

## 1 Extraction and Characterization of Oil from DATE PALM (*Phoenixdactylifera* L.) Seed

### 5 Abstracts

6 This work focuses on the extraction of oil from Date palm seed. Using n-hexane in Soxhlet  
7 extraction apparatus, standard procedures were followed to determine the oil feed stock yield.  
8 Proximate compositions and physicochemical characteristics were carried out. Also, Fourier  
9 Transform Infrared Spectrophotometry (FTIR) and Gas Chromatography Mass  
10 Spectrophotometry (GC-MS) were used to determine the covalent bond /functional groups and  
11 the fatty acid composition of the oil respectively. The result shows that the appearance of Date  
12 palm seed oil is reddish brown in colour. Result from the FTIR analysis also shows that 16 peaks  
13 were noticed from Date palm seed oil, indicating the presence of various functional groups such  
14 as OH, C-H, C=C, C=O,  $C \equiv C \wedge C - N$ . The dominating types and number of functional groups  
15 are found on the single bond stretch and on the fingerprint region skeletal vibration. Similarly,  
16 the GC-MS result also reveals that there are 5 dominating fatty acid compounds present in date  
17 palm seed oil in relation to their abundant relative weight composition. In date seed oil, oleic  
18 acid is found to be the only unsaturated fatty acid with the highest weight composition of 49.4%.  
19 The inferences that can be drawn from the results in this work in the area of application suggest  
20 that, date palm seed oil will be suitable for soap production and cleansing agents. Furthermore,  
21 research on the life shelf and storage of the oil should be looked into, as it relates to the  
22 peroxidation of oil.

23  
24 **Key Words:** Proximate, Physico Chemical, Extraction, Date Palm Seed Oil, Functional Group,  
25 Fatty Acid Composition.

### 26 1. INTRODUCTION

27 Date palm (*Phoenix dactylifera* L.) plant is a member of the palm family -*Arecaceae*. It is one of  
28 the oldest cultivated perennial crop/plants on earth, and is being used as food for over 6000  
29 years. Mainly, it is found in Saudi Arabia, Middle Eastern countries and Egypt [5]. The  
30 important quality criteria for consumers are the appearance including color, size and shape,  
31 physical condition and absence of defects, mouth feel or texture, flavor, and nutritional value.  
32 Report has shown that 30-40% of this fruit is mostly consumed in its fresh form, while up to 60 –  
33 70% of it is consumed in its dried form at Rutab (semi-ripe) and Tamar (fully ripe) stages with  
34 little or no processing [8]. The consumption of dates, however, reaches its peak in the Muslim's  
35 holy month of fasting -"Ramadan," when dates are commonly taken to break the fast. The major  
36 component of dates are carbohydrates (mainly the sugars; sucrose, glucose, and fructose), which  
37 may constitute about 70%. Its natural constituents like phytochemicals, sterols, carotenes and  
38 flavonoids have been screened for various medicinal activities to reduce the side effects of  
39 artificial drugs that bring harm to human body systems [1]. The date seed have been used  
40 traditionally as animal feed or roasted to turn it into caffeine-free coffee substitute, which have  
41 been commercialized by the Arabs, but mostly discarded in Nigeria. The Date palm trees are  
42 grown extensively and commercially in the arid region of northern Nigeria from latitude 10°N in

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43 the Sudan savannah and the Sahel regions [6]. Research has also shown that this seed has some  
44 oil content present in it.

45 It is well known that vegetable oils are usually obtained from various sources. These include  
46 common seeds vegetable oils such as Soybean seed oil, Cottonseed oil, Peanuts oil and  
47 Sunflower oil. They also include other oils such as Palm oil, Palm kernel oil, Coconut oil, Castor  
48 oil etc. [The utilization of oil for various applications is largely determined by the yield,  
49 composition, physical and chemical properties of the oil. In Nigeria however, the foremost  
50 sources of edible oils are Peanut (*Arachis hypogoea*) and Palm oil (*Eloesis guineensis*). These  
51 oils are used mainly for cooking, baking, frying, for the production of soap, margarine, paints  
52 and cosmetics [7]. However, increase in demand | has led to | increase in the importation of  
53 cooking oils. In order to bridge this demand gap, there is need to source for local oil-bearing-  
54 seeds which are in most cases discarded as waste and can be used in production of oils both for  
55 consumption and industrial applications. This work will further buttress the opportunity of  
56 making wealth from waste.

