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Extraction and characterisation of oil from *Delonix regia s*eeds

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Abstract: - The characteristic of *Delonix regia* seed oil was investigated with a view to establish its suitability for use as feedstock the production of biodiesel. The seeds were removed from the *Delonix regia* pods and boiled for 30minutes to enhance the easy removal of the seed coat and extraction of oil from the seeds. The boiled seeds were dehulled, sundried and milled using a Burr mill. The *Delonix regia* seed oil was extracted and characterized using the Soxhlet extractor and standard methods respectively. The results showed that the *Delonix regia* seed oil contains 29.0%. The density (kg/m^3), flash point (^{o}C), kinematic viscosity at 40^{o}C (mm^2/s) are 0.942, 201.30 and 43.75 respectively. The Saponification value (mg KOH/g), iodine value (g/100) value, acid value (mg KOH/g) and free fatty acid (mg KOH/g) for the *Delonix regia* seed oil are 213.48, 127.92, 1.97 and 0.985 respectively. The higher acid value, viscosity and flash point make it unsuitable for direct use in combustion engines without further processing. It can be concluded that the low saponification value and higher molecular weight will make *Delonix regia* seed oil suitable for use as biodiesel feedstock.

Key words: *Acid value, Delonix regia seed, free fatty acid, saponification value, viscosity*

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I. INTRODUCTION

Delonix Regia is a species of flowering plant in the bean family *Fabaceae*, subfamily *Caesalpinioideae*. It has a fern-like leaves and flamboyant display of flowers. The tree grown is mainly for its shade and ornamental value [1]. Because of its hardy nature and aggressive root system, it is a good tree to control soil erosion in the arid and semi- arid areas [2]. The flowers of *Delonix Regia* are large, with four spreading scarlet or orange-red petals up to 8 cm long and a fifth upright petal called the standard, which is slightly larger and spotted with yellow and white. The flower appears in corymbs along and at the ends of branches [3] [4]. The compound leaves have a feathery appearance, are a characteristic light, bright green, and are doubly pinnate. The pods are green and flaccid when young and turn dark-brown and woody which can be up to 60 cm long and 5 cm wide. The seeds are small, weighing 0.4 g on average [5]. The seed of *Delonix Regia* yield 18 to 27.5 % fatty oil known as the "*pangam*" or "*karanga*" oil of commerce and its main use is in tanning industry [4] [6].

Seed oils represent one of the largest key materials that can be obtained from biomass and cheaply processed raw materials. The characteristics of oils from different sources depend mainly on its compositions and no oil from a single source can be suitable for all purposes [7] [8]. The utility of any particular oil depends upon chemical and physicochemical properties of the oil. The fatty acids distributed are in different proportion in the lipid classes of seed oils, it is important to know the ratio of distribution of these fatty acids in the neutral lipids as well as the complex lipid fractions [9], [10], [8].

The high competition on the use of vegetable oil for food as well as its possible use in the production of biodegradeable oil and lubricant cannot be overemphasized. It is therefore necessary to produce oil for other non-edible oil bearing seeds [11], [10]. It has been reported that oil from *Delonix Regia* seed finds use in soap-making, illuminating and pharmaceutical preparations [12], [8]. The oil cake is good fertiliser and also used in poultry ration to substitute black til component [13]. The aim of this work is to extract and characterized *Delonix Regia* seed oil with a view to establish it suitability for use as feedstock the production of biodiesel.

II. MATERIALS AND METHODS

Delonix Regia seed was obtained from the campus of Federal University of Technology Minna, Niger State. The seeds were removed from the pods and boiled for 30minutes to enhance the easy removal of the seed coat and extraction of oil from the seeds. The boiled seeds were dehulled, sundried and milled using a Burr mill.

