



YIELD AND CHARACTERISTICS OF *Delonix regia* SEED OIL AS INFLUENCED BY COOKING TIME

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ABSTRACT

This study investigated the influence of cooking time on the yield and characteristics of *Delonix regia* seed oil. Oil was extracted from the seed of flamboyant (*Delonix regia*) plant using solvent extraction method. Four samples A, B, C and D were used. Sample A was used as control and sample B, C and D were cooked in one litre (1L) of distilled water for 30, 60 and 90 minutes respectively. The percentage oil yield, physical and chemical parameters of *Delonix regia* seed oil such as density, specific gravity, viscosity, refractive index, peroxide value, iodine value, saponification value and free fatty acid were determined. The results showed that as the cooking time increases, the oil yield, density, viscosity, refractive index, peroxide value, iodine value and saponification value decrease. On the other hand, pour point, acid value and free fatty acid increase with increased cooking time. Sample B has the highest oil yield of 29.50%. The study shows that cooking time has various degrees of influence on the yield and physicochemical characteristics of *Delonix regia* seed oil.

Keywords: *Delonix regia*, cooking time, seed oil, yield, physicochemical characteristics.

1. INTRODUCTION

Seed oils are increasingly important in recent times due to the embedded nutritional, industrial and pharmaceutical value (Oyedepi *et al.*, 2017). The oils are applicable for various purposes ranging from food sources for humans and animals alike, raw materials for industries to medicinal and cosmetic uses. Seed oils are specifically useful in the production of edible oils, lubricants, fuel and biodiesel, soap and body care products and for treatment of several skin problems and other diseases such as hair dandruff, muscle spasms, varicose veins and so on (Alemu *et al.*, 2015; Durairaj, 2019; Oyedepi *et al.*, 2017). The numerous uses of seed oils lead to the search for underutilized seeds such as *Delonix regia* seed.

Delonix regia plant, also referred to as flamboyant tree or flame of the forest, belongs to the bean family Fabaceae/Leguminosae. It thrives in tropical climate and is majorly used as ornamental plant or shade tree and also for erosion control (due to its hardy nature and aggressive root system). *Delonix regia* has large flowers with four spreading scarlet or orange-red petals of up to 8 cm long and a fifth upright petal called the standard, which is slightly larger and spotted with yellow and white (Abulude & Adejayan, 2017; Durairaj, 2019). The compound leaves have a feathery appearance, are a characteristic light, bright green, and are doubly pinnate. The dimension of each leaf is about 30–50 cm long with 20 to 40 pairs of primary leaflets, each divided into 10–20 pairs of secondary leaflets. *Delonix regia* has young, green and flaccid pods which turn dark-brown and woody when matured. They can be up to 60 cm long and 5 cm wide. The elongated hard seeds are revealed when the matured pod split open, weighing about 0.4 g on average (Bello *et al.*, 2019; Oyedepi *et al.*, 2017).

The usefulness of the different parts of the *Delonix regia* plant cannot be overemphasized. For instance, it has been reported in literature that its flowers can be used as natural colorant, as an anti-arthritis, anti-inflammatory, acid-base indicator and insecticide (Deepa, 2011; Liladhar *et al.*, 2012; Mariajancyrani *et al.*, 2013). The leaves and seeds have been reported to possess anti-inflammatory, anti-microbial, anti-ulcer, antimalarial and antioxidant potentials (Amata & Nwagu, 2013; Fatmawaty & Astuti, 2013). The



termiticidal properties of the bark were also reported (Rupal *et al.*, 2011). More importantly, the seed of *Delonix regia* contains an appreciable amount of oil. Alemu *et al.*, (2015) stated that the seeds yield thick and dark green oil which is suitable for medicinal uses, hair grease and alternatives source of biodiesel. The oil also finds its use in tanning industry, food and pharmaceutical sectors as the case may be. Therefore, considering the vast usage of *Delonix regia* seed oil, there is need to explore ways of extracting the oil in larger quantity and further study of its properties. This research seeks to accomplish that by investigating the influence of cooking time on the yield and characteristics of *Delonix regia* seed oil.

2. MATERIAL AND METHODS

2.1 Sample Preparation.

The pods of *Delonix regia* were obtained from Federal University of Technology Minna campus, Minna, Nigeria. The pods were split manually to release the seeds from the pods. The seeds were further separated from the chaff, sorted and cleaned to remove all foreign materials like dust, dirt, immature and broken seeds. The clean seed was divided into 4 portions; A was used as control, while B, C and D were cooked in one litre (1L) of distilled water for 30, 60 and 90 minutes respectively. The cooked samples were dehulled; sun dried and milled using a Burr mill. The control sample A was milled without cooking and dehulling. The samples were stored in airtight containers for further analysis.