57 The aim of this research work was achieved through the following objectives;

- 58 i. extraction and determination of oil yield from Date palm seeds.
- 59 ii. Determination of the proximate compositions of Date palm seeds.
- 60 iii. Determination of the physicochemical properties of oil from Date palm seeds.
- 61 iv. Determination of the functional groups present in the extracted oil using Fourier  
62 Transform Infrared Spectroscopy (FT-IR).
- 63 v. Determination of the fatty acids composition in the extracted oil using Gas  
64 Chromatography Mass Spectrophotometry (GC-MS).

## 66 2.0 MATERIALS AND METHODS

### 67 2.1 Sample Collection and Preparation

68 *Date palm seed Phoenix dactylifera L* was purchased from Marmara in Wukari town of Wukari  
69 LGA, Taraba state. The Sample were screened and cleaned thoroughly to remove the bad ones  
70 and to ensure that it is free from dirt. The seeds were manually crushed and then washed in order  
71 to remove the peels and dry under the sun for four days before grinding to fine particle size

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72 (250-149 $\mu$ m), using mortar and pestle. The grounded sample was put in a plastic bottle and  
73 stored in a refrigerator for further analysis.

## 74 2.2 Procedures and Method of Analysis

75 The procedure and method used in carrying out the proximate, physicochemical, Fourier  
76 transform infrared spectroscopy (FTIR) and Gas Chromatography Mass Spectrometry (GC-MS)  
77 analysis of this study is adopted from the first part of this work by [21] on african locust bean  
78 seed oil and from [4].

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## 80 3.0 RESULTS

### 81 3.1 Results of Proximate Analysis of Date Palm Seeds

82 The proximate analyses of date palm seeds is presented in Table 1.

83  
84 **Table 1. Results of Proximate Analysis of Date Palm Seed**

Proximate parameters	Mean Composition Amount (%)
Moisture	3.34 $\pm$ 0.02
Ash	1.20 $\pm$ 0.04
Crude fibre	6.15 $\pm$ 0.02
Crude fat	1.74 $\pm$ 0.01
Crude protein	5.69 $\pm$ 0.03
Carbohydrates	81.88 $\pm$ 0.12

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### 87 3.2 Results of Oil Yield and Physicochemical Parameters date palm Seed Oil

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89 The percentage oil yield and physicochemical analyses in this study is presented in Table 2.

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91 **Table 2. Results of Oil Yield and Physicochemical Parameters of date palm Seed Oil**

Physicochemical Parameters	Mean Composition Amount (%)
Yield (%)	2.63 $\pm$ 0.03

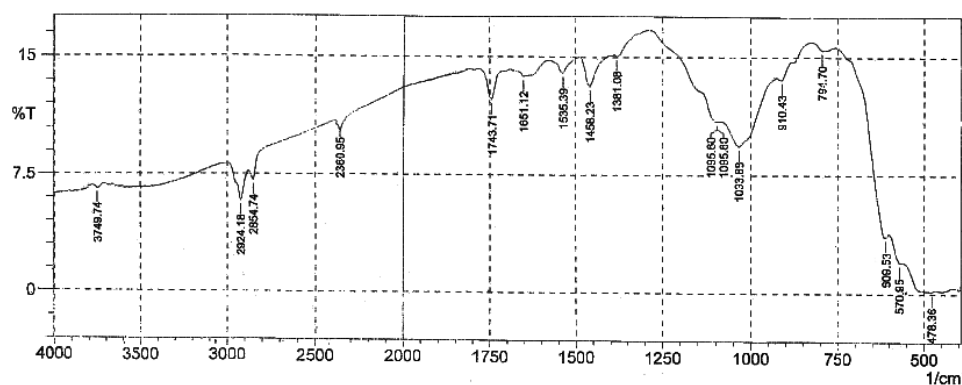
Colour	Reddish Brown
Acid value (mg/g)	1.77±0.03
Iodine value (g/100g)	58.82±0.12
Peroxide value (meqO <sub>2</sub> /kg)	1.91±0.01
Saponification value (mg KOH/g)	213.32±0.13
Specific gravity	1.2323±0.02
Free fatty acid (%)	0.89±0.01

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### 93 3.3 Result of FTIR Analysis on date palm Seed Oil

94 The FTIR analysis on date palm seed oil is presented in Fig. 1.

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97 Figure 1: Result of FTIR analysis on Date palm seed Oil.

