***Original Research Article***

**Gas Chromatography Mass Spectroscopy (Gc-Ms) Characterization and Physicochemical Evaluation Of *Dialium Guineense* (African Black Velvet Tamarind) Seed Oil**

**ABSTRACT**

This study aimed to determine the physicochemical properties of *Dialium guineense* (African black velvet tamarind)seed oil as well as to determine the bioactive compounds present in order to ascertain its suitability for consumption and industrial uses. This study assessed the moisture content, acid value, iodine value, peroxide value, free fatty acid, saponification value, specific gravity, colour and unsaponifiable matter of the seed oil obtained from *Dialium guineense* dried fruit purchased from Itam market, Uyo, Akwa Ibom State, Nigeria. The seed oil was also characterized to determine the bioactive compounds present. The physicochemical properties and bioactive compounds of *Dialium guineense* seed oil were evaluated using standard methods and Gas Chromatography-Mass Spectrometry (GC-MS) respectively. Results of the physicochemical properties indicated that some key properties such as acid value (14.52 mg KOH/g), iodine value (17.8g/100g), and peroxide value (4.075 meq O2/kg), were within acceptable industrial limits, except for moisture content (3.06%), which exceeded the permissible range. GC-MS analysis identified 65 compounds, with major bioactive components such as undecane, azulene, dodacane, naphthalene, 9,12-Octadecadienoic acid, n-hexadecanoic acid, cis- vaccenic acid, octadecanoic acid, squalene and vitamin E.

*Keywords****:*** *Dialium guineense, Saponification value, cis- vaccenic acid, Gas Chromatography-Mass Spectrometry (GC-MS)*

1. **Introduction**

 Vegetable oils obtained from different oil plants are mainly used as source of food and in the production of cosmetics, lubricants, paints, pharmaceuticals, biodiesel, among others (Taghizadeh et al, 2016). Nowadays, plant –based oils contain a variety of phytochemicals and are largely preferred to animal fat because of its low or complete absence of cholesterol, presence of unsaturated free fatty acids, complex carbohydrates and fat soluble vitamins like as A, D, E, and K (Kostik et al., 2013; Wilcox, 2006; Sandanasamy et al.,2013; Rui et al., 2007).

Although some major oilseeds as enumerated by Ononogbu (2002) are soybeans, groundnuts, cottonseeds, sunflower, rapeseeds, oil palm, and coconut, they are some unexploited sources of phyto-oil, which could be alternative to the conventional plants.

The chemical composition of fixed oil obtained from seeds of various plants are mostly influenced by weather, temperature, genetic composition as well as the stage of development during the time of the study (Pereira et al., 2005; Emara and Shalaby, 2011). The quest for good health by many has led to many researches on healthier and safer alternative to synthetic oil, hence the characterization of oils is important. This helps in determining the properties intrinsic in each oil as well as its suitability or otherwise for consumption and industrial purposes (Bezerra, and Antoniosi Filho, 2014).

*Dialium guineense* commonly known as African black velvet tamarind, “icheku” among the Igbo in the eastern part of Nigeria, as “awin” among the Yoruba in the western part of Nigeria and as “tsamiyar kurmii” among the Hausa in the northern part of Nigeria is a large tree found in many parts of Africa such as West Africa (Nigeria), Central African Republic and the Chad. The tree belongs to the family Fabaceae- caesalpinioidaea, it is 30 meters high, with a densely leafy crown, but often shrubby. The leaves are finely hairy, broadly elliptic, blunt at the apex, leathery and are a sunken midrib. Its flowers appear whitish and the branches are horizontally spread (Szolnok, T.W., 1985; Davies and Yusuf 2017; Abu et al, 2019; Ogungbenle and Ebadan, 2014; Sadipo et al., 2000). Fruits are usually circular and flattened, black in colour with stalk 6mm long, a little collar is seen near the apex and a bristle shell encloses one or two seeds embedded in a dry, brownish edible pulp (Hong, 1996).

Its flowers appear whitish and the branches are horizontally spread. The fruit pulp which is red, with a sweet-sour, astringent flavour which has multiple advantages to human and animals. Black red velvet is essentially a good source of nutrients for humans and animals. It is a good food for human consumption containing several vitamins, trace elements, such as iron which is able to boost red blood production that is needed to prevent anaemia. It also has the potential to reduce micro-nutrient deficiency and lowers body temperature when consumed as raw juice.

