Extraction and Physicochemical Determination of Garlic

(Allium sativum L) Oil

Gafar M. K., A. U. Itodo, A. A. Warra and L. Abdullahi

Abstract—The oil was extracted from powder of garlic cloves using soxhlet extraction method with n-hexane as the solvent. The garlic cloves give 22.5% oil yield with specific gravity density of 0.90g/cm³. The oil is light yellow in colour with a pungent smell. The chemical analyses revealed saponification value of 192 ± 1.00mgKOH/g, peroxide value of 2.5 ± 0.50mg/100g, acid value of 4.18 ± 0.01mgKOH/g, free fatty acid value of 2.10 ± 0.05% and iodine value of 12.69 ± 0.05g/100g. These results obtained shown that the oil could be of benefit for soap production.

Index Terms — chemical analysis, Extraction, Garlic oil, oil yield, Industrial uses.

I. INTRODUCTION

Allium the Latin word given to garlic[1], a flowering plant with hundreds of distinct species; which many have been harvested through human history, but only about a dozen are still economically important today as crops or garden vegetables[2]. One of the species belong to this genus is the Allium sativum L. also known as the cultivated garlic, which belong to the onion family Alliaceae and closely related to the onion, shallot, leek, chive, and rakkyo[3]. It has been used throughout recorded history for both culinary and medicinal propose[4]. Garlic plant is moderately tall (up to three feet) it is an erect herb normally grown as an annual that is a plant that only last for a year, it has adventitious roots and condensed, flattened stem and narrow flat leaves. The bulb consists of 6 to 35 bulblets called cloves with glistening and transparent covering, the plant grows as a vegetable rosette close to the ground, the leaves is broad like kidney shaped. The plants also produce an erect flowering stem with numerous quitter inch. The majority of Allium species are native to the Northern hemisphere, mainly in Asia. A few species are native to Africa and South America. They grow in various conditions from dry, well-drained mineral-based soil to moist organic soil, most grow in sunny locations but a number also grow in forests, or even in swap water areas[5].

Allium sativum L. consist of sulfur containing compounds such as allicin, alliin, diallyl disulfide, dithin and S-allylcysteine. These large number of sulfur compounds contributes to the smell and taste of garlic. Diallyl disulfide is believed to be an important odour component in the garlic. Allicin has been found to be the compound most responsible for the spiciness of the raw garlic and being a powerful antibiotic and antifungal compound, it believe to be the agent responsible for the speed recovery from strep throat or other mild ailments when garlic is used[6]. Garlic contain oil which is an essential oil, the oil is extracted by process of steam distillation of the garlic cloves using n-hexane as solvent.

Essential garlic oil contains variety of sulfide such as diallyl disulfide and dillyl trisulfide. During the process allicin is completely eliminated from the oil[7]. Commercially available garlic oil capsules generally contain vegetable oil and a small amount of garlic essential oil because of the pungent odors. Other garlic supplements fall into one of these categories, dehydrated garlic powder, garlic oil macerate and aged garlic extract[8]. Garlic oil has numerous uses in the world today, its uses include the flavouring some cuisine like salads, and sauces[9]. The regular consumption of garlic oil can reduce blood pressure, prevent heart disease including atherosclerosis, high cholesterol and cancer[10]. Garlic oil is an effective antibiotic, anti-viral, anti-fungal agent, which could be used to prevent nausea, diarrhea, ease coughs, even treatment in conditions such as malaria and cholera probably an immune system enhancement, some studies have found lower rates of certain types of cancer in people[11].

II. MATERIALS AND METHODS

Sampling and sample treatment: The garlic cloves were obtained from Kurya Madaro town Kaura Namada Local government area of Zamfara State and identified by a taxonomist at Botany department in Kebbi State University of Science and Technology, Aliero as cultivated garlic Allium sativum L. The transparent covering of garlic was removed manually and sun-dried for two weeks. Mortar and pestle was used to pound the dry garlic cloves into powder, then sieved and stored in a covered plastic container for further uses. All reagents were of analytical reagent grade unless otherwise stated. Distilled water was used in the preparation of solutions and dilution unless otherwise stated. The physicochemical analyses were carried out in triplicates unless otherwise stated.

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Oil extraction
The extraction of garlic oil was conducted with a soxhlet extractor with n-hexane (boiling point of 40°C - 60°C) for six hours. The oils were obtained after the solvent was removed under reduced temperature and pressure and refluxing at 70°C so as to remove any excess solvent used for the oil extracted. The extracted garlic oil was stored in refrigerator freezer at 2°C for subsequent physicochemical analyses[12].

