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Physicochemical Characteristics of Indian, Sudanese, and Yemeni (Hadhramout) Sesame Seed Oil

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Abstract: The study examined the chemical composition and physical properties of sesame oil from three different types of sesame, namely Indian sesame (Ind.S), Sudanese sesame (Sud.S), and Yemeni Al-Hadrami sesame (YHa.S). Using Fourier transform infrared and gas chromatography techniques. The oil was extracted from sesame seeds by the Soxhlet method with a non-Soxelite substance (hexane). A high percentage of oil or Indian sesame seeds was obtained at 50%. And Sudanese and Hadhrami by 48.96% and 43.67%, respectively. The chemical and physical parameters of sesame oil were analyzed, including free fatty acid (FFA) content of 0.94%, 3.38% and 3.29%, acid value of 2.06 ± 0.06 mg/g, 7.41 ± 0.1 mg/g and 7.23 ± 0.15 mg. Coefficient Refraction 1.4632 ± 0.01 , 1.4728 ± 0.01 and 1.4575 ± 0.01 at 28°C, moisture contents 0.163 ± 0.15 , 0.131 ± 0.002 and 0.573 ± 0.02 , density 0.875 ± 0.002 , 0.870 ± 0.002 f 0.843 ± 0.002 g/ml, specific gravity of 0.9441 ± 0.003 , 0.9442 ± 0.003 and 0.913 ± 0.003 g/mL, and viscosities 31.49, 32.35, 29.86 cP at 28 °C. These results provide important insights into the characterization of sesame oil and could have significant implications for its use in various industries.

Keywords: Fatty Acid Composition, Physicochemical characteristic, Sesame Oil

1. Introduction

Sesame (*Sesamum indicum* L.) known as one of the oldest oilseed crops domesticated by man. The crop is currently and since ancient times, counted as an important oilseed crop that human populations have relied on as a valuable food and trade commodity. The world harvested area is about 12.8 million hectares in 2019 with production of 6,549,725 tones [1]. It has around 36 species, 19 of which are native to Africa [2]. Sesame oil is most likely the oldest oil seed crop known to mankind, having been produced in Asia and Africa for over 2,000 years [3]. Sesame oil has therapeutic qualities and is widely utilised in pharmaceutical applications [4]. Sesame oil contains vitamin E and numerous vital antioxidants, such as sesaminol and sesamolol, which protect the body's tissues from oxidative stress [5]. Climate, soil, plant age, and seed

cultivar all have an impact on the quantity and quality of sesame seed oil.

The physicochemical properties of oil are significantly related to its lipid and glyceride content. Sesame oil is mostly constituted of fatty acids, the distribution of which varies according to the variety of sesame seed. The primary fatty acids are palmitic acid 16:0; 7.0-12.0%, stearic acid 18:0; 3.5-6.0%, oleic acid 18:1; 35-50%, and linoleic acid 18:2; 35-50%. The physicochemical properties of vegetable oil are frequently utilised to determine its quality. [6 -7]. The health advantages of some vegetable oils, such as toasted sesame oil and olive oil, are well known, which is driving up demand from consumers. Mixed oils are accessible in many marketplaces, and the prices of different vegetable oils vary depending on manufacturing costs and the availability of plant sources. Determining blended or adulterated vegetable oils from real ones requires accurate

and trustworthy ways to avoid financial loss, mislabeling, and unfair business activities [8]. Genetic variances, climate, oil production processes, and harvest circumstances all contribute to differences in the fatty acid makeup of distinct sesame seed oils. Chemical analysis was performed on seeds from two local kinds of sesame *Sesamum indicum L.*, one dark and one white, to determine their physicochemical parameters, which included specific gravity, refractive index, acidity, peroxide value, iodine number, saponification number, and unsaponified matter. Furthermore, the contents of six mineral components in the seeds were identified. Calcium, phosphorus, potassium, magnesium, sodium, and iron. Sesame is gaining popularity as a source of healthy edible oils and high-quality protein for human consumption. The majority of sesame seeds are used for oil extraction, with the remainder used for other uses. While industry owners claim the quality of their products, this has not been validated. A new creative enterprise in our country focuses on extracting high-purity natural oils in front of clients. They extract several types of oil kernels and grains in stores using small press samples. [9]. The physical and chemical properties of oil are directly proportional to its lipid and glyceride content.

