

### COMPARATIVE PHYSICOCHEMICAL CHARACTERISTICS, FATTY ACID COMPOSITION, AND BIOACTIVE PROPERTIES OF SESAME (*SESAMUM INDICUM* L.) OILS FROM THREE VIETNAMESE VARIETIES

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#### ABSTRACT

This study comprehensively evaluated the properties of sesame oils from three varieties commonly found in Vietnam: black sesame oil (BSO), white sesame oil (WSO), and yellow sesame oil (YSO). We investigated physical characteristics such as color ( $L^*$  values ranging from 38.46 to 45.97), viscosity (39.00 to 44.60 cP), and density (0.873 to 0.889 g/mL). Key chemical indices were also determined; acid value (AV) showed significant differences among samples (2.06 to 11.59 mg KOH/g), while peroxide value (PV) remained relatively stable (3.33-5.33 meq/kg). Gas chromatography–mass spectrometry (GC-MS) analysis of fatty acid composition identified variations in linoleic acid (34.93% - 42.76%) and oleic acid (43.91% - 51.30%) content. Principal component analysis (PCA) further highlighted distinct clustering among the oil samples. Regarding bioactivity, YSO and BSO exhibited significantly higher antioxidant capacity than WSO using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assays. However, all three sesame oils did not show antibacterial activity against *Salmonella enteritidis* and *Bacillus cereus* in in vitro assays. The results provide insight into the diverse properties of Vietnamese sesame oils, from their physical characteristics to chemical composition and bioactivity, serving as a basis for selecting appropriate applications for each type.

**Keywords:** Antibacterial capacity, Antioxidant activity, Chemical properties, Sesame oil

#### INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop that has been cultivated and used for thousands of years around the world (Anilakumar *et al.*, 2010). Sesame is native to Africa and India, and is now widely cultivated in many countries, especially in tropical and subtropical regions (Myint *et al.*, 2020). Sesame seeds are a nutritious food source, providing significant amounts of oil, protein, carbohydrates, vitamins, and minerals. Due to their rich nutritional composition, sesame seeds play an important role in the diets of many cultures, being used in traditional dishes, confectionery, and other food products (Wei *et al.*, 2022).

Sesame oil is a vegetable oil extracted from sesame seeds. It is known for its distinctive, aromatic flavor and is commonly used in cooking, especially in Asian cuisine (Pathak *et al.*, 2017). Sesame oil has a diverse fatty acid composition, including oleic acid, linoleic acid, and saturated fatty acids (Mondal *et al.*, 2010). Additionally, it contains bioactive compounds such as tocopherols, lignans, and phytosterols, which provide potential health benefits. Sesame oil can be classified based on the color of the original sesame seeds, resulting in different types of sesame oil, such as black sesame oil, yellow sesame oil, and white sesame oil, each of which may have distinct sensory and chemical properties (Morris *et al.*, 2021). Sesame oil is a versatile ingredient with many applications beyond the food sector. In culinary, it is used to enhance the flavor of dishes, as a frying oil, or used in salads (Lim, 2012). In addition, sesame oil also plays an important role in traditional medicine, used to treat a number of diseases thanks to its anti-inflammatory, antioxidant, and antibacterial properties (Dravie *et al.*, 2020). Not stopping there, sesame oil is also widely used in the cosmetics industry, becoming an ingredient in skin and hair care products (Manosroi *et al.*, 2015).

Despite the widespread use of sesame oil, comparative studies focusing on the physical and chemical properties, fatty acid composition, and bioactive activities of sesame oils derived from different seed varieties remain limited, particularly for sesame varieties cultivated in Vietnam. Vietnam produces several sesame varieties, including black, yellow, and white sesame, which may differ in chemical composition and functional properties due to genetic variation and environmental conditions. However, systematic evaluations comparing these Vietnamese sesame oils are still scarce. Based on these considerations, it is hypothesized that sesame oils obtained from different Vietnamese sesame varieties exhibit significant differences in physical and chemical properties, fatty acid composition, and bioactive activities due to variations in seed characteristics.

Therefore, understanding the physical and chemical characteristics, fatty acid profiles, and biological activities of oils extracted from different Vietnamese sesame varieties is important for determining their quality and potential applications in food, nutraceutical, and cosmetic industries. In this context, this study aimed to comparatively evaluate the physical and chemical characteristics, fatty acid composition, antioxidant activity, and antibacterial properties of oils extracted from three sesame varieties cultivated in Vietnam.