Pharmacologically, it is a good diuretic, it is able to bind the toxins and optimize urine excretion in the kidney, therefore preventing the kidney stones disease. It is also able to treat ulcer, eye diseases, jaundice, respiratory and inflammatory disorder such as asthma, allergy, bronchitis etc

(Achoba et al; 1992; Ayessou et al; 2014; Ajiboye et al; 2015; Ogungbenle, 2015; Satya et al*;* 2019).

The xyloglucan polysaccharide derived from tamarind seeds are used as a potential gel (formed by in situ gelation of the xyloglucan gel) for percutaneous administration of non-steroid anti-inflammatory drugs otherwise a vehicle for oral drug delivery (Kawasaki et al., 1999). Recent studies have also revealed that tamarind fruit is a good source of compounds active on complement system and was also showed that the xyloglucan gel formed from tamarind seed can be used as a sustained vehicle for intraperitoneal administration of Mytomycin C, a chemotherapeutic agent (Landi et al., 2007). The fruits of the plant are chewed among some women in south-east Nigeria to improve lactation and check genital infection (Nwosu, 2000). Tamarind intake appears to have beneficial effects on the mobilization of deposited fluoride from bone by enhancing urinary excretion of fluoride (Kumar et al., 2013). The seed extract also exhibits antioxidant potentials by reducing lipid perioxidation in vitro and anti-microbial activity (Barakat et al., 1993).

**2. Materials and Methods**

**2.1 Sample Collection**

The matured dried fruit of *Dialium guineense* were purchased from Itam market, Uyo, Akwa Ibom State, Nigeria.

**2.2 SAMPLE PREPARATION**

The fruits were peeled and soaked in water to remove the pulp. The seed was sun dried for about 17 hours and then milled in a blender to fine flour (2 mm particle size). The flour was preserved an air tight container at room temperature.

*Dialium guineense* seed oil was obtained from the resulting powder by continuous extraction in a Soxhlet apparatus for 6 hours using hexane as solvent according to method described by AOAC (2005).Solvent was recovered by rotary evaporator under reduced pressure and residual oil was oven-dried at 75oC for one hour. The oil was then transferred to a desiccator and allowed to cool before being weighed. The drying, cooling and weighing was repeated until a constant dry weight was obtained. The extracted oil sample was sealed in dark brown coloured glass bottle and kept for analytical tests.

**3. Methodology**

**3.1 Melting point**

*Dialium guineense* seed oil extracted was weighed into a test tube and kept in a refrigerator and a thermometer was inserted into the frozen oil sample. The temperature at which the oil turned into liquid was taken as the melting point (AOAC, 1984).

**3.2 Moisture Content**

The sample of *Dialium guineense* oil (1.0g) was weighed into an empty beaker with known weight and was kept in an oven for six hours at temperature of 105°C.After six hours the beaker was cooled, reweighed after cooling to obtain constant weight (AOAC, 1984).

**Formula:**

Moisture Content = $\frac{b-c x 100}{b-a}$

Where,

 a = weight of empty beaker

 b = weight of beaker + oil before drying

 c = weight of beaker + oil after drying

**3.3 Percentage Yield**

The weight of the sample was obtained before the extraction. After isolation process, the oil recovered was weighed and yield of oil was calculated using the formula below.

Yield of oil = $\frac{weight of oil extracted x 100 }{weight of dried fruit}$

**3.4 Specific Gravity**

The density bottle was washed and weighed (M1). The bottle was filled with boiled and cooled water taken as (M2). Water was poured out and the bottle dried, the sample was poured into the bottle and the weight was taken as (M3).

Specific Gravity = $\frac{M3-M1 }{M2-M1}$

**3.5 Acid Value**

1.0g of oil sample of *Dialium guineense* was added to carbon tetrachloride (10ml) in a conical flask. Phenolphthalein solution (3 drops) was added as an indicator to the solution and titrated with KOH (0.1M), until a colour change was observed. A blank determination was ran (AOAC, 1984). The formula for calculating the acid value is given below.