The Sesame's chemical composition consists mostly of oil 50-60%, protein 18-25%, carbs 13.5%, and ash 5%. [10]. Sesame oil is mainly made up of fatty acids, the distribution of which varies according to the species of sesame seed [11 -12]. Sesame seed is a major food source in Yemen. However, there has been minimal scientific investigation on locally generated oil. [6]. Sesame has a wide range of vital nutrients for the human body. The Sesame is an important source of fibers, metal salts, protein 17.73%, fats 50% and vitamins from his family B, which is rich in vitamin E, which strengthens the nervous system, heart and arteries. It contains a scientific fiber that plays an antioxidant role and contributes to the stomach facilitation and relieves the proportion of cholesterol's food and it relieves cholesterol secretions in the liver. Sesame oil is very rich with the rule of lips in, which maintain brain cells and is used for frustration and psychological pressure as it helps to facilitate blood circulation. It is also rich in unsaturated fatty acids [13]. *Sesamum indicum* and *Sesamum radiatum* seeds exhibit greater tumorigenic, estrogenic or anti-estrogenic, and antioxidant activity than other plants. Phytochemically, they are high in phenolic compounds such as phenols, sterols, flavonoids, and lignans, as well as non-protein amino acids, cyanogenic glucosides, alkaloids, unsaturated fats with numerous double bonds, glazes, phospholipids, and vitamins E, B₁, and B₂. These seeds are also rich in minerals like calcium, iron, magnesium, zinc, copper, and phosphorus. According to an analysis, sesame seeds contain around 50-60 % oil, 8% protein, 5.8% water, 3.2% crude fibre, 18% carbohydrate, and 5.7% ash. These seeds, which are around 3 to 4 mm long, 2 mm wide, and 1 mm thick, are wrapped in capsules known as pods. They can appear in a variety of colours, including white, buff, tan, gold, brown, reddish, grey, and black. The purpose of this research was to examine the physicochemical properties of oil extracted

from sesame seeds utilising the hexane solvent soxhlet method. [14].

The purpose of this study was to examine the physicochemical parameters of sesame oil extracted with the n-hexane solvent soxhlet method. The results were then compared to those obtained from gas chromatography analysis, which revealed that Moringa oil's principal fatty acids are oleic acid, linoleic acid, and palmitic acid. This study aimed to investigate the Physicochemical Properties of Indian, Sudanese, and Yemeni (Hadhramout) Sesame Seed Oil.

2. Materials and Methods

2.1 Sample Collection

Indian and Sudanese sesame seeds were obtained from market, and Crude Yemen Hadhramaut sesame Oil was obtained from Agricultural Research Station in Wadi Hadhramout - Al-Suwairi. The sample was collected manually at the temperature 35°C. The sample was manually collected at 35°C. The fruit seeds were sun-dried for three days before dehulling and drying at 100-105°C for 30 minutes. The seeds were then ground into a powder prior to extraction. Figure 1 photos illustrate of the sesame tree, seeds, powder and oil.



Figure 1. Photos illustrating of the Sesame tree, seeds, powder and oil

2.2 Chemicals and Reagent

All Chemicals and Solvents were used as received and they include Ethanol 99%, Isopropanol 99%, Ethanol 95%, Pyridine 99%, Toluene 99%, Hydrochloric Acid 36.5%, Potassium Hydroxide 99%, Potassium Iodide 99.5% and Sodium Sulphate 99%. The Wij's solutions, Cyclohexane 99%, Sodium Thiosulphate 99%, n-hexane 99% and Phenolphthalein were purchased from Sigma- Aldrich.

2.3 Oil Extraction Procedure (Soxhlet Method)

The dried seeds (powdered) of Sesame Indian, Sudanese and Yemeni (Hadhramaut) were used for Soxhlet mechanical oil extraction. 30 g of dried seeds (powdered) were placed in an extraction thimble and placed in a Soxhlet extractor. The seeds were extracted with 200 mL of n-hexane as a solvent for 3 hours at 60 °C. The solvent was removed by evaporation, and the outgoing vapors were recycled by rotary evaporation. The oil was then dried in an oven at 50 °C for 4 hours to remove the residual solvent. The yield of oil was determined by the Soxhlet method [15].