#### MATERIAL AND METHODS

##### Sesame oil extraction

There were three sesame (*Sesamum indicum* L.) varieties used in this study: "Me Den" (BSO), "Me Trang" (WSO), and "Me Vang" (YSO) from Dien Bien, Vietnam. Oil extraction was performed using a hot-pressing method with an oil press machine (Hakawa, model HK-ED43, 430 W, China). The pressing chamber temperature was maintained at approximately 160°C, and the temperature was monitored through the machine's built-in control system during operation. The oil temperature at the outlet during pressing was around 55 to 60°C. Following extraction, the crude oil was centrifuged for 10 min at 4000 rpm to get rid of residue. The obtained oil was put in bottles and kept at room temperature until further analysis.

##### Bacterial strains

*Salmonella enteritidis* (ATCC 13072) and *Escherichia coli* (ATCC 25922), two common Gram-negative bacterial strains, were supplied for this study by the Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City, Vietnam.

##### Chemicals

Among the compounds used during the study were dimethyl sulfoxide (DMSO, China) and 2,2-diphenyl-1-picrylhydrazyl (DPPH, Sigma, USA). Furthermore, the culture and antibacterial testing media, including nutritional broth (HiMedia, India) and Mueller–Hinton agar (MHA) (HiMedia, India), as well as other chemicals, were of analytical quality.

### Evaluation of the physical and chemical properties of sesame oils

The color of the oil was measured using a colorimeter (Konika Minolta, model CR-400, Japan). Using the CIE color space model, the significant parameters are interpreted as follows: Lightness is denoted by L\*, green or red by a\*, and blue or yellow by b\*.

The viscosity was measured using an LVDV-E BROOKFIELD viscometer (Brookfield Ametek, model LVDV-E, USA) with an S63 spindle rotating at 100 rpm.

The recovery yield was computed as the percentage of oil volume to seed weight (% v/w). The quality indices of oil, such as density, acid value, saponification value, and peroxide value, were determined according to ISO 6883 (2017), ISO 660 (2020), ISO 3657 (2023), and ISO 3960 (2017), respectively.

### Gas chromatography–mass spectrometry (GC-MS) analysis

The GC–MS analysis was performed using a GC-MS-QP2020 system (Shimadzu, Japan) coupled with a GC-2030 gas chromatograph (Shimadzu, Japan). Prior to analysis, the fatty acids in sesame oil were converted to fatty acid methyl esters (FAMES) using a standard methylation procedure. Briefly, the oil sample was mixed with methanolic solution and heated to facilitate methyl ester formation before GC–MS analysis. An aliquot of 1 µL of the prepared sample was injected into the GC–MS system in split mode (1:10). Separation was carried out on an Rxi-5MS capillary column (30 m × 0.25 mm i.d., 0.25 µm film thickness). The oven temperature program was as follows: initial temperature at 50 °C for 4 min, increased to 80 °C at 1 °C/min, then to 150 °C at 5 °C/min, 200 °C at 10 °C/min, and finally to 300 °C at 20 °C/min, with a 3 min hold at the final temperature. The ion source temperature was maintained at 230 °C. Helium was used as the carrier gas at a flow rate of 1.69 mL/min with a head pressure of 100 kPa. Mass spectra were obtained in electron ionization (EI) mode at 70 eV. The identification of fatty acid methyl esters was carried out by comparing the obtained mass spectra with those in the NIST mass spectral library.

### Determination of the antioxidant capacity of sesame oils

Free radical scavenging activity (RSA) was used to measure antioxidant capacity (AC) using the DPPH assays, which was modified slightly from Quoc's (2021) description. The oils were dissolved in 96% ethanol to produce different concentrations. After that, 2.7 mL of 0.1 mM DPPH solution and 0.3 mL of oil solution were mixed, and the mixture was left to stand at room temperature in the dark for 30 min. The color loss of DPPH was measured using a spectrophotometer (Thermo Fisher Scientific, model Genesis 20, USA) set at 517 nm. The following formula was used to calculate the AC:

$$\%DPPH_{RSA} = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

The A<sub>sample</sub> value is the measured absorbance of the oil solution in the presence of DPPH solution, and A<sub>control</sub> is the measured absorbance of the DPPH solution.

### Determination of the antibacterial activity (AA) of sesame oils

A modified version of Quoc's (2021) paper disk method was employed to measure antibacterial activity (AA). Using sterile paper disks, first evenly distribute 100 µL of bacterial suspension (0.5 McFarland standard concentration, or around 1.5×10<sup>8</sup> CFU/mL) onto MHA medium. 5 µL of the oils were seeded onto sterile paper disks (6 mm in diameter), whereas the positive control was gentamicin (10 µg/disc). For twenty-four hours, the paper was incubated at 37°C. To evaluate the AA, the diameter of the inhibitory zone surrounding the paper disk was measured.

