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Physicochemical Characteristics, Nutrient Content and Fatty Acid Composition of *Nigella sativa* Oil and Sesame Oil

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Abstract The core objective of this research was to determine the physicochemical characteristics, mineral composition, vitamin composition and fatty acid composition of *Nigella sativa* oil (NSO) than that of (SO). The data indicated that there was a marked variation in iodine value, saponification value, free fatty acids, and peroxide value between NSO and SO. The data revealed that NSO recorded higher values of ascorbic acid and vitamin E than that of SO. Besides, NSO had higher levels of Ca, P, K, Na and M than that of SO. While SO had higher levels of Mg, Cu, and Se. Characteristics of NSO and SO revealed higher degree of unsaturation as determined by gas liquid chromatography (GLC) reported herein. The major unsaturated fatty acids were linoleic acid (46.036% in NSO, and 12.607% in SO), followed by oleic acid (20.917% in NSO and 12.430% in SO). The main saturated fatty acid was palmitic acid (9.658% in NSO, and 9.367% in SO) are considered as two newer sources of good edible oils, thanks to their important role in human nutrition health.

Keywords Physicochemical Characteristics, Minerals, Fatty Acids, Vitamins, *Nigella sativa* oil, Sesame Oil and Sensory Characteristics

1. Introduction

Black cumin (*Nigella sativa* L.) belongs to Ranunculaceae family and is native to some parts of the Mediterranean region .It grows in the Mediteranean countries to a maximum height of about 60 cm and is cultivated in Turkey**[1],[2],[3]**. Black seed oil is used as edible oil**[4]**. It is important source of oil being of nutritional ,industrial and pharmaceutical importance .As non-conventional oil, *Nigella sativa* oil is under consideration because, it has unique chemical properties and may augment the supply of the functional edible oils**[2]**. Black seed oil is popularly used in certain cases of chronic cough, as diuretic or carminative agent and in bronchial asthma**[3]**. Little information is available concerning the exact composition of *Niglla sativa* seed oil. There exist limited studies on the *Nigella sativa* oil, its properties and the contents of fatty acids and tocopherols**[3]**.

Black seed oil is reported to be beneficial in the control or management of African sleeping sikness due to its content of over a hundred components such as aromatic oils, trace elements, and vitamins. It is a phytotherapeutic known to reduce the risk to illness and disease by strengthening immune system and protecting the body. Recent reports however suggest that thymoquinone present in the oil might be the active component**[5]**.

Nigella sativa oil is considered as one among newer sources of edible oils, thanks to its important role in human nutrition and health**[5]**. Sesame (*Sesame indicum* L.) is believed to be one of the most ancient crops cultivated by humans. It was first recorded as a crop in Babylon and Assyria over 4000 years ago. The seeds of the crop are used both as condiment and oil source. Babylonians used sesame oil for cooking, medical, and cosmetic purposes. Sesame seed has higher oil content (around 50%) than most of the known oil- seed although its production is far less than the major oilseeds such as soybean or rapseed due to laborintensive harvesting of the seeds. Sesame oil is generally regarded as a high- priced and high- quality oil. It is one of the most stable edible oil despite its high degree of unsaturation. The presence of lignan type of natural antioxidants accounts for both the superior stability of sesame oil and the beneficial physiological effects of sesame**[6]**.

Despite sesame oil's high proportion of polyunsaturated (omega-6) fatty acids, it is least prone, among cooking oils with high smoke points, to turn rancid when kept in the open**[19]**. This is due to the natural antioxidants present in

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the oil**[7]**.

Sesame oil is a source of vitamin E.Vitamin E is antioxidant and has been correlated with lowering of cholesterol levels. Sesame oil also contains magnesium, copper, calcium, iron, zinc, and vitamin B6. Copper provides relief to rheumatoid arthritis. Magnesium supports vascular and respiratory health. Calcium helps prevent colon cancer, osteoporosis and migraine**[6]**.

The present investigation was carried out to assess the physic- chemical characteristics, nutrients content and fatty acid composition of black seed (*Nigella sativa*) oil and sesame oil.

2. Materials and Methods

2.1. Materials

2Kg of natural *Nigella Sativa* oil (black seed) were produced from Chema Lab Company, Assiut Governorate in November, 2012.

2Kg of natural sesame oil (*Sesamum indicum* L.) were obtained from Chema Lab Company, Assiut Governorate in November, 2012.