Acid value = $\frac{(sample Titre \left(ml\right)-blank titre) x 5.61}{weight of sample \left(g\right)}$

**3.6 Peroxide Value**

1.2g of the oil sample was weighed into conical flask. Chloroform (6ml) and acetic acid (9ml) was added in a ratio of 2:3 respectively to saturate KI (5ml). This was allowed to stand for 1min and thereafter 30ml of distilled water was added with starch (2ml) as an indicator. It was titrated with 0.1Na2S2O3 until a yellowish colouration almost disappears to a colourless endpoint (AOAC, 1984). The formula for calculating the peroxide value (PV) is

Peroxide Value = $\frac{1000 \left(V1-V2\right)T}{M}$

Where,

 M = Mass of the oil taken

V1 = Volume of 0.1MNa2S2O3

V2 = Volume of Blank

T = Normality of Na2S2O3 for blank

**3.7 Free Fatty Acid**

 25ml of ethanol was added to 1.0g of the sample contained in conical flask. The sample mixture was boiled and allowed to cool. The essence of boiling was to enable some of the undissolved oil to dissolve. 1cm3(10 drops) of phenolphthalein indicator was added to the solution and titrated with NaOH (0.1M) until a purple colouration was observed (AOAC, 1984).

The Formula:

%FFA = $\frac{V x 0.0282 x 100^{}}{weight of the sample}$

**3.8 Saponification Value**

1.0g of the oil sample was weighed into a conical flask and 25ml of 0.5M ethanolic potash was added. 25cm3 of 0.5M ethanolic potash was added to another conical flask and this was used as blank. Both flasks were boiled in a water bath for 30 mins with frequent shaking. 3 drops of phenolphthalein indicator was added and titrated with 0.5M HCl without delay and with vigorous shaking. After which the blank determination was also titrated (AOAC, 1984).

The Formula:

Saponification Value (SV) = $\frac{\left(b-s\right) 28.05^{}}{W}$

Where

b = Average blank titre

 s= Average sample titre

 w= Weight of the sample

**3.9 Unsaponifiable Matter**

The oil sample of *Dialium guineese* (2g) was added to 0.5M alcoholic potash (25ml) in a conical flask. The flask was attached to efflux condenser and heated in a boiling water bath for 1 hour constantly to ensure complete saponification. The flask was removed from the bath and the content was then transferred to 25ml separating funnel, washing with distilled water (50ml). The conical flask was rinsed with diethyl ether (50ml) and was poured into the separating funnel. This was stopped and shaken vigorously while the content was allowed to stand until the layer separations were clarified. This was evaporated to dryness preferably recovering the ether in a Soxhlet apparatus. The extract was poured into a pre-weighed beaker and heated to constant weight in an oven at 100°C - 111°C (AOAC, 1984).

The Formula:

 Unsaponifiable Matter = $\frac{W2-W1 x 100 }{1g}$

**3.10 Iodine Value**

*Dialium guineense* seed oil extract (0.5g) was dissolved in chloroform (10ml) in a conical flask. Hanus solution (25ml) was added into the flask, corked and allowed to stand for 30mins in the dark. A blank test was carried out without the sample using chloroform (10ml) and Hanus solution (25ml), corked and kept in the dark for 30 mins. After 30 minutes, potassium iodide (15ml, 1%) and distilled water (10ml) was added to each flask with gentle shaking, the content of both flasks was titrated with 0.1M Na2SO3 to pale yellow colouration. Starch solution (2ml) was added as indicator with continuous titration until blue-black colour was formed (AOAC, 1984).