2.4 Chemical Characteristics Analysis

The sample was manually collected at 35°C. The fruit seeds were sun-dried for three days before DE hulling and

drying at 100-105°C for 30 minutes. The seeds were then ground into a powder prior to extraction.

2.5 Determination of FFA percentage and Acid Value (AV)

Acid value and %FFA: The acid value of seed oil was evaluated using the AOCS approved method. Ca 5a-40 [16-17]. First, 50 mL of isopropanol and 0.5 mL of phenolphthalein were added to a flask and neutralised with sodium hydroxide (NaOH, 0.1 N) until a persistent pink colour was obtained. In an Erlenmeyer flask, the neutralised isopropanol was mixed with 5 g of Indian, Sudanese, and Yemeni (Hadhramaut). The mixture was heated to 40 degrees Celsius until dissolved. The mixture was then titrated with 0.1 N NaOH until a light pink colour appeared, using 1 mL of phenolphthalein as an indicator. The percentage of free Fatty Acid was calculated with the underlying Equation 1:

$$\% \text{ FFA as oleic acid} = \frac{28.2 \times N \times V}{W} \quad (1)$$

Where, V is volume of NaOH solution used in (ml); N is normality of NaOH solution in Equivalent per liter (Eq/l); W grams is the weight of the sample

$$\text{Acid value} = \% \text{ FFA as Oleic Acid} \times 2.81 \quad (2)$$

where, 2.81 is the conversion factor for Oleic Acid.

2.6 Determination of Iodine Value (IV)

The iodine value of the seed oil was determined using the AOCS (1989) method Cd1-25, as well as an additional method described by [18-19]. First, 0.5 g of MPO was added to a 500 ml flask, followed by 15 ml of Cyclohexane (Oil Solvent). Next, 25 ml of Wijs solution was added, and the flask was sealed with a stopper. The flask containing the mixture was then gently shook before being placed in the dark for 60 minutes. After one hour of incubation, a mixture was made by combining 20 ml of 10% potassium iodide (KI) solution with 150 ml of distilled water. The mixture was then titrated with Sodium Thiosulphate 0.1N $\text{Na}_2\text{S}_2\text{O}_3$ until a yellow colour developed, indicating that the iodine had almost totally vanished. Then, 1 ml of Starch Solution (1%) was added, and the titration continued until the blue colour faded after shaking the flask. The identical technique was followed for the blank sample. The iodine value was calculated using equation 3 as shown as follows:

$$I.V = \frac{12.69 \times N (V_b - V_s)}{W} \quad (3)$$

2.7 Determination of Saponification Value

The saponification value was derived using BS684 2.6:1977 [19-20]. First, 2 g of Indian, Sudanese, and Yemeni (Hadhramaut) was placed in a flask with 25 mL of Ethanolic Potassium Hydroxide (KOH, 0.5 N) and few boiling stones. The boiling flask was attached to a condenser. The liquid was slowly simmered for an hour before adding 1 cc of Phenolphthalein. The mixture was then titrated with 0.5 N HCl until a pink hue was observed. The Saponification Value was calculated applying Equation 4:

$$S.V = \frac{56.1 \times N (V_b - V_s)}{W} \quad (4)$$

Where, V_b = ml of blank; V_s = ml of titrant; W = weight (g) of the sample; N = normality of the KOH Eq/l

2.8 Physical Characteristics Analysis

1. Refractive Index

The Refractive Index of Sesame Indian, Sudanese and Yemeni (Hadhramaut) was determined in line with the AOCS Official Methods (Cc7-25), as explained by [21-22]. Using a refract meter model (TAGO Co. Ltd. Series No.1211), connected to a Japanese Digital Thermometer Model (DTM-1T) at 26.5°C.

2. Moisture Content

The moisture content of Sesame Indian, Sudanese, and Yemeni (Hadhramaut) types was measured with a Moisture Analyzer model MX-50. Approximately 5 g of the material were weighed onto a moisture dish and dried in the moisture analyzer for 30 minutes at 101°C [17].

3. Viscosity

The viscosity of Sesame Indian, Sudanese, and Yemeni (Hadhramaut) kinds was measured with a Brookfield model RV DV-I+ viscometer from the United States, equipped with a spindle size of 5. The viscosity was measured directly in centipoises (cp) using a viscometer set to 100 rpm for 1 minute at room temperature. [17-23]. Viscosity is a critical factor in determining the quality and stability of food systems. It is directly related to specific chemical features of vegetable oils. [24].