Determination of percentage yield
The oil which was recovered by complete distilling of the solvent on a heating mantle was then transferred into a measuring cylinder. The measuring cylinder is then placed over water bath for complete evaporation of solvent for about 2-3 hours in accordance with the method reported[12] and volume of the oil was recorded and expressed as oil content (%) as follow[12].

Oil content (%) = \( \frac{\text{Volume of the oil}}{\text{Weight of sample}} \times 100 \% \)

Determination of specific gravity
10cm³ of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and oil were measured, the weight of the oil was then obtained by subtracting the weight of the cylinder from the weight of the oil and cylinder. The specific gravity of oil was obtained using equations below[13].

Density of water = \( \frac{W_1 - W_0}{V_0} \)

Where
- \( W_1 \) = weight of empty measuring cylinder + water
- \( W_0 \) = weight of measuring cylinder
- \( V_0 \) = volume of water used

Density of oil = \( \frac{W_1 - W_0}{V_0} \)

Where
- \( W_1 \) = weight of empty measuring cylinder + oil
- \( W_0 \) = weight of measuring cylinder
- \( V_0 \) = volume of oil used

Therefore specific gravity = \( \frac{\text{Density of water used}}{\text{Density of oil used}} \)

Determination of saponification value
About 2g of the garlic oil was added to a flask with 30 ml 2.0g of oil extracted was added to 22cm³ of a solution mixture of 12cm³ chloroform and 10cm³ acetic acid. 0.5cm³ of saturated potassium iodide was added to the flask. The flask was corked and allowed to stay with occasional shaking for 1 minute. 30cm³ of distilled water was then added to the mixture and titrated against 0.1M of Na₂S₂O₃, until yellow colour is almost gone. 0.5cm³ of starch indicator was quickly added and titration continued until blue colour just disappeared. A blank titration was also carried out at the same condition[15].

\[ \text{Peroxide value} = \frac{(S - B) \times N \times 1000}{W} \]

Where
- \( S \) = volume of titrant (cm³) for sample
- \( B \) = volume of titrant (cm³) for blank
- \( N \) = molarity of Na₂S₂O₃ solution (mEq/cm³)
- 1000 = conversion of units (g/kg)
- \( W \) = Weight of oil sample

Determination of iodine value
0.4 g of the garlic oil sample was weighed into a conical flask and 20 cm³ of carbon tetrachloride was added to dissolve the oil. Then 25 cm³ of wij’s reagent was added to the flask using a safety pipette in fume chamber. Stopper was then inserted and the content of the flask was vigorously swirled. The flask was then placed in the dark for 2 hours 30 minutes. At the end of this period, 20 cm³ of 10% aqueous potassium iodide and 125ml of water were added using a measuring cylinder. The content was titrated with 0.1M sodium-thiosulphate solutions until the yellow colour almost disappeared. Few drops of 1% starch indicator was added and the titration continued by adding thiosulphate drop wise until blue coloration disappeared after vigorous shaking. The same procedure was used for blank test and other samples[14].

The iodine value (IV) is given by the expression

\[ \text{Iodine value} = 12.69C \left( V_1 - V_2 \right) \]

Where
- \( C \) = Concentration of sodium
- \( V_1 \) = Volume of sodium thiosulphate used for blank
- \( V_2 \) = Volume of sodium thiosulphate used for determination
- \( M \) = Weight of the sample.

Determination of free fatty acid
The mixed sample was then added to a condenser for 30 minutes to ensure the sample was fully dissolved. After sample cooled, 1 ml of phenolphthalein was added and titrated with 0.1M NaOH with continuously shaking until the endpoint is reached, which is indicated by a slight pink color that persists for 30seconds, the free fatty acid is expressed as[16]

\[ \%\text{FFA} = \frac{V \times N \times 282 \times 100}{W} \]

Where
- \( \%\text{FFA} \) = Percent free fatty acid (g/100g)
- \( V \) = Volume of NaOH (cm³)
- \( N \) = Molarity of NaOH
- \( 282 \) = Molecular weight of oleic acid
- \( W \) = weight of oil sample
Determination of acid value

25cm³ of 5% ethanol was boiled on a water bath the heating is to ensure the removal of dissolved gases. 2.5g of garlic oil was added to 25cm³ of hot ethanol and the mixture was heated to boil. Then drops of 1% phenolphthalein indicator was added and titrated against 0.1M KOH with constantly shaking until a permanent pink colour was obtained, the acid value is expressed as[17].

\[
\text{Acid value} = \frac{56.1X \text{M} \times \text{V}}{\text{W}}
\]

Where M = Concentration of KOH
V = Titre value
56.1 = Molecular weight of KOH
W = weight of oil sample

III. RESULTS AND DISCUSSION

The results of the physicochemical analyses conducted on the garlic oil sample are presented in Tables 1 and 2.