Formula:

Iodine value = $\frac{1.269 (a-b)^{}}{W}$

Where a = 0.1M Na2S2O3 for blank

 b = 1M of 0.1 Na2S2O3 for sample

 w = weight of the sample

**3.11 GC-MS Conditions**

GC-MS was performed on a Varian Factor Four VF-5ms column using helium as the carrier gas. The temperature program ranged from 140°C to 280°C. Data were collected for m/z 40–650 to identify bioactive compounds. Compounds were identified by comparing their mass spectra of some standards and commercial mass spectral databases NIST Mass Spectral Library

4. RESULTS AND DISCUSSION

**Table1: Results of Physico-chemical screening of *Dialium guineense* oil**

|  |  |  |
| --- | --- | --- |
| **Physicochemical properties** |  | **values** |
| Percentage yield (%)  |  | 10.25 |
|  Acid value(mg KOH g-1oil) |  | 14.52 |
| Iodine value (g iodine 100 g-1of oil) |  | 17.8 |
| Peroxide value(Meq KOH/g) |  | 4.075 |
| Free Fatty acid(meq/g) |  | 0.15 |
| Saponification value(mg KOH/goil) |  | 298.25 |
| Specific gravity at 25 °C (g mL-1) |  | 0.812  |
| Colour |  | Golden green |
| Unsaponifiable matter |  | 4.34 |
| Moisture |  | 3.06 |

The result of the physicochemical properties of *Dialium guineense* seed oil is presented in Table 1. The oil had a characteristic golden green coloration and it was liquid at ambient temperature. The percentage yield of *Dialium guineense* oil in this study was 10.25%, which was higher than 4.35% reported by Dressman et al., (2024) for black velvet tamarind gotten from Port Harcourt, Rivers state, Nigeria. The result also indicated that *Dialium guineense* seed is a low oil yielding plant.

Acid value of oil is used to indicate the level of rancidity and edibility of oils (Amos et al., 2012). In this study, black Velvet tamarind seed oil had acid value of 14.52 mg KOH g-1oil, which was lower than 16.55 mg KOH g-1oil reported by Ajayi et al; (2024) and higher than 1.38 mg KOH/g reported by Dressman et al., (2024) for black velvet tamarind seed oil from Ekiti and Rivers states respectively. The difference in acid values maybe due to different sources of oils that differ in moisture content and iron content. It is known that moisture and iron are auxiliary substances for the hydrolysis process, which leads to the release of free fatty acids and, thus, increases the value of acidity measured in oils. (Mohammed 1980). The high acid value reported in this study implied high free acid content, which may lead to high lipolytic activities and a reduced shelf life.

The iodine value of oil can be defined as the number of grams of iodine absorbed by 100 grams of oil. It also indicates the degree of unsaturation of the oil (Ononogbu 2002). According to Codex Alimentarius (1999), lipids are classified as drying and non-drying according to standard based on iodine value. Lipids with iodine values lower than 100gI2/100g oil are referred to as non-drying oil. The iodine value of black Velvet tamarind seed oil from this study was 17.8/100g, indicating that it is non- drying oil. Aremu et al., (2006) reported that the lower the iodine value the lesser the number of unsaturated bonds; thus the lower the susceptibility of such oil to oxidative rancidity and polymerization especially when heated.

Peroxide value is used as a measure of the extent to which rancidity reactions have occurred during storage and it is used as a good criterion for the prediction of the quality and stability of oils (Nangbes et al., 2013). The peroxide value of tamarind seed oil obtained in this study was 4.075meq KOH/g, which was below the maximum acceptable value of 10 meq/KOH/g set by the Codex Alimentarius Commission for oils obtained from vegetable sources. The low acid and peroxide values in this study showed that velvet tamarind seed oil has the ability to resist lypolitic hydrolysis and oxidative deterioration.

Free fatty acid is the Percentage by weight of a specified fatty acid such as percent oleic acid in oil. Free fatty acid (FFA) values are used to indicate the level of rancidity and edibility of oils (Amos et al., 2013). The free fatty acid in this study 0.15 meq/g was below the permissible limit of free fatty acid for oil by both FAO/WHO and Ethiopian Standards (ES) is (1.0- 3.0%). Therefore, the low level of % free fatty acid in this study indicated that the sample oil is edible and would not spoil easily via oxidative rancidity.

Saponification value is an index of average molecular mass of fatty acid in the oil sample. The saponification value obtained for black Velvet tamarind seed oil from this study (298.25mg KOH/g) was lower than 330.7mgKOH/g reported by Ajayi et al; (2024). It was also observed that the saponification value in this study was higher than the values 195–205 mg KOH/g of oil

for edible palm oils as specified by SON (2000) and NIS (1992). Oils with saponification value of 200 mg KOH/g and above have been reported to possess low molecular weight triglycerides (Abayeh et al., 1998). The result implied that black velvet tamarind seed oil is a good source of essential fatty acids required in the body and can be used in the preparation of liquid soaps, shampoos and cosmetic products.