The oil was extracted using the Soxhlet extractor. Two hundred grams (200g) of the powdered *Delonix Regia* seed sample was packed in filter paper. The filter paper is then placed in an extraction chamber which is being suspended above a flask containing 300ml of N-hexane as the extraction solvent; the solvent is heated to reflux. The solvent vapor travels up a distillation arm and flows into the chamber housing the filter paper. The condenser ensures that any solvent vapor cools, and drips back down into the chamber housing the powdered *Delonix regia* seed sample. The chamber containing the powdered seed slowly fills with warm solvent. When the Soxhlet chamber is almost full, the chamber is emptied by the siphon and the solvent is returned to the distillation flask. The filter paper ensures that the rapid motion of the solvent does not transport any solid material from the powdered *Delonix regia* seed. This cycle takes place for 9 hours and is allowed to repeat many times. The advantage of this system is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled. After extraction the oil was filtered using cartilage filter to remove solid debris and the distilled residual oil was heated at 100^{0}C for One hour (1hour) in order to remove any water molecule [14].

2.1 Determination of percentage oil yield

The extraction of oil using Soxhlet extractor was repeated on each of the sample and the oil was recovered by solvent evaporation, it was heated at a temperature higher than that of the solvent until the solvent finally evaporates leaving behind the extracted oil. The procedure was carried out for all samples [15].
The percentage oil yield was calculated as follow:

$$\%\ \text{oil yield} = \frac{\text{Weight before extraction} - \text{wieght of sample after extraction}}{\text{Weight of sample before extraction}} \times 100 \qquad 1$$

2.2 Determination of the physicochemical properties of *Delonix Regia* seed oil

The physicochemical properties of the *Delonix regia* oil were determined using standard methods. The density, pour point, cloud points, flash points, dynamic and kinematic viscosities were determined using standard methods [16] while the acid value, free fatty acid, saponification value and iodine value were determined using the Association of Official Analytical Chemist standard procedures [17].

III. RESULTS AND DISCUSSION

The results of the oil yield and characteristics of the extracted oil from *Delonix Regia* seeds are as presented in Table 1. The results showed that the *Delonix Regia* seed contains 29.0% oil; this is higher than 9.82% and 17.16% earlier reported [18], [19], [10], [20], [4], [6]. The higher oil yield obtained from this experiment could be as a result of the pretreatment carried out on the seed prior to extraction. The boiling of *Delonix Regia* seeds enhanced the extraction of the oil resulting from the release of the oil entrapped in the tissue of the seeds and flowability hence the higher oil yield. At room temperature, *Delonix regia* oil was a liquid, amber in colour and sweet-smelling [8].

TABLE 1: Yield and characteristics of *Delonix Regia* seeds oil

Properties	Values
Yield (%)	29.0
Density (kg/m^3)	0.942
Pour point (^{o}C)	-2^{o}C
Cloud point (^{o}C)	12^{o}C
Flash point (^{o}C)	201.3
Dynamic viscosity (mm^2/s)	48.50
Kinematic viscosity (mm^2/s)	43.75
Acid value (mg KOH/g)	1.97
Free fatty acid (mg KOH/g)	0.985
Saponification value (mg KOH/g)	213.48
Iodine value (g iodine/100g)	127.92

Density: The results showed the *Delonix regia* oil has a density of 0.942 kg/m^3, this is similar to 0.97 kg/m^3 and 0.933 kg/m^3 earlier reported [20], [18] however, the slight variation maybe due to the variety use and the pretreatment prior to oil extraction. The higher mass of oils would give higher energy available for work output per unit volume.
Pour point: The *Delonix regia* seed oil had a pour point of -2^{o}C. The pour point is the temperature at which the fuel contains so many agglomerated crystals that it is essentially a gel and will no longer flow [21] [20].
Cloud point: the *Delonix regia* seed oil had a cloud point of 12^{o}C. The cloud point (CP) is the temperature at which crystals first start to form in oil. The cloud point is reached when the temperature of the oil is low enough

to cause wax crystals to precipitate. Initially, cooling temperatures cause the formation of the solid wax crystal nuclei that are submicron in scale and invisible to the human eye. Further decrease of temperature causes these crystals to grow. The temperature at which crystals become visible is defined as the cloud point because the crystals form a cloudy suspension. Below the CP these crystals might plug filters or drop to the bottom of a storage tank. The CP is the most commonly used measure of low-temperature operability of the oil. The cloud point of oil depends on the nature of the feedstock it was obtained from [21], [22], [23].