TABLE 1

<table>
<thead>
<tr>
<th>Physical properties of the garlic oil</th>
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<tbody>
<tr>
<td>Parameters</td>
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<tr>
<td>Colour of oil</td>
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<td>Specific gravity</td>
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<td>Smell</td>
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<td>Oil yield</td>
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TABLE 2

<table>
<thead>
<tr>
<th>Chemical properties of garlic oil</th>
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<tbody>
<tr>
<td>Parameters</td>
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<tr>
<td>Saponification value</td>
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<tr>
<td>Peroxide value (mg/100g)</td>
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<tr>
<td>Acid value (mgKOH/g)</td>
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<tr>
<td>Free fatty acid (% oleic acid)</td>
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<tr>
<td>Iodine value (gI²/100)</td>
</tr>
</tbody>
</table>

Values expressed as: Mean ± SD

Physical properties

The percentage yield was found to be 22.5% which is low when compared to Boute Gourd Lageneria siceraria seed oil 39.22%[18] and specific gravity is 0.90g/cm³ which is within 0.915g/cm³ and 0.923g/cm³ in Sesamum indicum L. seed oil[19] and 0.89g/cm³ in African Oil Bean seeds Pentaclethra macrophylla[20], this indicate that the oil could be used on commercial scale. The colour of the oil is light yellow with a pungent odour. However the oil is liquid at room temperature which could indicate the presence of oleic acid and linoleic acid and other unsaturated fatty acids[18].

Chemical properties

Peroxide value: This measured deterioration of oil from oxidation[16]. Therefore, the low peroxide value 2.50 ± 0.50% obtained from oil when compared to palm kernel oil 3.58%[21], indicates that the oil can be kept for a very long period of time[21].

Acid value: The acid value 4.18 ± 0.01mgKOH/g obtained from the oil is low when compared to Shea nut butter oil 0.05mgKOH/g[22] and high when compared to 2.39 ± 0.05mgKOH/g, 1.20 ± 0.065mgKOH/g and 0.81 ± 0.01mgKOH/g for castor seed oil, jatropha oil and cotton seed oil respectively[12]. Thus the higher the acid value of an oil, the lower its storage quality and vice-versa[15], this shows that the garlic oil have an excellent storage quality when compared to that of Shea nut butter oil[22].

Free fatty acid: - Free fatty acid (oleic acid), determine the suitability of the oil for edibility or industrial uses. The free fatty acid value is 2.10 ± 0.05% which is low when compared to the Hyptis spicigera seed oil 3.50%. This shows that it is suitable for eating[23].

Saponification value: -The saponification value of the garlic oil was found to be 192 ± 1.00mgKOH/g which is high when compared to 183.1mgKOH/g of shea butter oil[22] and 123.3 ± 3.428mgKOH/g, 122.49 ± 2.591mgKOH/g and 199.42 ± 0.53mgKOH/g for castor seed oil, jatropha oil and cotton seed oil respectively, which they have potential for soap production[12]. This indicates that the oil could be used in soap making since its saponification value is higher than these oils[22].

Iodine value: - This is a measure of the proportion of unsaturated acid or fat and oil present, but the test measures the amount of iodine absorbed per gram of sample. The determination of iodine value measures the reaction of the double bonds with halogen[24]. The iodine value 12.69 ± 0.05g/100g which was obtained from the oil is low when compared to 16.0g/100g Tiger nut oil[24]. The oil shows quite degree of unsaturated fatty acid which indicates that the oil is suitable for consumption and can also be used as a non drying oil, which are useful in the manufacture of soap[24].

IV. CONCLUSION

The results in this analysis indicated good quality for the garlic oil. chemical analyses presented saponification value, peroxide value, acid value ,free fatty acid and Iodine values that fell within the range of those acceptable as having good potential for soap production and with an excellent storage property.

REFERENCES


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