Specific gravity is the ratio of the density of a respective substance to the density of water at 4°C (Bamgboye and Adejumo, 2010). The density of vegetable oils is dependent on their fatty acid composition, minor components and temperature (Fakhri et al., 2011). The result obtained in this research indicated that tamarind seed oil had a specific gravity of 0.812, showing that the oil of tamarind was less dense than water. It is reported that high specific gravity is a good indicator of the purity of the oil and depends on the number of double bonds and chain length of fatty acids (Pearson, 1971).

The determination of water content in oils is quite valuable because the conversion of the triglycerides in oils to free fatty acids is just one of the side-reactions that lead to oil decomposition. From the result obtained, the moisture content in tamarind seed oil (3.06) was above 0.2% permissible limit for oil, which may be attributed to improper treatment during oil processing. This may encourage microbial growth, rancidity and reduces shelf –life of the oil.

Unsaponifiable matters which include hydrocarbons, sterols, vitamins and pigments compounds usually play crucial roles in the oil stability (Umezuruike et al, 2016). The high unsaponifiable matter of tamarindoil suggest that the oil may contains natural antioxidants such as sterols, tocopherols, phenolics, lycopene and carotene (Ikram et al., 2015).

**Table 2: GC-MS analyses of the oil extracts from *Dialium guineense* seed oil**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **PK** | **RT** | **Area Pct.** | **Library/ID** | **Ref** | **CAS** | **Qual** |
| 1 | 1 | 7.5148 | 0.1099 | 2-Heptenal, (E)- | 6608 | 018829-55-5 | 68 |
| 2 | 2 | 8.9374 | 0.1386 | Benzene, 1,2,4-trimethyl- | 9590 | 000095-63-6 | 94 |
| 3 | 3 | 10.9089 | 0.1632 | Benzene, 4-ethyl-1,2-dimethyl- | 15224 | 000934-80-5 | 94 |
| 4 | 4 | 11.4688 | 0.1514 | Benzene, 2-ethyl-1,4-dimethyl- | 15226 | 001758-88-9 | 92 |
| 5 | 5 | 11.698 | 0.1178 | Benzene, 2-ethyl-1,3-dimethyl- | 15215 | 002870-04-4 | 97 |
| 6 | 6 | 12.1056 | 0.3855 | Nonanal | 20436 | 000124-19-6 | 64 |
| 7 | 7 | 12.2723 | 0.11 | Benzene, 1,2-diethyl- | 15178 | 000135-01-3 | 60 |
| 8 | 8 | 12.6721 | 1.7863 | Undecane | 29355 | 001120-21-4 | 93 |
| 9 | 9 | 12.7668 | 0.5573 | Benzene, 1,2,4,5-tetramethyl- | 15208 | 000095-93-2 | 95 |