2.2. Methods

2.2.1. Determination of Physical and Chemical Properties: Refractive Index

At 25℃, specific gravity, acid value, peroxide value, iodine value and saponification value were determined as outlined in**[8]**.

2.2.2. Determination of Minerals Contents

The samples were wet acid-digested using a nitric acid and perchloric acid mixture (HNO3; HCSO4; 2:1v/v). The amounts of iron, zinc, copper and manganese in the digested sample were determined using a GBC Atomic Absorbation Spectrophotometer 906 A, as described in**[9]**. Sodium and potassium were determined by a flame photometer 410, calcium and magnesium were determined by titration with version 0.0156 N. Phosphorus, and selenium were determined according to the methods described by**[9]**.

2.2.3. Determination of Vitamin Content

Vitamin C was determined according to**[10]**. Vitamin E was determined according to the method described by**[11]**.

2.2.4. Fatty Acids Composition

2.2.4.1. Preparation of Methyl Ester of Fatty Acids

The methyl esters of fatty acids were prepared from aliquots total lipids using 5 ml 3% H2SO4 in absolute methanol and 2 ml benzene as mentioned in**[12]**. The contents were heated for methanolysis at 90℃ for 90 minutes. After cooling, phase separation was performed by addition of 2 drops of distilled water and methyl esters were extracted with 3 aliquots of 2 ml hexane each. The organic phase was removed, and filtered through anydrous sodium sulfate.

2.2.4.2. Gas Liquid Chromategraphic of Methyl Esters of Fatty Acids

Fatty acid methyl esters were injected into (HP 6890 series GC) apparatus provided with a DB-23 column (60m × 0.32mm × 25 µm). Carrier gas was N2 with flow rate 2.2 ml/min, splitting ratio of 1:50. The injector temperature was 250℃ and that of Flame Ionization Detector was 300℃. The temperature setting was as follows: 150℃ TO 225℃ at 5℃ /min, and then held at 225℃ for 20 min. Peaks were identified by comparing the retention times obtained with stander methyl esters.

3. Results and Discussion

3.1. Organoleptic and Physical Properties

The organoleptic and physical properties of *Nigella sativa* oil and sesame oil established its capability of application in either nutrition or in food and pharmaceutical industries. Data of organoleptic and physical properties of *Nigella sativa* oil and sesame oil are outlined in Table (1). The color, odor, and taste of the two studied oils were: yellowish brown, aromatic, and agreeable; clear light yellow, odorless, and agreeable for *Nigella sativa* oil, and sesame oil; respectively. The results indicate that there is a slight variation in refractive index between the two studied oils. However, the specific gravity of *Nigella sativa* oil was markedly higher than that of sesame oil. The results are in good agreement with**[13]**,**[14]** for sesame oil; and **[15]** for *Nigella sativa* oil.

Table 1. Organoleptic and physical properties of *Nigella sativa* oil and sesame oil*

Organoleptic and physical properties	*Nigella sativa oil*	Sesame oil
Organoleptic properties: - Color	Yellowish brown	Clear, light yellow (almost colorless)
- Oder	Aromatic	Odorless
- Taste	Agreeable	Agreeable
physical properties		
- Refractive index	1.4758	1.4740
- Specific gravity	0.9424	0.8809

*Mean of three replicates
Such results coincide, with **[16]**, **[13]**, **[17]**, **[18]**, and **[14]** for sesame oil; and **[19]**, and **[15]** for Nigella sativa oil

3.2. Chemical Characteristics

The results of the chemical characteristics of *Nigella sativa* oil and sesame oil are given in Table 2. The data indicate that there is a marked variation in iodine value, saponification value, free fatty acids, and peroxide value

between *Nigella sativa* oil and sesame oil. High values of refractive and iodine values might be due to a high concentration of unsaturated fatty acids in Nigella sativa oil. Saponification is useful in assessing the chain lengths of fatty acids in the oil, since it is inversely comparatively to the molecular weight of the oil.

On the other hand, free fatty acids and peroxide value were higher in sesame oil than that of the corresponding values in *Nigella sativa* oil. The acid values of an oil may be used as a measure of quality. However, the acid value of the oil must not be too high, as this denotes an excessively high content of free fatty acids, which causes the oil to turn sour. Discoloration may also occur. The free fatty acids of *Nigella sativa* oil and sesame oil as show in Table 2 are 0, 82%, and 0.96% respectively, being in the allowable limit.