4. Density and Specific Gravity

The density of the Sesame Indian, Sudanese, and Yemeni (Hadhramaut) types was set by a delicate balancing. A millilitre of each kind was placed on the balance, and the weight was taken at room temperature. The specific gravity was then computed using the Lund equation, which is: Specific Gravity = Density of Water / Density of Sesame Indian, Sudanese, and Yemeni (Hadhramaut). [25-26].

5. Fourier Transform Infrared Spectroscopy Analysis of Ind.S, Sud.S and YHa.S

Fourier Transforms Infrared Spectroscopy (FTIR) was carried out according to Osman. et al. [27]. FTIR spectra of the Ind.S, Sud.S and YHa.S were recorded (Perkin Elmer Spectrum GX Spectrophotometer) in the range of 500–4000 cm^{-1} . FTIR was used to measure functional groups of the Ind.S, Sud.S and YHa.S

6. Gas Chromatograph Flam Ionization Conductor (GC-FID)

A Gas Chromatograph (Shimadzu GC-17A) equipped with a capillary column BPX 70 (30m × 0.25mm × 0.25_μm) and a Flame Ionization Detector was used to analyze the FAME [28].

3. Results and Discussion

3.1 Oil Extraction

Table 1 shows the physical parameters of the Indian, Sudanese, and Yemeni (Hadhramaut) oils investigated. In this investigation, the percentage of oil extracted from sesame seeds was between 50% and 43%. The percentage of oil extracted from Indian sesame seeds (Ind.S) using the Soxhlet Method with Hexane as the solvent was discovered to be 50%, whereas Sudanese sesame seeds (Sud.S) yielded 43% and Yemeni (Hadhramaut) sesame seeds (YHa.S) yielded 48.96%. However, these oil yields are modest when

compared to those obtained using solvent extraction, which normally yields 60%. [29]. In this study, the refractive index of (Ind.S) is 1.4622 ± 0.01 , (Sud.S) is 1.4728 ± 0.01 and (YHa.S) is 1.4575 ± 0.01 at 25.9°C ; has a high number of Carbon Atoms in their Fatty Acid composition. The value of Moisture content of the three types of sesame seeds oil under study was determined where the result is as follows (Ind.S), 0.163 ± 0.015 , (Sud.S) 0.131 ± 0.002 and (YHa.S) 0.573 ± 0.02 at 101°C . They are shown in table 1. The Density of the sample also showed a slight difference and was in the range of 0.875 ± 0.002 , 0.870 ± 0.002 and 0.843 ± 0.002 g/ml for (Ind.S), (Sud.S) and (YHa.S) and the specific gravity of (Ind.S), (Sud.S) and (YHa.S) was 0.9441 ± 0.003 , 0.9442 ± 0.003 and 0.913 ± 0.003 g/ml at 28°C . So, the data for viscosity at 28°C showed that (Ind.S), (Sud.S) and (YHa.S) exhibited the highest resistance to flow with viscosity of 31.49, 32.35 and 29.86 cp. [30].

Table 1. Physical properties of sesame oil (Ind.S), (Sud.S) and (YHa.S)

Characteristic	Units	(Ind.S)	(Sud.S)	(YHa.S)
Oil content	%	50	43	48.97
Refractive index		1.4632	1.4728	1.4575
Moisture content	%	0.163 ± 0.15	0.131 ± 0.002	0.573 ± 0.02
Density	g/ml	0.875 ± 0.002	0.870 ± 0.002	0.843 ± 0.002
Specific gravity	g/ml	0.9441 ± 0.03	0.9442 ± 0.003	0.913 ± 0.003
Viscosity	Cp	31.49	32.35	29.86

Note: Ind.S (Indian Sesame seeds), Sud.S (Sudanese Sesame seeds), YHa.S (Yemeni (Hadhrumaut) Sesame seeds).