| 10 | 10 | 13.2411 | 0.5997 | 1-Methyldecahydronaphthalene | 26217 | 002958-75-0 | 98 |
| 11 | 11 | 13.5265 | 0.3909 | Benzene, 1-methyl-2-(2-propenyl)- | 14407 | 001587-04-8 | 64 |
| 12 | 12 | 13.5873 | 0.3369 | Benzene, 1-methyl-4-(1-methylpropyl)- | 23448 | 001595-16-0 | 60 |
| 13 | 13 | 13.6934 | 0.3522 | Benzene, 1,2,4,5-tetramethyl- | 15208 | 000095-93-2 | 95 |
| 14 | 14 | 13.8084 | 0.2385 | Naphthalene, 1,2,3,4-tetrahydro- | 14398 | 000119-64-2 | 55 |
| 15 | 15 | 14.0666 | 0.1673 | Benzoic acid, 2,4-dimethyl-, (2,4-dimethylphenyl)methyl ester | 128769 | 055000-43-6 | 47 |
| 16 | 16 | 14.2039 | 0.3089 | Benzenepropanal, .beta.-methyl- | 23310 | 016251-77-7 | 46 |
| 17 | 17 | 14.3446 | 1.108 | Azulene | 12191 | 000275-51-4 | 95 |
| 18 | 18 | 14.4566 | 0.6659 | Benzene, 1-methyl-4-(1-methylpropyl)- | 23448 | 001595-16-0 | 80 |
| 19 | 19 | 14.6482 | 0.5069 | Decane, 2,9-dimethyl- | 39997 | 001002-17-1 | 72 |
| 20 | 20 | 14.7897 | 0.8366 | Benzene, (1,2-dimethyl-1-propenyl)- | 22219 | 000769-57-3 | 62 |
| 21 | 21 | 14.9156 | 0.3139 | Naphthalene, decahydro-2,6-dimethyl- | 36616 | 001618-22-0 | 76 |
| 22 | 22 | 15.7192 | 2.3632 | Dodecane | 39974 | 000112-40-3 | 95 |
| 23 | 23 | 16.182 | 0.6904 | Undecane, 2,6-dimethyl- | 51435 | 017301-23-4 | 94 |
| 24 | 24 | 16.5796 | 0.2349 | Benzene, (1-methyl-1-butenyl)- | 22201 | 053172-84-2 | 93 |
| 25 | 25 | 16.7225 | 0.333 | Cyclohexane, (4-methylpentyl)- | 38371 | 061142-20-9 | 83 |
| 26 | 26 | 16.9596 | 0.2986 | Naphthalene, 1,2,3,4-tetrahydro-5-methyl- | 22245 | 002809-64-5 | 86 |
| 27 | 27 | 17.2652 | 0.3397 | Nonanoic acid | 31237 | 000112-05-0 | 53 |
| 28 | 28 | 17.4725 | 0.2711 | Undecane, 2,8-dimethyl- | 51416 | 017301-25-6 | 18 |
| 29 | 29 | 17.6548 | 1.524 | Naphthalene, 1-methyl- | 19727 | 000090-12-0 | 95 |
| 30 | 30 | 17.9298 | 0.5789 | Tridecane, 7-methyl- | 63634 | 026730-14-3 | 90 |
| 31 | 31 | 18.082 | 0.5887 | Naphthalene, 1-methyl- | 19727 | 000090-12-0 | 95 |
| 32 | 32 | 18.2475 | 0.1771 | 2-Hexen-4-yn-1-ol, (E)- | 2844 | 053497-80-6 | 58 |
| 33 | 33 | 18.6313 | 0.8761 | Tridecane | 51394 | 000629-50-5 | 95 |
| 34 | 34 | 20.8237 | 0.3313 | Oxalic acid, 2-ethylhexyl isohexyl ester | 146000 | 1000309-38-8 | 46 |
| 35 | 35 | 21.1435 | 0.1856 | Naphthalene, 1,8-dimethyl- | 29426 | 000569-41-5 | 97 |
| 36 | 36 | 21.2946 | 0.2197 | 3H-3a,7-Methanoazulene, 2,4,5,6,7,8-hexahydro-1,4,9,9-tetramethyl-, [3aR-(3a.alpha.,4.beta.,7.alpha.)]- | 68867 | 002387-78-2 | 97 |