### Statistical data analysis

ANOVA and mean comparisons were performed using Statgraphics Centurion 19 (Statgraphics Technologies, USA). All experiments were conducted in triplicate (n = 3). A 95% confidence level (p < 0.05) was determined by applying the HSD method. The findings are displayed as mean ± standard deviation (mean ± SD).

## RESULTS AND DISCUSSION

### Physical properties of sesame oils

Table 1 presents the physical properties of the three sesame oils: WSO, YSO, and BSO. In terms of color, WSO and YSO are bright yellow, while BSO is darker, as indicated by the markedly lower L\* (brightness) value of BSO (38.46) compared to WSO (45.97) and YSO (44.02). The a\* (red-blue) value reveals that BSO leans toward red (1.58), while WSO (-4.83) and YSO (-2.00) lean toward blue. The b\* (yellow-blue) value is highest in YSO (35.73), followed by BSO (31.59) and WSO (29.90), illustrating the variation in yellowness among the samples (Figure 1).

**Table 1** Physical properties of sesame oils

No.	Physical properties	WSO	YSO	BSO
1	L*	45.97 <sup>a</sup> ± 0.08	44.02 <sup>b</sup> ± 0.05	38.46 <sup>a</sup> ± 0.05
2	a*	-4.83 <sup>a</sup> ± 0.15	-2.00 <sup>b</sup> ± 0.03	1.58 <sup>c</sup> ± 0.02
3	b*	29.90 <sup>a</sup> ± 0.15	35.73 <sup>c</sup> ± 0.02	31.59 <sup>b</sup> ± 0.87
4	Viscosity (cP)	39.60 <sup>a</sup> ± 0.30	39.00 <sup>a</sup> ± 0.31	44.60 <sup>b</sup> ± 1.01
5	Density (g/mL)	0.875 <sup>a</sup> ± 0.003	0.887 <sup>b</sup> ± 0.003	0.873 <sup>a</sup> ± 0.001
6	Specific gravity	0.877 <sup>a</sup> ± 0.013	0.889 <sup>b</sup> ± 0.005	0.875 <sup>a</sup> ± 0.009
7	Colour	Bright yellow	Bright yellow	Dark yellow

Different small letters in the same row indicate significant differences (p ≤ 0.05) between samples

Regarding viscosity, WSO and YSO had similar values (about 39 cP), while BSO had a significantly higher viscosity (44.60 cP). When compared with other studies, the viscosities of WSO and YSO were similar to those of sesame oil from Akure, Ondo State, Nigeria (39.1 cP) (Ollannsuununkami *et al.*, 2017), but higher than those of sesame oil from Kogi State, Nigeria (35.80 cP) (Betiku *et al.*, 2012). This difference may be due to the different chemical compositions between the oils, especially the content and ratio of fatty acids, as well as other compounds that may influence molecular interactions. The specific gravity of the oil samples in this study ranged from 0.875 to 0.889, with WSO (0.877), YSO (0.889), and BSO (0.875). Comparison with other studies shows that the specific gravity of sesame oil in this study was somewhat lower than that of sesame oil from Akure, Ondo State, Nigeria (0.91) and comparable to that of sesame oil from Kogi State, Nigeria (0.88) (Ollannsuununkami *et al.*, 2017; Betiku *et al.*, 2012). The differences in viscosity and specific gravity may be due to many factors, including sesame variety, growing conditions, extraction method, and other environmental factors.



**Figure 1** Sesame oils from different varieties (a: WSO, b: YSO, c: BSO)

### Chemical properties of sesame oils

The results of the study on the quality parameters of three sesame oils (WSO, YSO, and BSO) provided important insights into the characteristics and quality of the products (Table 2). The acid value (AV)—reflecting the degree of fat hydrolysis—varied significantly among the samples, with BSO having the highest (11.59 mg KOH/g), nearly 6 times that of WSO (2.06) and 3 times that of YSO (4.11). When compared with previous studies, the AV value of YSO was similar to that of sesame oil from Akure, Nigeria (4.488 mg KOH/g), while all oil samples in this study had significantly higher AV than that of the sample from Kogi State, Nigeria (0.5 mg KOH/g) (Betiku *et al.*, 2012; Olanrasununkami *et al.*, 2017). It is noteworthy that all three samples in our study were crude oils, so it is common to have high levels of free fatty acids. These free acids will be removed, reducing AV and improving oil quality after refining. According to Choe and Min (2006), high AV can accelerate oxidation, causing bad taste and affecting product stability. However, for crude oils, high AV values are somewhat acceptable characteristics in the pretreatment stage. The relatively high AV observed in BSO may indicate a greater extent of lipid hydrolysis, which could be associated with differences in seed composition, post-harvest handling, or enzymatic activity during storage. In practical terms, oils with higher AV may require more intensive refining to reduce free fatty acids and improve their sensory quality and oxidative stability (Maszewska *et al.*, 2018). Nevertheless, once properly refined, sesame oils with initially high AV can still be suitable for food and industrial applications.