3.2 Chemical and Physical Characteristics

Table 2 presents the chemical characteristics of sesame seed oil. The physicochemical qualities of the selected sesame samples from Indian, Sudanese, and Yemeni (Hadhrumaut) did not exhibit significant differences ($p < 0.05$), while there were modest variances in particular metrics [26]. The result shows that the Acid Value (AV) was 2.06 ± 0.06 mg NaOH /g, 7.41 ± 0.1 mg NaOH /g and 7.23 ± 0.15 mg NaOH /g oil for (Ind.S), (Sud.S) and (YHa.S). The Iodine Value (I.V) of the (Ind.S), (Sud.S) and (YHa.S) were measured in this study as 98.39 ± 0.06 mg/g, 87.64 ± 0.12 mg/g and 101.19 ± 0.06 mg/100g. The value determined saponification value of Ind.S, Sud.S and YHa.S as 184.71 ± 0.15 mg KOH /g, 203.36 ± 0.12 mg KOH /g and 186.95 ± 0.12 mg KOH /g and was also compatible with the range of oil specifications. [31].

Table 2. Chemical properties of sesame oil (Ind.S), (Sud.S) and (YHa.S)

Characteristic	Units	(Ind.S)	(Sud.S)	(YHa.S)
FFA (as oleic acid)	%	0.94	3.38	3.29
Acid value	mg /g	2.06 ± 0.06	7.41 ± 0.01	7.23 ± 0.15
Iodine value	g/100 g	98.39 ± 0.05	87.64 ± 0.12	101.19 ± 0.06
Saponification value	mg /g	184.71 ± 0.15	194.36 ± 0.12	186.95 ± 0.12

Note: Ind.S (Indian Sesame seeds), Sud.S (Sudanese Sesame seeds), YHa.S (Yemeni (Hadhrumaut) Sesame seeds)

3.3 FTIR Analysis of (Ind.S), (Sud.S) and (YHa.S)

FTIR spectroscopy can be used to infer the molecular structures of the (Ind.S), (Sud.S) and (YHa.S) extracted

oil by the Soxhlet extractor using hexane to determine the functional groups in the structural structure, which are displayed as a spectrum of peaks [27]. The FTIR spectrum of vegetable oil is often dominated by the spectra representing the Triacylglycerol TAGs, as shown in figure 2.

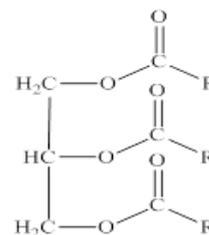


Figure 2. Structure of triacylglycerol

The characteristic peaks of the main functional groups in (Ind.S), (Sud.S) and (YHa.S) sample appear in table 3 respectively. Figure 3 also displays the spectra of the infrared spectrum for samples in the range from 4000 to 500 cm^{-1} .

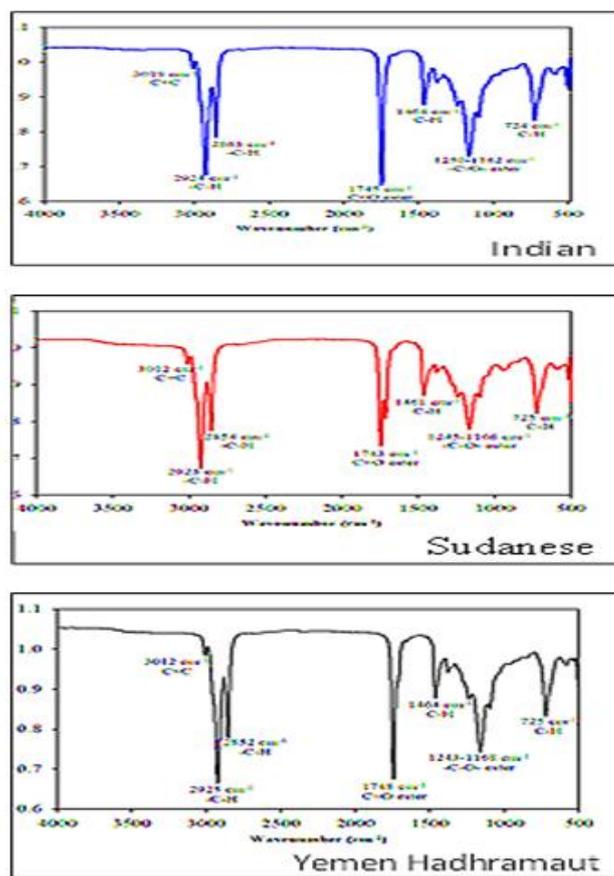


Figure 3. The main wavenumber in the FTIR

3.4 GC-FID Analysis of (Ind.S), (Sud.S) and (YHa.S)

To prepare the sample, exactly 0.5 mL was added to a 10 mL vial. The mixture was then further diluted by adding 5 mL of GC grade ethyl acetate. Next, the material was dried overnight using 5 g of anhydrous sodium sulphate. The mixture was filtered twice with a disposable LC filter disc (0.45 μL capacity).