| 37 | 37 | 21.3952 | 0.6277 | Tetradecane | 63624 | 000629-59-4 | 97 |
| 38 | 38 | 23.6103 | 0.2001 | 1,3-Benzodioxole, 4-methoxy-6-(2-propenyl)- | 57377 | 000607-91-0 | 98 |
| 39 | 39 | 24.0008 | 0.294 | Pentadecane | 76606 | 000629-62-9 | 83 |
| 40 | 40 | 26.4879 | 0.5974 | Hexadecane | 89843 | 000544-76-3 | 95 |
| 41 | 41 | 28.7331 | 0.1101 | Heptadecane | 102599 | 000629-78-7 | 93 |
| 42 | 42 | 29.3907 | 0.064 | Tetradecanoic acid | 91420 | 000544-63-8 | 64 |
| 43 | 43 | 30.0725 | 0.1104 | 17-Pentatriacontene | 265113 | 006971-40-0 | 87 |
| 44 | 44 | 30.1972 | 0.5051 | Octadecane | 115547 | 000593-45-3 | 97 |
| 45 | 45 | 30.4963 | 0.201 | 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester | 138182 | 000084-69-5 | 86 |
| 46 | 46 | 31.2639 | 0.2835 | Nonadecane | 128834 | 000629-92-5 | 89 |
| 47 | 47 | 31.343 | 0.1681 | Hexadecanoic acid, methyl ester | 130817 | 000112-39-0 | 87 |
| 48 | 48 | 31.4485 | 0.541 | Palmitoleic acid | 115311 | 000373-49-9 | 98 |
| 49 | 49 | 31.7256 | 23.3112 | n-Hexadecanoic acid | 117416 | 000057-10-3 | 99 |
| 50 | 50 | 31.938 | 0.1536 | 3-Eicosene, (E)- | 140277 | 074685-33-9 | 56 |
| 51 | 51 | 32.1167 | 0.4576 | Eicosane | 142240 | 000112-95-8 | 96 |
| 52 | 52 | 32.6154 | 0.1232 | 1-Eicosene | 140273 | 003452-07-1 | 90 |
| 53 | 53 | 32.6514 | 0.1539 | Estra-1,3,5(10)-trien-17.beta.-ol | 117583 | 002529-64-8 | 90 |
| 54 | 54 | 32.7126 | 0.3109 | Estra-1,3,5(10)-trien-17.beta.-ol | 117583 | 002529-64-8 | 91 |
| 55 | 55 | 32.7634 | 0.1945 | Estra-1,3,5(10)-trien-17.beta.-ol | 117583 | 002529-64-8 | 93 |
| 56 | 56 | 32.9817 | 24.4678 | 9,12-Octadecadienoic acid (Z,Z)- | 140138 | 000060-33-3 | 99 |
| 57 | 57 | 33.033 | 14.0245 | cis-Vaccenic acid | 142073 | 000506-17-2 | 99 |
| 58 | 58 | 33.177 | 6.2293 | Octadecanoic acid | 144272 | 000057-11-4 | 99 |
| 59 | 59 | 33.5461 | 0.3258 | Cycloeicosane | 140274 | 000296-56-0 | 91 |
| 60 | 60 | 33.6245 | 3.1497 | Squalene | 243219 | 000111-02-4 | 99 |
| 61 | 61 | 34.2683 | 0.1519 | Eicosane | 142238 | 000112-95-8 | 90 |
| 62 | 62 | 34.6753 | 1.9717 | Vitamin E | 250946 | 000059-02-9 | 99 |
| 63 | 63 | 34.8985 | 2.4163 | Tridecane, 7-propyl- | 89845 | 055045-09-5 | 91 |
| 64 | 64 | 35.9686 | 0.2719 | Cycloeicosane | 140274 | 000296-56-0 | 94 |
| 65 | 65 | 36.124 | 0.2258 | Bis(tridecyl) phthalate | 269430 | 000119-06-2 | 80 |