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### 100 3.4 Results for GC-MS Analysis on Date Palm Seed Oil

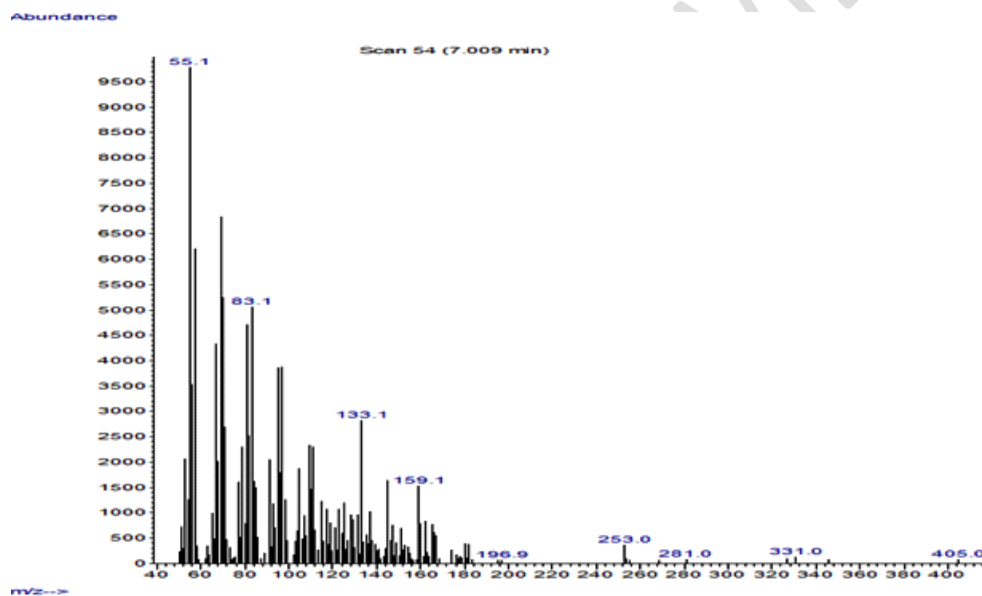
101 The fatty acids compositions of **Date palm** seed oil that were detected in this study are presented

102 on Table 3 below. The result reveals the fatty acids present and their corresponding weight

103 compositions and retention time.

104 Table 3: Result for GC-MS Analysis on **Date** palm seed oil

Retention Time	IUPAC Name	Common Name	Saturation	Weight Composition(%)
5.479	Decanoic acid	Capric acid	C10:0	11.19
6.546	Dodecanoic acid	Lauric acid	C12:0	24.37
7.009	Cis-9-octadecenoic acid	Oleic acid	C18:1	49.40
14.229	Eicosanoic acid	Arachidonic acid	C20:0	7.69
18.070	Docosanoic acid	Behemic acid	C22:0	5.58



105

106 Figure 2: Oleic acid from **Date** palm seed oil (GCMS Analysis)

107 **Discussion of Results**

108 The paramount nutrients to consider when selecting foods for human consumption and as well as

109 animal feeds are crude fibre, crude protein, moisture content, crude fat, ash content and energy.

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110 Therefore, Table 1 presents the results of proximate composition carried out on date palm seed.

111 The result indicates that date palm seed has a moisture content of 3.34%. This relative high  
112 moisture content might be as a result of difference in seed variety or in geographical growth  
113 conditions such as temperature, rainfall and humidity of the seeds [14]. This is also an indication  
114 that date palm seed has a relative low percentage of water which may make it less vulnerable to  
115 microbial attack compared to others like African locust bean (5.12%) as reported by [21], and  
116 also less than cashew seed, moringa seed bitter kola seed and melon seed as reported by [26].  
117 Furthermore, the ash content which is also referred to as mineral content needed by the body was  
118 found to be 1.20% for **Date** palm seed. This value is within the recommended standard limit  
119 proposed by [10], which is within the range of 1-5%. However, in another literature by [11], it is  
120 also recommended that ash content in seeds should fall within the range of 1.5-2.5% in order to  
121 be suitable for feeds in animals. This low value for **Date** palm seed in this work is similar with  
122 values obtained for *Phoenix dactylifera L.* by [19] and [27]. Crude fibre which plays a significant  
123 role in the maintenance of internal distention in intestinal tract was found to be 6.15% for **Date**  
124 palm. This value is less than that of African locust bean seed (9.22%) as observed by [21] and  
125 date pits by [9]. However, it is greater when compared to the report by [27] for *Phoenix*  
126 *dactylifera L.* It is instructive to note that adequate consumption of dietary fibres from a variety  
127 of foods will help to guide against the risk of cardiovascular diseases and colon cancer.