2.2 Oil extraction from seed

Extraction of oil from the powdered *Delonix regia* seed sample was done using a laboratory-scale soxhlet extractor/apparatus. In the extraction chamber, *Delonix regia* powder was placed in a filter paper which is being suspended above a flask containing 250ml of n-hexane as the extraction solvent; the solvent is heated to reflux. The solvent vapor travels up a distillation arm and floods into the chamber housing the filter paper. The condenser ensures that any solvent vapor will cool 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 about 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°C for one hour (1hour) in order to remove any water molecule (Adewuyi *et al.*, 2010).

2.3 Determination of percentage oil yield

The extraction of oil using soxhlet extractor was carried out 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. This procedure was carried out for all samples. The yield of the extracted oil was expressed as percentage, which is defined as weight of oil extracted over weight of the sample taken as shown (Alemu *et al.*, 2015):

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

2.4 Physicochemical Properties

The physicochemical parameters of *Delonix regia* seed oil such as density, specific gravity, peroxide value, iodine value, saponification value and free fatty acid were determined using standard methods similar to those used by Adewuyi *et al.*, (2010); Ajiboye *et al.*, (2017) and Surlehan *et al.*, (2019). Refractive index was determined using a refractometer (Oyedeki *et al.*, 2017).

2.5 Statistical Analysis and Empirical models

All data recorded from the experiment were analyzed, and compared using analysis of variance (ANOVA) which was carried out using the Statistical Package for Social Sciences (SPSS) for windows 10.0.



3. RESULT AND DISCUSSION

3.1 Effect of Cooking Time on the Oil Yield and Physical characteristics of *Delonix regia* Seed

The results of the effect of cooking time on the yield and physical characteristics of *Delonix regia* seed oil are presented in Table1.

3.1.1 Effect of Cooking Time on the Oil Yield

The percentage oil yield of *Delonix regia* seed for sample A, B, C, D are 15.90%, 29.50%, 21.72%, 18.58%, respectively. Sample B with 30 minutes cooking time gave the optimum oil yield when compared with other samples, as there is a reduction in the oil yield when the seed is cooked above 30 minutes cooking time. These values were also a little lower than the FAO/WHO standard for oil yield (38-40%) (FAO, 2002). However, these values (especially sample B with the highest oil yield) were similar to the oil content of *Delonix regia* seed reported by Alemu *et al.*, (2015) and higher than those of Ajiboye *et al.*, (2017) and Malik *et al.*, (2015). This variation in the oil yield could possibly be due to variation in extraction method, seed and other prevailing conditions (Surlehan *et al.*, 2019).

Table 1: Percentage Yield and Physical Characteristics of *Delonix regia* Seed Oil

Parameters	Sample A	Sample B	Sample C	Sample D	*FAO/WHO
Oil yield (%)	15.90	29.50	21.27	18.58	38-40
Specific gravity	0.900	0.960	0.890	0.910	0.9-1.16
Density (kg/m ³)	1.060	0.990	0.980	0.96	0.88-0.9
Cloud point (°C)	-1	-3	-2	-1	-2±0.55
Pour point (°C)	-2	-4	-3	- 2	1±0.23
Viscosity (mpa/s)	14	22	13	11	
Smoke point(°C)	245	248	221	225	226.10±0.40
Refractive index	1.47	1.46	1.45	1.45	0.5-0.89

*Source: FAO/WHO International standard for edible oils (FAO, 2002)

Sample A-Control; Sample B-30 minutes cooking time; Sample C-60 minutes cooking time; Sample D-90 minutes cooking time

3.1.2 Effect of Cooking Time on the Physical Properties of *Delonix regia* Seed Oil

The specific gravity, densities, cloud point, smoke point and refractive indices of the *Delonix regia* seed oil samples decreased with increase in the cooking time while the viscosity and pour point of the oil increased as the cooking time increases. The values for specific gravity of samples A, B, C and D are 0.90, 0.96, 0.89, and 0.91 respectively are within the range provided by FAO/WHO for edible oil, which is 0.9-1.16. These values are higher than 0.743 reported by Alemu *et al.*, (2015) and 0.79 by Ajiboye *et al.*, (2017). The values of densities (kg/m³) of the seed oil are also within the range provided by FAO/WHO for edible oil, which is 0.88-0.9. The density of *Delonix regia* seed oil as reported by Alemu *et al.*, (2015) was found to be 1.621g/ml, which implies that *Delonix regia* seed oil is suitable for consumption as biofuel, because the higher the mass of oil, the higher energy available for work output per volume. The control sample has the highest density value implying that cooking of *Delonix regia* seed for a period of time has an impact on the density of the seed oil. Based on oil fluidity, sample B with the highest viscosity of 18mpa/s can be used as a lubricant for light duty engine. The results for the cloud point of *Delonix regia* seed oil were similar to the one reported by Alemu *et al.*, (2015). Cloud point is the temperature at which dissolved solids are no longer completely soluble, precipitate as a second phase, giving the fluid a cloudy appearance. Cloud point also determines the storage stability of the oil. Sample B will retain its stability after being stored for a period of time when compared to other samples.