Table 3. The functional groups of Ind.S, Sud.S and YHa.S regarding the main wavenumber in the FTIR

Functional Group	Wavenumber (cm ⁻¹)		
	Ind.S	Sud.S	YHa.S
C = C	3010	3012	3012
C-H	2924,286	2923,285	2925,285
C = O	1745	1743	1748
C-H	1464	1461	1464
-C-O	1250-116	1245-116	1243-116
C-H	724	725	725

Note: C = C bending vibration (aliphatic) C-H stretching vibration (aliphatic) C = O stretching vibration (ester) C-H scissoring and bending for methylene -C-O-Stretching vibration(ester) C-H group vibration (aliphatic)

Finally, the filtered sample was added to the GC-FID system. The GC system's separation was carried out using DB5ht. The oven temperature was originally set at 100 °C and held for one minute. Then, a step-by-step process was followed:

1. Gradual climb to 380°C at a rate of 5°C/min, with a 72-step increment, followed by a 25-minute period of steady temperature.
2. Set the column temperature to 100°C, then increase it to 380 °C at a rate of 5 °C/min with a 1°C step increment.

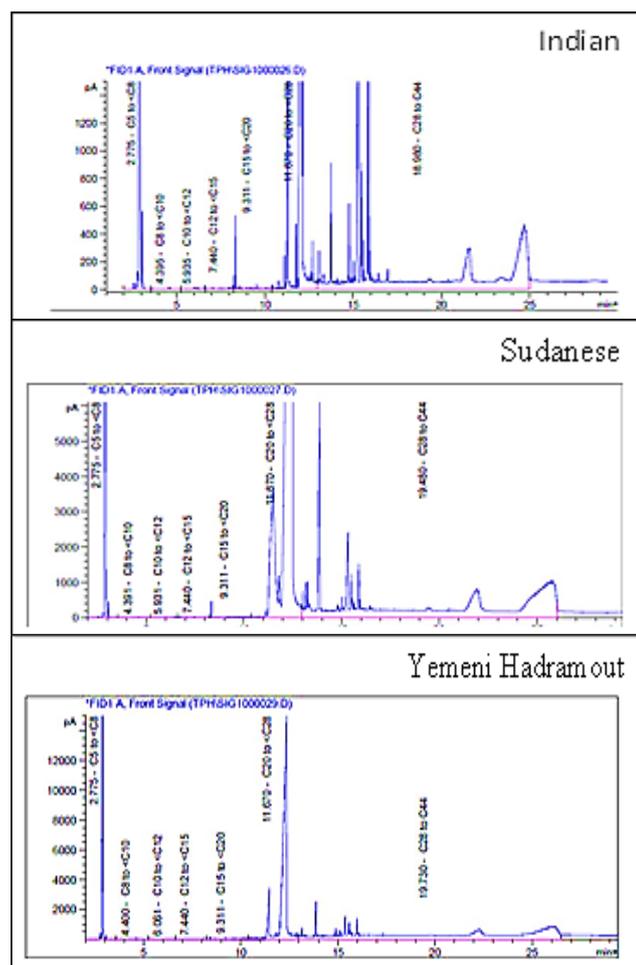


Figure 4. Gas chromatogram of Indian, Sudanese, and Yemeni (Hadramout) Sesame Seed oil

The temperature was maintained at 380°C for 20 minutes. The injector temperature was set at 380°C, while the detector temperature was set at 400°C. The GC apparatus maintained a flow rate of 1 µL of the sample as the carrier gas. The GC profile and corresponding quantitative data are presented in Figure 4. and table 4 [32].