128 Similarly, Fats are important in diet because they promote fat soluble vitamin absorption and are  
129 high energy nutrient. The crude fat value is 1.74% for **Date** palm seeds. The lower crude fat  
130 value of **Date** palm seed depicts low amount of energy giving food. This value is similar to the  
131 research survey of some **Date** palm fruit carried out in some major markets in Minna by [27].  
132 However, this value fell short of the requirement for it to be classified as an oil-rich legume  
133 when compared to soybean [11] and other seeds such as *Citrullus Vulgaris Schrad* by [20] which

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134 is grown in Nigeria. Moreover, the effort to reduce the amount of calories consumed and derived  
135 from fat in some countries such as the United States emphasizes the significance of  
136 understanding the lipid components of food [13].

137 Crude protein is known to enhance growth. In this study, the crude protein values for Date palm  
138 seeds is 5.69%. This value is low when compared with a similar study on Date palm seed by  
139 [19], *Parkia biglobosa* [21] and some legume such as *Phaseolus coccineus* L. [12]. Though, it can  
140 still serve as an alternative source of protein in a country like Nigeria where the staple food is  
141 more of the carbohydrate class. Furthermore, the carbohydrates content in date palm seed is  
142 81.88%. this value is also higher compared to that found in african locust bean seed (52.94%) as  
143 reported by [21], the carbohydrate content of the six different varieties of date palm fruit from  
144 Sudan analyzed by [18] and those for Cranberry bean [12]. According to this study, date palm  
145 seed can actually offer a relative high amount of energy needed by the body and for feed  
146 formulations. This is why it is often recommended and used for breaking fast by Muslims during  
147 Ramadam, since both the edible part of the date palm fruit and its seed are good source of  
148 energy.

149 It is of paramount importance to note that the yield and physicochemical properties of any oil  
150 feed stock and oil extract its self is cardinal when considering it for use for both consumption  
151 and commercial purpose. Therefore, the results of oil yield and physicochemical analysis carried  
152 out on **Date** palm seeds oils is represented in Table 2. The result shows that the mean oil yield  
153 from date palm seed feedstock is 2.63%. This oil yield is lower compared to the oil yield from  
154 African locust bean seed (11.41%) as observed by [21] and a similar study of [28]. The variation  
155 in oil yield may be due to specie, climatic conditions, particle size and method of extraction [14].  
156 This shows that date palm seed may not be a good oil feed stock for commercial purpose in

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157 relation to its yield. Furthermore, physical observation from this study shows that date palm seed  
158 oil is reddish brown in colour, with specific gravity of 1.2323 which is greater than that of water.  
159 According to [25] and [28], date palm seed oil may require bleaching for further use.

160 Acid value which is an index of free fatty acid content and also an indicator for edibility of oil  
161 and suitability for industrial used was found to be lower in *Phoenix dactylifera L* (1.77mg/g) in  
162 relation to African locust bean seed oil (8.96 mg/g) as opine by [21]. The low value in *Phoenix*  
163 *dactylifera L*. indicates negligible amount of free fatty acid present in the oil but is closely  
164 comparable with Castor seed oil and Melon seed oils [28]. The low value of this oil in this study  
165 suggests that the oil is suitable for edible purpose as asserted [22]. The iodine value of any oil is  
166 known to predict and reflect the drying property of an oil. In this study, the iodine value is 58.82  
167 g/100g, but is less compared to *Parkia biglobosa* (82.40 g/100g) as reported by[21]. This value  
168 shows that date palm seed oil does not fall under the category of a drying oil since iodine values  
169 is less than 100 [24]. According to [29], this iodine value also signifies the presence of C=C  
170 double bond in the *Phoenix dactylifera L* seed oil, which can be useful in the production of  
171 hydraulic brake fluid, candle lubricant , oil paint, vanish and cosmetics as reported by [2] and  
172 [23]. Also, the low iodine value (58.82 g/100g) observed in date palm seeds oil is also an  
173 indication that the oil contain low level of polysaturated fatty acid. The storage procedure to be  
174 used should ensure the protection of the oil from oxidative deterioration. This value compared  
175 favorably with values obtained by [15] for **Peanut** oil, [23] for **Shea**-nut oil.