Table 2. Chemical characteristics of *Nigella sativa* oil and Sesame oil*

Chemical characteristics	*Nigella sativa oil*	Sesame oil
Iodine value (g oI2/100g of oil)	116.00	103.00
Saponification value (mg KOH/g of oil)	190.00	188.00
Free fatty acids (% as oleic)	0.82%	0.96%
Peroxide value (m Eq/kg of oil)	0.40	0.86%

*Mean of three replicates

3.3. Vitamin Content

The data of ascorbic acid and vitamin E contents of *Nigella sativa* oil and sesame oil are given in Table 3 and Fig.1 & 2. Tocopherols are natural antioxidants with biological activity. Especially, the antioxidant effect is higher due to high α- tocopherol content. The data revealed that *Nigella sativa* oil recorded higher values of ascorbic acid and vitamin E than that of sesame oil (0.770 mg/100ml, 0.623 mg/100ml); and (0.612 mg/100ml, 0.597mg/100ml); respectively. Such data are in good agreement with**[3]** for *Nigella sativa* oil, and**[7],[20],** and**[21]** for sesame oil. Sesame oil is a source of Vitamin E. Vitamin E is antioxidant and had been correlated with lowering cholesterol levels**[20]**.

Table 3. Ascorbic acid and Vitamin E contents of *Nigella sativa* oil and Sesame oil*

Vitamin content	*Nigella sativa oil*	Sesame oil
Ascorbic acid	0.770	0.612
Vitamin E	0.623	0.597

*Mean of three replicates

On the other hand sesame oil is well known for its oxidative stability; one of the reasons for this extra stability is attributed to its tocopherol content. α- Tocopherol is the predominant tocopherol in sesame oil, and is a more potent antioxidant in sesame oil**[21]**. Besides, tocopherols are natural antioxidants with biological activity. Especially, the antioxidant effect of was higher in *Nigella sativa* oil due to high α- tocopherol content**[3]**.

3.4. Mineral Content

The mineral content of Nigella sativa oil and sesame oil given in Table 4. The data revealed that Nigella sativa oil had higher levels of Ca, P, K, Na, and M than that of sesame oil. While sesame oil had higher levels of Mg, Cu and Se. Such data are in general agreement with**[22]**, and**[23]** for Nigella sativa oil; and**[7]** for sesame oil.

Table 4. Mineral content of *Nigella sativa* oil and sesame oil*

Mineral (Mg/ml)		*Nigella sativa oil*	Sesame oil
Calcium (Ca)	Mg/ml	1540	1440
Phsphorus (P)	Mg/ml	4505	3505
Magnesium (Mg)	Mg/ml	1255	1333
Potassium (K)	Mg/ml	7700	6500
Sodium (Na)	Mg/ml	118	115
Zinc (zn)	Mg/ml	15	15
Copper (Cu)	Mg/ml	13	16
Iron (Fe)	Mg/ml	16.2	17.5
Manganese (M)	Mg/ml	11	10
Selenium (Se)	Mg/ml	0.233	0.542

*Mean of three replicates

Table 5. Fatty acid composition of *Nigella sativa* oil and sesame oil* (% of total hydrocarbons)

Hydrocarbons	*Nigella sativa oil*	Sesame oil
Tetradecane 14	0.111	1.020
Eicosane C2o	25.071	0.752
Docosane C22		35.675
Miristic acid (C14:0)	Traces	—
Palmitic acid (C16:0)	9.658	9.367
Stearic acid (C18:0)	—	1.476
Oleic acid (C18:1)	20.917	12.430
Linoleic acid (C18:2)	46.036	62.036
Linolenic acid (C18:3)	—	12.607
Linolenic acid (C18:3)	18.188	—
Eicosapentaenoic acid (C20:5)	—	—
Docosapentaenoic acid (C22:5)	—	—
Total indentified saturated fatty acid	9.658	10.843
Total indentified unsaturated fatty	85.141	87.978
Saturated: unsaturated fatty acids	0.11	0.12