Fig .1 GC-MS analyses indicated the tamarind oil contained a wide range of bioactive compounds

GC/MS was used in identifying bioactive compounds present in the oil obtained from black velvet seeds. The GC-MS analyses indicated that the tamarind oil contained a wide range of bioactive compounds as presented in Table 2 and Figure 1. The identified compounds, their retention indexes and percentage composition of each compound were given in the Table 2. The results obtained indicated that sixty five (65) compounds were identified. The identified bioactive compounds consist of aldehydes, alkanes, alkenes, alcohols, terpenoids, saturated and unsaturated fatty acids, fatty acid esters and aromatic hydrocarbons. The major compounds identified were undecane, azulene, dodacane, naphthalene, 9,12-Octadecadienoic acid, n-hexadecanoic acid, cis- vaccenic acid, octadecanoic acid, squalene and vitamin E.

Alkanes, alkenes and aromatic compounds are secondary metabolites with antimicrobial, antioxidant, antiviral, anticancer and anti-inflammatory properties (Bakkali et. al., 2008; Zhang et. al., 2015).

Azulene is an isomer of naphtalene. It is an essential oil that is used in skincare to treat inflamation and it also has anti bacterial effects (Kumar et al.,2012).

Dodecane is a hydrocarbon reported by Mou et al, (2013) to possess potent antifungal and antibacterial activities.

 Squalene, a triterpene is reported to have antibacterial, antioxidant, antitumor and anticancer properties. It is also known for its immuno-stimulant, chemo preventive, Lipoxgenase inhibitory, neurotransmission and Pesticidal properties (Kesava and Usha –Rani 2016; Agnel and Mohan 2014; Sasaki et al; 2019; Amarowicz et al; 2009).

Cis-Vaccenic acid is a monounsaturated Omega-7 fatty acid known for its anticancer, antibacterial and hypolipdermic properties (Kehkashan et al; 2016; Hamazaki et al., 2016; Semwal et al., 2018).

n-Hexadecanoic acid commonly known as Palmitic acid is a saturated fatty acid known to have antioxidant, antiinflammatory, hypo-cholesterolemic anti-inflammatory, anticancer, hepatoprotective, anti-arthritic, and anti-coronary properties (Adnan et al; 2019; Sera et al., 2021; Siswadi and Saragih, 2021).

Octadecanoic acid commonly known as stearic acid is a saturated fatty acid reported to have antimicrobial and antioxidant properties by Singh and Chaturvedi (2019).

9, 12-Octadecadienoic acid (also known as linoleic acid) belongs to omega 6-fatty acids used in the biosynthesis of arachidonic acid and thus some prostaglandins, thromboxane and leukotrienes collectively known as eicosanoids. It is reported that linoleic acid exhibits hepatoprotective, anti-histaminic, anti-acne, 5-α reductase inhibitor, anti-androgenic, anti-arthritic, and anti-coronary activities (Rehana and Nagarajan, 2013).

Vitamin E, also known as tocopherol is involved in the oxidative stability of the oil and has a protective role against cancer and cardiovascular diseases. It is vital to the formation and normal

function of red blood cell and muscles (Yoshida et al, 2003; Lukaski, 2004).

Other compounds with low concentrations such as 3- eicosene, Estra-1,3,5(10)-trien-17.beta.-ol

 and eicosane possess biological activities such as antimicrobial, antitumor, anti-arrhythmic and cytotoxic activities (Yogeswari et al, 2012; Akpuaka et al, 2013).

**4. CONCLUSION AND RECOMMENDATIONS**

**4.1 Conclusion**

The physicochemical properties of *Dialium guineense*seed oil were determined to ascertain its suitability or otherwise for consumption and industrial uses. The oil from the seeds was analyzed

using GC-MS. The result obtained indicated that *Dialium guineense* is a low oil yielding plant. The results also showed that the physicochemical properties determined in the seed oil under study were within the permissible limits as stipulated by different regulating bodies except the moisture content, which was significantly above the permissible limit. The result of the GC-MS analysis of the seed oil of *Dialium guineense* revealed that 65 bioactive compounds were identified. The most abundant compounds identified with respect to their % peak areas were undecane, azulene, dodacane, naphthalene, 9,12-Octadecadienoic acid, n-hexadecanoic acid, cis- vaccenic acid, octadecanoic acid, squalene and vitamin E. The biological activities of each of the identified phyto-components ranged from antimicrobial, anti-inflammatory, anticancer, antioxidant and antitumor activities. The nature of the identified compounds is mostly organic acids, aldehydes, alkanes, alkenes, alcohols and terpenoids. This study further revealed that the seed oil of *Dialium guineense* has many bioactive compounds of biological importance; hence it’s fit for consumption and industrial uses.

**4.2 Recommendations:**

since oils obtained from plants also known as phyto- oil remain the best alternative to synthetic oils, there is need for extensive characterization and isolation of potent bioactive compounds from some unexploited sources of phyto-oil, which could be alternative to the conventional plants. Extensive research should be carried out to evaluate the specific roles played by the bioactive compounds obtained from the seed oil of *Dialium guineense* and their potential health and industrial benefits when consumed and used industrially respectively.

**DISCLAIMER (ARTIFICIAL INTELLIGIENCE)**

Authors hereby declare that NO generative AI technologies such as large language models, (ChatGPT, COPILOT etc) and text to image generators have been used during writing or editing the manuscript.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist

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