176 The Saponification value for date palm seed oil is 213.32 mgKOH/g, which is higher than  
177 African locust seed oil by [21] but less than melon seed and and bitter kola seed by [26]. This  
178 value suggest that the oils from date palm seed, bitter kola seed and melon seed contain low  
179 molecular weight fatty acids and high molecular weight fatty acids in **african** locust bean seed

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180 since according [10] | AOAC 1990, saponification values greater or equal to 180mg KOH/g has  
181 low molecular weight fatty acid and vice versa. This is evident that the oil from this study will be  
182 suitable for soap production [17] and [3]. The last but not the least physicochemical properties of  
183 the date palm seed oil is the peroxide value, known to be the measure of oxidative rancidity of  
184 oil. in this study, the value is 1.91 meqO<sub>2</sub>/kg. This low value is an indication that the oil may not  
185 be easily vulnerable to deterioration or peroxidation process, but will be able to remain fresh  
186 over a considerable period of time, having a better natural shelf life in comparism to melon seed  
187 oil, moringa seed oil and sesame seed having high peroxide value as reported by [24], and [26].  
188 The essence of FTIR analysis is to know the types and number of functional groups present in  
189 the extracted Date palm oil. This will provide information on the area of application or use of the  
190 oil obtained from Date palm. The result on figure 1 reveals the functional groups present in Date  
191 palm which has a maximum transmittance of 16.5%. Out of the total 16 peaks on the result, 3  
192 were recorded on the single bond stretch spectrum, 1 on the triple bond spectrum, 3 peaks were  
193 observed at the double bond stretch vibration while 9 peaks were recorded on the finger print  
194 region skeletal vibration where C-O, C-N and C-C groups are found.  
195 There is an indication of the presence of hydroxyl (OH) functional group at a peak of 3749.74.  
196 The peaks in the 2924.18 - 2854.74 cm<sup>-1</sup> region signify the presence of C-H functional group for  
197 alkanes on the band stretch. The peak at 1743.71 cm<sup>-1</sup> is attributed to the C=O stretching  
198 vibration of carboxylic esters. The peak at 1651.12 cm<sup>-1</sup> coincide with the C=C vibration of  
199 alkenes. The peak at 1536.39 cm<sup>-1</sup> represents N-O asymmetric stretch of nitro compounds. The  
200 peak at 1458.23 cm<sup>-1</sup> is assigned to C-C stretch aromatic compound. The peaks in the 1095.6-  
201 1033.88 cm<sup>-1</sup> region are represented to the stretching vibration of C-N aliphatic amines. The peak  
202 at 910.43 cm<sup>-1</sup> is ascribed to the C-H double bond unsaturated alkene hydrocarbon, and the peaks

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203 from 794.7 - 570.95  $\text{cm}^{-1}$  are attributed to the C-X stretch of alkyl halides. This result is similar  
204 those found in [16] and [21] for waste cooking palm oil and african locust bean seed oil  
205 respectively.

206 The Gas Chromatography Mass Spectrometry (GC-MS) result as shown on Table 3 for Date  
207 palm seed oil shows that there are 5 fatty acids compounds that are present in relative abundance  
208 quantity. Namely: capric acid, lauric acid, oleic acid, arachidonic acid and behemic acid.  
209 However, oleic acid is the only unsaturated fatty acid present in the date palm seed oil, having  
210 the highest percentage composition of 49.4%, eluting the gas chromatography column at 7.009  
211 mins as shown on table 3 and figure 2 of this work.

212

### 213 **Conclusion**

214 The extraction and characterization of oil from date palm seed feed stock was successfully  
215 carried out to ascertain its potential properties and area of application. Date palm seed in this  
216 study has a relatively low mean oil yield compared to African locust bean seed, melon seed and  
217 sesame seed. The result from proximate analysis is quite reasonable having appreciable high  
218 carbohydrate content favourable as a good energy source for the body and for feed formulation.  
219 The physicochemical properties of this reddish brown oil will be useful for soap production base  
220 on its saponification value. Its iodine value and peroxide value shows that date palm seed oil is  
221 not a drying oil and as such is not susceptible to deterioration or peroxidation; of which when  
222 further refined can also be used for production of hydraulic brake fluid, oil paint, vanish and  
223 cosmetics. The FTIR and gas chromatograph result confirm the edibility of this oil due to the  
224 presence of carboxylic acid/ester functional groups as well as the unsaturation of the dominating  
225 oleic acid.

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226 **COMPETING INTERESTS**

227 No competing or conflicting interests amongst the authors.

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Date palm seed



Ground powdered date palm seed



Date palm seed oil

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329 **Image: Date palm seed, Ground powdered date palm seed and Date palm seed oil**