**Table 2** Chemical properties of sesame oils

No.	Chemical properties	WSO	YSO	BSO
1	Acid value (mg KOH/g)	2.06 <sup>a</sup> ± 0.32	4.11 <sup>b</sup> ± 0.64	11.59 <sup>c</sup> ± 0.26
2	Saponification value (SV, mg KOH/g EO)	187.00 <sup>a</sup> ± 8.10	218.32 <sup>c</sup> ± 2.14	190.27 <sup>b</sup> ± 2.14
3	Peroxide value (meq/kg)	5.33 <sup>a</sup> ± 2.31	4.67 <sup>a</sup> ± 1.15	3.33 <sup>a</sup> ± 1.15
4	Ester value (mg KOH/g)	184.94 <sup>a</sup> ± 8.42	214.18 <sup>b</sup> ± 1.93	178.68 <sup>a</sup> ± 2.40
5	Extraction yield (%)	43.4 <sup>c</sup> ± 2.16	31.77 <sup>b</sup> ± 0.53	33.69 <sup>a</sup> ± 1.37

Different small letters in the same row indicate significant differences ( $p \leq 0.05$ ) between samples

Regarding the peroxide value (PV), all three samples showed values in the range of 3.33–5.33 meq/kg. This indicates that the initial oxidation level of the samples was relatively low and stable. When compared with other studies, the PV of these samples was lower than that of sesame oil from Kogi State, Nigeria (7.8 meq/kg) (Betiku *et al.*, 2012) but comparable to that of the sample from Akure, Nigeria (6 meq/kg) (Olanrasununkami *et al.*, 2017). According to the Codex Alimentarius Commission (2019), the maximum acceptable peroxide value for crude vegetable oils is 10 meq O<sub>2</sub>/kg, so the samples in this study were completely within the permissible limits. This stability can be explained by the high content of natural antioxidants in sesame oil, such as sesamin, sesamol, and tocopherol, which are capable of inhibiting peroxide formation (Elleuch *et al.*, 2007).

The saponification value (SV), which reflects the average molecular weight of fatty acids, ranged from 187 to 218 mg KOH/g. The YSO sample had the highest SV (218.32 mg KOH/g), which was significantly different from the other two samples. The AV values of WSO and BSO are similar to those in previous reports from Nigeria (190–192 mg KOH/g) (Olanrasununkami *et al.*, 2017; Betiku *et al.*, 2012), confirming the stability of the fatty acid composition of sesame oil despite the differences in geographical origin. The ester index (EV) also showed a similar trend, with the YSO sample having the highest value (214.18 mg KOH/g).

Regarding the extraction efficiency, the results obtained (31.77–43.40%) were lower than those of the Soxhlet method reported in Brazil (47.54–58.93%), but significantly higher than those of the supercritical fluid extraction (SFE) method (14.19–26.47%) (Carvalho *et al.*, 2012). This difference can be explained by differences in sesame varieties and cultivation conditions, extraction methods and parameters, and moisture content of the starting materials.

**Chemical composition of sesame oils**

Fatty acid composition analysis of sesame oil samples (WSO, YSO, and BSO) showed significant differences among the samples (Table 3). Regarding the major fatty acids, palmitic acid content was relatively stable among the three samples (6.40% - 6.83%), while linoleic acid content was highest in YSO (42.76%), followed by WSO (37.37%) and BSO (34.93%), and oleic acid content was highest in BSO (51.30%), followed by WSO (47.45%) and YSO (43.91%). Stearic acid content was similar in WSO and BSO (about 7%), but slightly lower in YSO (6.50%). When grouping fatty acids, the saturated fatty acid (SFA) content was similar in all three samples (13.33% - 13.92%), while the monounsaturated fatty acid (MUFA) content was highest in BSO (51.30%), indicating the predominance of oleic acid, and lowest in YSO (43.91%), and the polyunsaturated fatty acid (PUFA) content was highest in YSO (42.76%), indicating the predominance of linoleic acid, and lowest in BSO (34.93%). Notably, WSO contained small amounts of other fatty acids such as heptadecanoic acid, 11-octadecenoic acid, cis-11-eicosenoic acid, and arachidic acid, which were absent in YSO and BSO.

