INTRODUCTION

The demand for edible oils have increased tremendously in recent years. This is due to the ever increasing world’s population and their industrial applications. Edible oils can be gotten from both plants and animals. However, about 80% of the edible oils are obtained from plants sources (Damude and Kinney, 2008), most especially plant seeds.

Edible oils obtained from plant seeds have wide applications, they are used as cooking oils, or they may be solidified to make fat in food industries (Adebayo et al., 2012). This makes them an important component of diet. They contain lipids and fatty acids that are important for human health, though in varying quantities (Dyer et al., 2008). In addition, some fatty acids in these oils also make them useful for cosmetic production in industries due to their beneficial properties. For example, linoleic acids helps to moisturize the skin when used in cosmetic products, it also aids healing of dermatoses and sun burns (Vermaak et al., 2011).

Moringa oleifera Lam. is a small graceful deciduous and fast growing tree with sparse foliage that is widely cultivated in different part of Nigeria. It belongs to the family Moringaceae and grows up to 8 m in height (Ambi et al., 2011). Every part of the plant is edible and have nutritional and commercial uses (Fahey, 2005). The major source of moringa oil is the seeds. The seeds are round with a brownish semi-permeable seed hulls with an average weight of 0.3g. Each tree can produce 15 000 and 25 000 seeds per year (Pant, 2016). The pods are used in culinary preparation, and the seeds can be fried and eaten. Moringa seeds have been reported to have a high content of methionine and cysteine similar to those found in milk (Leone et al., 2016), in addition to having antimicrobial activity. The Moringa oleifera seed oil is known as ‘Ben oil’ and is used in salad, and also as lubricant (Anwar et al., 2006).

The use of edible seed oils for nutritional, industrial and pharmaceutical purposes has increased demand on the need to characterize and provide information on the lipid composition of more under explored seed oil, in order to meet the demand of the growing population. This study therefore, aim to characterize and provide information on the lipid content of Moringa oleifera seed oil.

MATERIAL AND METHODS

Seed Collection and Identification

The seeds of Moringa oleifera were collected from house yards around Federal Locust Makurdi, Benue state, Nigeria. The seeds were identified at the Department of Biological Sciences, University of Agriculture Makurdi, Benue State, Nigeria while the research was conducted at the Department of Biochemistry, Kogi State University, Nigeria. The seeds were sun dried and the seed coat removed manually. The dehulled seeds were further dried at 60°C in an oven for 48 hours.

Oil Extraction

The oven dried seeds were ground to fine powder using a mortar and pestle. Oil was extracted from the ground seed by Soxhlet extraction method using n-hexane. To extract the oil, 100g of sample, 50g each was accurately weighed into a Watman filter paper, wrapped and the weight taken. The weighed sample were then fed into a Soxhlet apparatus fitted with a 500ml round bottom flask. About 300ml of n-hexane was used and extraction carried out for 6 hours. After which the solvent was completely evaporated over a water bath.

Percentage (%) Yield

After complete evaporation of the solvent, the weight of the extracted oil was taken and the percentage yield calculated as:

\[
\text{Percentage (\%)} \text{ yield} = \frac{\text{weight of extracted sample}}{\text{original weight of sample}} \times 100
\]

Chemical Analysis

Saponification value, iodine value, acid value were determined by the methods described by Amadi et al. (2004). The free fatty acid value and ester value were determined by standard methods recommended by A.O.A.C (1980). Peroxide value was determined by the method described by Pearson (1962).

High performance liquid chromatography (AKPA HPLC) was used to determine the fatty acid profile and \( \alpha \)-tocopherol content.

Sample Preparation

To prepare the sample for HPLC analysis, 0.5g of Moringa oleifera seed sample was weighed into 10ml capped bottle...
and 10 ml of n-hexane (BDH HPLC grade) added. The mixture was left overnight after shaking. The content was then centrifuged and supernatant pipetted and kept for fatty acid and α-tocopherol analysis.

**Determination of fatty acid composition**

The fatty acid composition was done by method described by Friday et al. (2011). An amount (2.0 ml) of Moringa oleifera oil was measured into a test tube and 0.3 ml of 1 M sodium methoxide was mixed thoroughly and left overnight and centrifuged. The clear solution was decanted and evaporated to dryness and then 2.0 ml of acetonitrile (BDH HPLC grade) was added to dissolve the precipitate. Then 2.0 µl was injected into the HPLC with column ODS-2 (18) detector, UV at 215 nm and F/R = 1 µl/min. The fatty acids was calculated with reference to the standards using this formula:

\[
\text{Conc. of sample} = \frac{\text{Peak area (in AU µl) of sample}}{\text{Peak area (in AU µl) of Standard}} \times \text{conc. of standard}
\]

**Determination of α-tocopherol content**

The α-tocopherol content was determined by the method described by Friday et al. (2011). The extracted moringa oil (2.0 ml) was measured into a test tube and the hexane evaporated through nitrogen gas. Methanol (HPLC grade) (2.0 ml) was added to dissolve the vitamin then 20 µl of the mixture was injected into the HPLC with ODS-2 C18 detector, UV at 290 nm and F/R = 10 µl/min.

**Determination of Sterol Composition**

The sterol composition was determined by A.O.A.C (1990).

**Statistical analysis**

Analysis of Moringa oleifera seed sample was carried out and results were reported as mean ± SD. Samples were prepared and measured separately in triplicate. The results of the lipid profile were in percentages.