Flash point: The flash point temperature of the fuel is the minimum temperature at which the fuel will ignite (flash) on application of an ignition source. Flash point varies inversely with the fuels volatility. The flash point is defined as the "lowest temperature corrected to a barometric pressure of 101.3kPa (760 mm Hg), at which application of an ignition source causes the vapors of a specimen to ignite under specified conditions of test." The *Delonix regia* seed oil had a flash point of 201.3^{o}C; this result is higher than the 197^{o}C earlier reported [24] and the recommended ASTM value of 78^{o}C for biodiesel. The higher value could be as a result of the pretreatment of the seed prior to oil extraction and varietal differences. The high flash point indicates that *Delonix regia* oil will be unsuitable for use as a biofuel except it undergoes transesterification [24], [8], [10].

Kinematic and dynamic viscosity: The result showed that the *Delonix regia* seed oil had kinematic and dynamic viscosities of 43.75mm^2/s and 48.5mm^2/s respectively. These values are higher than 36.65 mm^2/s and 38.45 mm^2/s earlier reported [24], [18]. The recommended ASTM values for biodiesel hence the need for further processing for it to be made suitable for use as biodiesel hence indicating the need for transesterification of the oil [24], [10].

Acid value: Acid value which is the measure of the acidity of oil is an indication of the foaming formation in soap making process [8], [25]. The acid value obtained for this study showed a value of 1.97 mg KOH/g for the *Delonix regia* seed oil. This result is lower than the 4.88 mg KOH/g earlier reported [18] [24]. However, the acid value of *Delonix regi*a seeds oil is generally higher than the recommended ASTM value of 0.128 mg KOH/g for combustion engines. High value of acid can indicate the presence of oxidation products in the oil bath; this can cause corrosion and sludge in your system.

Free fatty acid: The result showed that *Delonix regia* seed oil contains 0.985 mg KOH/g free fatty acid; this is lower than the 2.45 mg KOH/g earlier reported [18]. A total saturated free fatty acid of 44.71% has also been reported [20]. Previous reports on the fatty acid composition of *Delonix regia* seed oil reveals the presence of higher amount of unsaturated fatty acids such as linoleic acid and oleic acid [26], [27], [10].

Saponification value: The results showed that the *Delonix regia* seed oil had a saponification value of 213.48 mg KOH/g; this is higher than 198.23 mg KOH/g and 203.40 mg KOH/g earlier reported [18], [20]. Saponification value is a measure of the alkali reactive groups in fats and oils and is useful in predicting the type of glycerides in an oil sample and also indicates the average molecular weight of the oil. Saponification value of *Delonix regia* seed oil indicates that the oil will be very good for the production of soaps and shampoos [8].

Iodine Value: The results showed that *Delonix regia* seed oil had 127.92 g iodine/100g iodine value, this is higher than 117.46 g iodine/100 g and 121.03 g iodine/100 g earlier reported [18], [20], [8] for *Delonix regia* seed oil. The variations in the iodine value could be as results of the varietal differences and pretreatment prior to oil extraction. The iodine is a measure of total unsaturation of a fatty material and the higher value of iodine number indicates the presence of more unsaturated fatty acids which determines the oxidation stability of the oil [10], [8].

IV. CONCLUSION

It is concluded that the oil yield of *delonix regia* seeds can be increased by pre-treatment (boiling and dehulling) of the seed before extraction. This suggests that delonix regia seed oil can be extracted on a commercial scale, thereby providing alternate and more economical brand oil. The higher acid value, viscosity and flash point make it unsuitable for direct use in combustion engines without further processing. The low saponification value, and higher molecular weight makes it suitable for use for the production of soap, shampoo and as biodiesel feedstock.

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