSO has also been used as partial substitute to mineral oil as carrier for copper fungicide in the management of abnormal leaf fall disease of rubber in an attempt to reduce cost without compromising on the efficacy of diseases control [10].

The extraction and characterization of oils from rubber seeds have been carried out extensively for the oil from different geographical origin [6]. It becomes important to obtain the specific data for sample of oil from a particular area because there is a range of variation in the physicochemical parameters of the oil due to environmental factors such as rain-fall, soil fertility, agronomic practices, maturation period and genetic substitution. This study is aimed at the extraction and characterization of rubber seed oil from Akwa Ibom State, Nigeria in order to obtain specific data for the oil from this part of the country.

2. Materials and Methods

Rubber (*Hevea brasiliensis*) seeds were obtained from a rubber plantation at Ekpene Ukim in Uruan local government area of Akwa Ibom State, Nigeria. The seeds were dehulled, cleaned and dried under the sun for a day and later dried in the oven for three hours at 50 ℃ to ensure that water and moisture were removed. The seeds were immediately grounded using mortar and pestle into a paste in order to weaken and rupture the cell. The paste was stored in a labeled airtight container for oil extraction. All chemicals and reagents used were of analytical grade. In all cases, distilled water was used.

2.1. Oil Extraction

Oil was extracted from the paste with n-hexane solvent for five hours using Soxhlet apparatus.

2.2. Degumming and Purification

The oil was heated to 60 ^{o}C, and activated carbon was added, which decolourized the oil. The bleached oil was mixed with water thoroughly and heated again to 60 ^{o}C, stirred vigorously for 15 min, filtered, and cooled. The sludge on the filter paper was discarded. The extracted oil (purified) was transferred into a glass bottle and stored in a refrigerator until all analyses were completed.

2.3. Physicochemical Characterization

Standard procedures of American Oil Chemists Society were used for indices values [11], including acid value (standard 969.17, 1997), iodine value (standard 965.33, 1997), saponification value (standard 920.16, 1997). Refractive index, color, viscosity, melting point and specific gravity were determined using recommended methods [11]. Viscometer, refractometer and tintometer were used to determine viscosity, refractive index and color, respectively. The unsaponifiable matter in the oil was determined using standard methods [11], while the ester value was obtained by subtracting the acid value from the saponification value. The percentage of moisture content in the seeds was determined by the recommended method [11].

3. Results and Discussion

Rubber seed oil was characterized along the following physicochemical parameters and the results are shown in Table 1.

Table 1. Physicochemical properties of rubber seed oil

Parameter Number	Parameter	Rubber Seed Oil
1	Color	Dark brown
2	Clarity	Clear
3	Odor	Unpleasant
4	Refractive index	1.46
5	pH	6
6	Viscosity	10.32 poise
7	Specific gravity	0.92
8	Melting point	45-48 ^{0}C
9	Peroxide value	14.4
10	Moisture content	8.6%
11	Saponification value	193.61
12	Iodine value	134.51
13	Esther value	191.93
14	Acid value	1.68
15	Unsaponificable matter	0.7%

Table 1 shows the results of the physicochemical properties of rubber seed oil (RSO) from Akwa Ibom State, Nigeria. The refractive index of 1.46 obtained in this study falls within the standard

value for refractive index of organic oil which is between 1.3 – 1.6 [12]. The value is also in the range found for common oils such as castor seed (1.47), butyrospermium parki (1.453), sterculia setegera (1.465), blighia sapida (1.449) and shear butter oils (1.60) [13,14]. Refractive index is an indication of the level of saturation of the oil.

The pH value of 6 obtained for RSO compares favorably with those obtained for castor seed oil (6.8) and luffa cylindrical (3.93) [15]. This value is an indication of the presence of reasonable amounts of free fatty acid and the advantageous utilization of the oil in soap making. The viscosity value (10.32 poise) obtained for RSO is slightly lower than those of other oils e.g. castor oil (13.02 poise), shear butter oil (17.78 poise) and crambe oil (27.20 poise) [13].

The specific gravity of RSO was found to be 0.92 indicating tat the oil is less dense than water. Also, the value seems to indicate that no heavy element is present in the oil [16]. The specific gravity obtained for RSO in this study is similar to those of other oils e.g. shea butter oil (0.92) and castor seed oil (0.96) [17]. High specific gravity is caused by the presence of hydroxyl groups as found in castor oil. Aigbodion and Bakare [16] reported a specific gravity of 0.916 for RSO obtained from the rubber research institute of Nigeria.