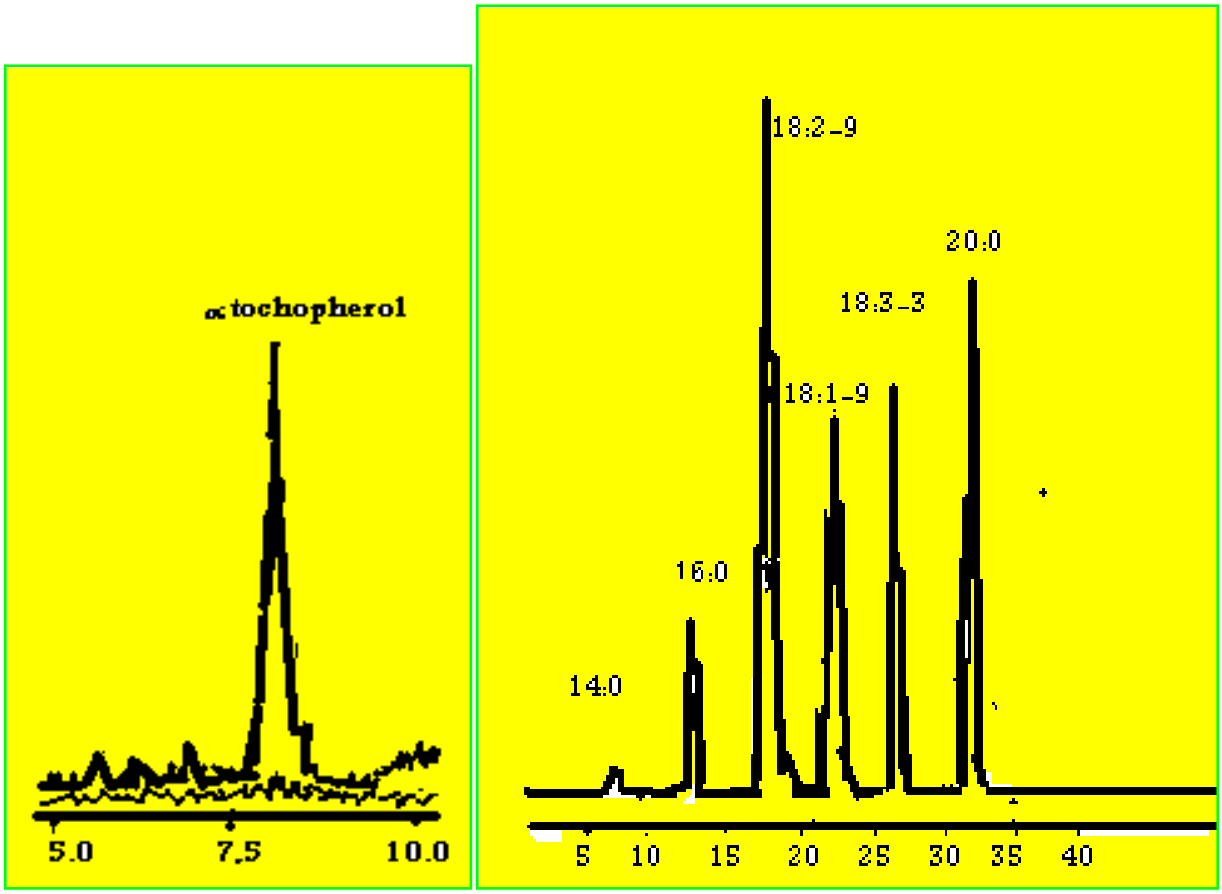

Figure 1. Separation of fatty acids and vitamin E in Nigela sativa oil

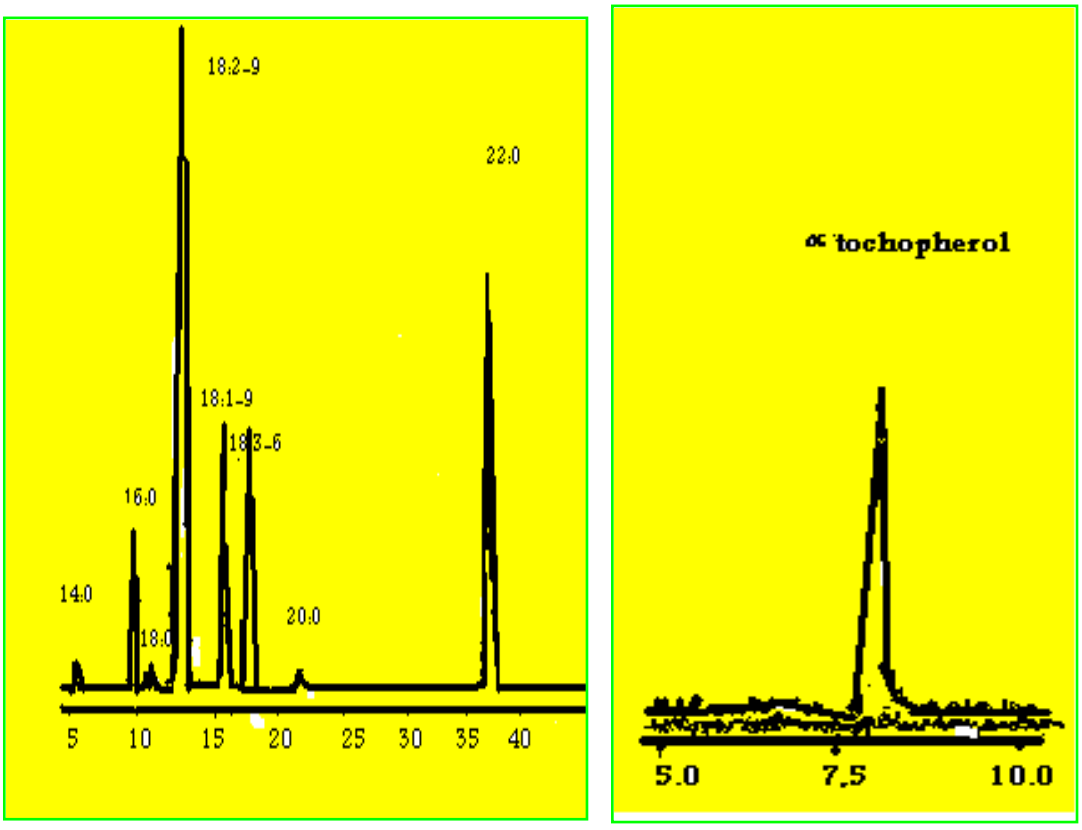

Figure 2. Separation of fatty acids and vitamin E in Sesame oil

The following trace elements Zn, Cu, Fe, Mn, Se are considred a good supplements for the deficiency of these elements in blood serum. The deficiency might be due to the action of agents such as phytate, oxalate and phosphate which are found in quite large amounts in food rich in cereals and proteins from insoluble complexes with zinc and iron to decrease their absorbation. Copper provides relief from rheumatoid arthritis. Magnesium supports vascular and respiratory health. Calcium helps prevent colon cancer, osteoporosis and migraine. Zinc promotes bone health**[20]**.

3.5. Fatty Acid Composition

The data presented in Table 5 and Fig. 1&2 illustrated the fatty acid composition of *Nigella sativa* oil and sesame oil. The tabulated data showed that the predominant unsaturated fatty acids in both studied oils were lenoleic acid (C18:2) followed by oleic acid (C18:1). While, the predominant saturated fatty acid was palmitic acid in both studied oils. The total unsaturated fatty acids were 85.141% and 87.978% in *Nigella sativa* oil and sesame oil respectively.

The data are in good agreement with **[24],[25],[26],[3], [27],[28],** and**[5]** for *Nigella sativa* oil; and**[7]** and**[21]** for sesame oil. It is note- worthy to state that *Nigella sativa* oil is rich in unsaturated fatty acids, mainly linoleic acid (46.036%), and oleic acid (20.917%). While saturated fatty acid palmitic amounts to 9.658%. *Nigella sativa* oil is considered as one among newer sources of edible oils, thanks to its important role in human nutrition and health.

On the other hand, despite sesame oil's high proportion of unsaturated fatty acids, it is least prone, among cooking oils with high smoke points, to turn rancid when kept in the open, This is due to the natural antioxidants present in the oil**[7].** Light sesame oil has a high smoke point and is suitable for deep frying. Therefore, sesame oil belongs to the oleic-linoleic acid group. It has less than 20% saturated fatty acids**[21]**. Due to the antioxidant properties of sesame oil which provide high levels of antioxidants and lignans, it is stable oil, and when mixed with other oils, actually increases the stability of the blend**[29]**, and**[30]**.

In conclusion, on the basis of the above- mentioned data, both *Nigella sativa* oil and sesame oil are considered as two among newer sources of good edible oils, on account of their important roles in human nutrition an health.

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