Table 4. Compounds present in Ind.S, Sud.S and YHa.S, extracted by n-hexane using GC-FID analysis

Name sample	N	Exp. RT	Meas. RT	Compound Name	Main Peak Area %
Ind.S	1	2.775	2.775	C5 to <C8	39.890
	2	4.391	4.935	C8 to <C10	0.058
	3	5.900	5.935	C10to <C12	0.092
	4	7.400	7.440	C12 to <C15	0.173
	5	9.300	9.311	C15 to <C20	0.475
	6	11.60	11.67	C20 to <C28	26.047
	7	18.90	18.98	C28to <C44	33.264
Sud.S	1	2.775	2.775	C5 to <C8	9.633
	2	4.391	4.391	C8 to <C10	0.031
	3	5.900	5.931	C10to <C12	0.045
	4	7.400	7.440	C12 to <C15	0.071
	5	9.300	9.311	C15 to <C20	0.199
	6	11.60	11.67	C20 to <C28	59.938
	7	19.40	19.48	C28to <C44	30.086
YHa.S	1	2.775	2.775	C5 to <C8	13.962
	2	4.391	4.400	C8 to <C10	0.052
	3	6.000	6.061	C10to <C12	0.046
	4	7.400	7.400	C12 to <C15	0.109
	5	9.300	9.311	C15 to <C20	0.476
	6	11.60	11.67	C20 to <C28	35.556
	7	19.73	19.73	C28to <C44	49.802

4. Conclusions

This study showed that the physical and chemical properties of sesame oil, in the three countries from which the samples were taken were similar compared to some previous, studies that worked in these countries. GC- FD analysis revealed the presence of the dominant fatty acids, which are lauric acid, myristic acid and oleic acid, in sesame oil. FTIR analyzes of sesame oil showed positive results, with strong absorption observed at the carbonyl ester peak, specifically at 1748 cm⁻¹ and 1243 cm⁻¹. Understanding the pattern of interactions within triacylglycerol molecules could be useful in various medical industries and therapeutics, providing insight into their functional properties and potential applications.

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الخصائص الفيزيائية والكيميائية لزيت بذور السمسم الهندي والسوداني والحضرمي اليمني

المخلص: تناولت الدراسة دراسة التركيب الكيميائي وتوصيف الخصائص الكيميائية والفيزيائية لزيت السمسم المستخلص من ثلاثة أصناف مختلفة من بذور السمسم، وهي: السمسم الهندي، السمسم السوداني، والسمسم الحضرمي اليمني. وقد استخدمت تقنيًا التحليل الطيفي بالأشعة تحت الحمراء (FTIR) والكروماتوغرافيا الغازية (GC) في توصيف الزيوت. جرى الاستخلاص باستخدام جهاز سوكسلت مع مذيب الهكسان. بلغت نسبة استخلاص الزيت من بذور السمسم الهندي 50%، بينما كانت 48.96% للسمسم السوداني و43.67% للسمسم الحضرمي اليمني. أظهرت التحاليل الكيميائية والفيزيائية فروقاً ملحوظة بين العينات. فقد بلغت نسبة الأحماض الدهنية الحرة 0.94%، 3.38%، و3.29%، مع قيم حموضة مقدارها 0.06 ± 2.06 ملغ/غ، 0.10 ± 7.41 ملغ/غ، و 0.15 ± 7.23 ملغ/غ على التوالي. كما بلغت معاملات الانكسار عند درجة حرارة 28 °م 0.01 ± 1.4632 ، 0.01 ± 1.4728 ، و 0.01 ± 1.4575 . أما محتوى الرطوبة فكان 0.15 ± 0.163 ، 0.002 ± 0.131 ، و 0.02 ± 0.573 . الكثافة كانت 0.002 ± 0.875 ، 0.002 ± 0.870 ، و 0.002 ± 0.843 غ/مل، في حين بلغت الكثافة النوعية 0.003 ± 0.9441 ، 0.003 ± 0.9442 ، و 0.003 ± 0.913 غ/مل. أما اللزوجة عند 28 °م فكانت 31.49، 32.35، و 29.86 سنتيبواز على التوالي. تقدم هذه النتائج رؤى مهمة حول الخصائص الفيزيائية والكيميائية لزيت السمسم، وتبرز الفروق بين الأصناف المختلفة، مما قد يكون له انعكاسات كبيرة على استخدامه في الصناعات الغذائية والدوائية والصناعية.