The smoke points of samples A, B, C and D were 245°C, 248°C, 221°C and 225°C respectively. The smoke point indicates the temperature at which smoke is first detected. Sample B has the highest smoke point of 248°C and it is most suitable both for food and for lubricant under high temperature conditions (especially when used as lubricant in moving parts of a mechanical component). Smoke points are the temperatures in which the fat begins to break down into free fatty acids. Heating oil beyond the smoke point changes the chemical composition and they go rancid. Sample A has the highest refractive index of 1.47 which is about the same range as 1.455 for *Delonix regia* seed oil reported by Malik *et al.*, (2015) and 1.458 for date seed oil (Dehdivan & Panahi, 2017). Refractive index indicates the purity of the oil and is dependent on the density of the seed oil.

3.2 The Effect of Cooking Time on the Chemical Properties of *Delonix regia* Seed Oil

The effects of cooking time on the chemical properties of *Delonix regia* seed oil are presented in Table 2.

Table 2: Chemical properties of *Delonix regia* seed oil samples

Parameters	Sample A	Sample B	Sample C	sample D	*FAO/WHO
Free fatty acid (mg/KOH/g)	2.00	1.60	2.40	4.4	5.78-7.28
Acid value (mg/mol/kg)	1.00	0.80	1.2	2.2	2.00-2.60
Peroxide value (Meq/g)	11.8	10.28	9.7	9.1	10.79±1.16
Saponification value (mg/KOH/g)	30.21	37.48	33.20	32.11	90-105
Iodine value (g/100g)	11.86	10.28	9.70	9.10	10±1.16

*Source: FAO/WHO International standard for edible oils (FAO, 2002)

The Free Fatty Acid (mg/KOH/g) of samples A, B, C and D are 4.42, 2.21, 1.60, and 2.40 respectively. Sample A (control i.e. uncooked) has the highest free fatty acid value of 4.42(mg/KOH/g) and could be most suitable for consumption because its value is closer to the range specified for edible oils by FAO/WHO which is 5.78-7.28. Higher values of free fatty acid indicate the quality/edibility of *Delonix regia* seed oil. However, some studies have shown a contrast to this result by reporting that *Delonix regia* oil may not be much desirable in terms of nutrition due to its low percentage of oleic acid (Oyededeji *et al.*, 2017). Previous studies on the fatty acid composition of *D. regia* seed oil have also revealed variation in the composition of free fatty acid (Ajiboye *et al.*, 2017; Deepu Krishnan *et al.*, 2015)

The Acid values (mg/mol/kg) of the oil samples increase as cooking time increases and are within the range of 0.8-2.2. These values are similar to the one recorded by previous studies (Ajiboye *et al.*, 2017; Alemu *et al.*, 2015; Deepu Krishnan *et al.*, 2015). The results of the present study also reveal that saponification values (mg/KOH/g) of the oil range between 30.21-37.48 and decreased as cooking time increases with sample B having the highest value of 37.48. The iodine values (g/100g) range from 9.10-11.86 while peroxide values (Meq/g) between 9.10-11.80 and both decreased as cooking time increases. Higher iodine and peroxide values indicate that *Delonix regia* seed oil contains more unsaturated oil which makes it to be classified as non-dry oil and suitable as a lubricant (Zaharaddeen *et al.*, 2013). These results are comparable to previous studies on *Delonix regia* seed oil, though some have higher values (Ajiboye *et al.*, 2017; Alemu *et al.*, 2015; Deepu Krishnan *et al.*, 2015; Malik *et al.*, 2015; Oyededeji *et al.*, 2017). Zaharaddeen *et al.*, (2013) stated that extent of glycerides constituent decomposition by lipase action and the level of rancidity of the oil can be measured by the peroxide value. The lower the peroxide value, the lower the rancidity and the longer the shelf life of the oil (and vice versa). Hence, sample D with the lowest peroxide value will have the longest shelf life in comparison to other samples. This result is similar to the report of Alemu *et al.*, (2015).



4. CONCLUSIONS

It was concluded that the percentage oil yield of *Delonix regia* seed decreases as cooking time increases. The lower saponification values of *Delonix regia* seed oil show that it contains more unsaturated free fatty acid which is an indicator of the oil quality. *Delonix regia* seed oil is suitable for lubrication due to its high viscosity and has a longer shelf life due to its low peroxide value. The highest oil yield of *Delonix regia* seed obtained in this study was 29.50% at a cooking time of 30 minutes.

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