Peroxide value of 14.4 was obtained for RSO in this study. Peroxide value is an indication of deterioration of oils. Oils with higher peroxide values are more unsaturated than those with lower peroxide values. More unsaturated oils are known to absorb more oxygen and develop higher peroxide values, and oils with higher peroxide values are prone to rancidity [17]. The WHO/FAO stipulated a permitted maximum peroxide level of not more than 10 M equivalent of peroxide oxygen/Kg of the oils [17]. Therefore, the oil in this study may not be suitable for consumption since it has a peroxide value above 10.

The percentage moisture content of 8.6% obtained for RSO in this study is in between those of shear butter oil (10%) and castor seed oil (8%) [13]. Low moisture content is an indication of good shelf life for the oil. Low moisture content of oil might be as a result of effectiveness of the distillation apparatus used for recovering the oil.

Saponification value helps to determine the gravity of potassium hydroxide (in mg) needed to neutralize the acids and saponify the esters contained in 1 g of the lipid [13]. The saponification value (193.61) obtained for RSO in this study is within those of common oils such as soybean (189 – 195), peanut (187 – 196) and cotton seed oil (189 – 198) (Codex, 1993). The higher the saponification value of oil, the higher the lauric acid content of that oil. The lauric acid content and the saponification value of oil serve as important parameters in determining the suitability of oil in soap making. The saponification value obtained for RSO in this study (Table 1) projects the oil as good in such areas as soap making and in the detection of adulteration in the oil. However, in comparison with palm oil with

saponification value of 111, RSO is uncommercial in soap production [17]. The saponification value obtained for RSO in this study is also in the range of 203 reported for RSO obtained from Edo State Nigeria and 182.12 ± 0.27 reported for Malaysian rubber seed oil [19].

From the results in Table 1, RSO has a dark brown color similar to the dark color reported for RSO obtained from the rubber research institute of Nigeria [16]. This indicates that in its natural form, RSO is only suitable in applications where bright color is not the major consideration e.g. pigmented coatings. However, it is possible to enhance the color of the oil by bleaching.

Iodine value measures the degree of unsaturation in a fat or vegetable oil (i.e., the number of double bonds). It determines the stability of oils to oxidation, and allows the overall unsaturation of the fat to be determined qualitatively [13]. The iodine value of 134.51 obtained for RSO in this study compares favorably with 136 and 135.79 ± 0.33 reported for MRSI and RSO obtained by the Rubber Research Institute of Nigeria (RRIN) [19]. This value is within the standard of iodine value for organic oil which is between 125 and 150 [17]. Based on the iodine value obtained in this study, RSO can be classified as a semi-drying oil (with iodine values of 100 – 150) [17].

The ester value of 191.93 obtained for RSO in this study is higher than those obtained for shear butter oil (183.4), and castor oil (174.09) [13]. Ester value represents the number of milligrams of potassium hydroxide required to saponify the esters present in 1 kg of the oil. It is obtained as the difference between the saponification value and the acid value.

The acid value (1.68) obtained in this study is lower than those reported for Malaysian RSO (15.03 ± 0.04) and RSO obtained from the RRIN (43.62) [19]. The value is within the standard acid value for organic oil which is 2 [13]. Acid value measures the degree of unsaturation of oil. It corresponds to the amount of potassium hydroxide needed to neutralize free fatty acids. The lower the acid value of an oil, the fewer free fatty acids it contains which makes it less exposed to the phenomenon of rancidification [13]. Acid value varies according to the extraction method with high acidity by Soxhlet method due to the onset of oxidation. Low acid value implies rather suitable oil at the extraction temperature [13]. Acid value can be used to check the level of oxidative deterioration of the oil by enzymatic or chemical oxidation.

The unsaponifiable matter content of 0.7% obtained in this study is lower than those reported for other oils e.g. shear butter (5.68%), corn oil (0.92%), red egusi oil (1.6%), avocado pear oil (2.8%) and dacryodesedulis (2.3%) [13].

4. Conclusion

This study was undertaken to determine the physicochemical characteristics of oil extracted from rubber seeds from the rubber plantation in Ekpene Ukim, Uruan local government area, Akwa

Ibom State, Nigeria. The properties are in agreement with the properties of RSO from other places and those of other oils. The characteristic features of RSO can be exploited in the production of environmentally friendly solvent-borne and water-reducible coatings and in other industrial uses.

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