### RESULTS AND DISCUSSION

The oil yield and chemical properties of the seed oil of Moringa oleifera are shown in Table 1. The oil extracted from the Moringa oleifera seeds has a yellow colour, liquid at room temperature with an agreeable and characteristic odour. The oil content of Moringa oleifera seed from Makurdi was not so different from those reported by Anhwange et al. (2004) and Ogbumugafur et al. (2011) which were 41.58% and 41.47% respectively. However, the oil was slightly higher than those reported (38.30%) by Lalas and Tsakins (2002). The variation in the oil yield of M. oleifera seeds might be attributed to the genetic composition of the plant or variation in geographic conditions.

### Table 1: Percentage Yield, Organoleptic and Chemical Parameters of Moringa oleifera Seed Oil

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M. oleifera oil</th>
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<tbody>
<tr>
<td>Organoleptic</td>
<td></td>
</tr>
<tr>
<td>Colour</td>
<td>Yellow</td>
</tr>
<tr>
<td>Odour</td>
<td>Characteristic</td>
</tr>
<tr>
<td>State at room temperature</td>
<td>Liquid</td>
</tr>
<tr>
<td>Yield (%)</td>
<td>41.16</td>
</tr>
<tr>
<td>Iodine value (g/100g of oil)</td>
<td>67.56 ± 0.10</td>
</tr>
<tr>
<td>Saponification value (mg of KOH/g)</td>
<td>174.40 ± 0.20</td>
</tr>
<tr>
<td>Acid value (mg/KOH/g)</td>
<td>3.13 ± 0.01</td>
</tr>
<tr>
<td>Peroxide value (meq/kg)</td>
<td>1.80 ± 0.00</td>
</tr>
<tr>
<td>Ester value</td>
<td>171.27 ± 0.19</td>
</tr>
<tr>
<td>Free fatty acid (%)</td>
<td>1.58 ± 0.70</td>
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</table>

Each value is mean of three replicates ± SD (Standard deviation)

Iodine value indicate the degree of unsaturation of oil. The iodine value of the Moringa oleifera seed oil was 67.56 ± 0.10. The saponification value was 174.40± 0.20. The saponification value was comparable to those obtained (178.11) by Tsakins et al. (1999). Saponification value provides information about the fatty acids present and the ability to make soap. The high saponification value of the oil suggest that the oil is suitable for making soap, lather shaving creams, shampoo, oil based ice-cream and cosmetics (Adebayo et al., 2012). In addition, the high saponification value also indicates that the oil contains a high proportion of lower fatty acids, and therefore can be regarded as an edible oil. The acid value was 3.13± 0.01. The low acid value indicates a possible low free fatty acid composition which suggest lesser susceptibility to hydrolysis (Li et al., 2007). The peroxide value 1.80± 0.00 obtained for the Moringa oleifera seed oil is comparable to those from Kenya (Tsakins et al., 1999) but different from those of Pakistan and Malawi (Anwar and Rashid, 2007). Since peroxide value indicate the oxidative rancidity of the oil, the low peroxide value show that the oil is less prone to rancidity and it is stable (Adebayo et al., 2012). In addition, the peroxide value was observed to be lower than the stipulated FAO/WHO (2009) standard. The lower peroxide value therefore suggest that the oil is suitable for consumption.

The ester value obtained was 171.27 ± 0.19. The high ester value of the oil show that high proportions of glyceride are intact and that the oil is of appreciable quality (Anhwange et al., 2004). The free fatty acid value was 1.58 ± 0.70. Free fatty acid value indicates the deteriorating condition and edibility of the oil. The low free fatty acid value suggest that the oil is edible. The low free fatty acid also indicate that the oil is suitable for refining. This is because oil with high free fatty acid result in loss of neutral oil during the refining process (Aremu et al., 2015). High amount of free fatty acids can also lead to the development of objectionable flavour and odour and reduction in the half-life of the oil.

The lipid profile of Moringa oleifera seed oil is shown in Table 2. The following fatty acids were identified from the analysis: oleic acid, stearic acid, myristic acid, palmitic acid, linoleic acid and linolenic acid. Oleic acid has the highest percentage among the fatty acids with a percentage of 67.67%. This result is comparable to those reported by Abdulkarim et al. (2005). The value of α-tocopherol obtained in this study was 10.25%. Oleic acid is an unsaturated fatty acid with one double bond. The high percentage of oleic acid

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in the oil makes it desirable for cooking and frying. Vegetable oils such as those obtained from canola, corn and sunflower with high oleic content have demonstrated a strong stability to oxidation when used in frying (Bouanga-Kalou et al., 2014).

Table 2: Lipid Profile of Moringa oleifera Seed Oil

<table>
<thead>
<tr>
<th>Lipid profile</th>
<th>Composition (%)</th>
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</thead>
<tbody>
<tr>
<td>Oleic acid</td>
<td>69.67</td>
</tr>
<tr>
<td>Searic acid</td>
<td>1.99</td>
</tr>
<tr>
<td>Myristic acid</td>
<td>1.01</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>6.96</td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>1.60</td>
</tr>
<tr>
<td>Linolenic acid</td>
<td>1.30</td>
</tr>
<tr>
<td>Sterol</td>
<td>0.70</td>
</tr>
<tr>
<td>a-tocopherol</td>
<td>10.25</td>
</tr>
</tbody>
</table>

Each value represents percentage (%) composition of the lipid profile

Oleic acid in diet is important for human health. Oleic acid in olive oil has been reported to be associated with prevention of breast cancer (Win, 2005). Tocopherols have antioxidant activity, the present of tocopherol in the oil can offer some protection during storage and processing. Alpha tocopherols also play several biochemical function in the body. They have been reported to modulate expression proteins involved in cholesterol metabolism and cell proliferation and inhibition (Grilo et al., 2014).

CONCLUSION
The analysis of the chemical characteristics and lipid profile of the Moringa oleifera seed oil confirm that the oil has potential as both an edible and industrial oil. The oil should be fully exploited for nutritional, industrial and pharmaceutical use.

REFERENCES