**Table 3** Fatty acid profile in sesame oils

Fatty acid	WSO (%)	YSO (%)	BSO (%)
Palmitic acid	6.40	6.83	6.73
Linoleic acid	37.37	42.76	34.93
Oleic acid	47.45	43.91	51.30
Stearic acid	7.04	6.50	7.04
Heptadecanoic acid	0.06	-	-
11-octadecenoic acid	1.02	-	-
Cis-11-eicosenoic	0.18	-	-
Arachidic acid	0.48	-	-

Total	100	100	100
Saturated fatty acid (SFA)	13.92	13.33	13.77
Mono unsaturated fatty acid (MUFA)	48.47	43.91	51.30
Poly unsaturated fatty acid (PUFA)	37.61	42.76	34.93

Notes: (-) not detected

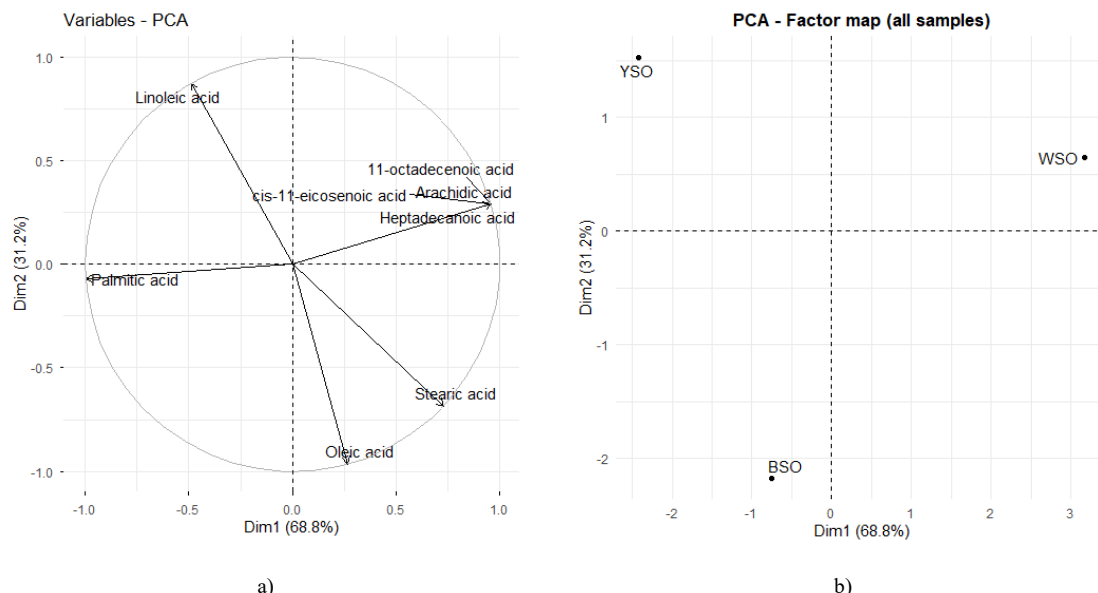
Compared with the data reported by Sanusi *et al.* (2024) for pure sesame oil from Nigeria, which contained relatively low levels of individual fatty acids such as 11-octadecenoic acid (0.40%), cis-11-eicosenoic acid (0.56%), and heptadecanoic acid (0.14%), as well as total PUFA, MUFA, and SFA contents of 1.93%, 27.72%, and 3.54%, respectively, the samples in this study exhibited notable differences in fatty acid composition. In particular, the monounsaturated fatty acid (MUFA) content in the present samples was considerably higher (43.91%–51.30%), while the saturated fatty acid (SFA) content ranged from 13.33% to 13.92%. These variations may be attributed to differences in sesame variety, cultivation conditions, and oil extraction processes, contributing to distinct lipid profiles among studies.

PUFA – including linoleic acid fatty acids—have been shown to provide many health benefits, such as reducing bad cholesterol (LDL) and the risk of cardiovascular disease and supporting brain and immune system development (Gaundal *et al.*, 2020). In addition, MUFA such as oleic acid also contribute to effective cardiovascular protection (Luo *et al.*, 2024).

The PUFA/SFA ratio is an important indicator in assessing the nutritional quality of oils, especially related to cardiovascular health. According to Chen and Liu (2020), this ratio is used to estimate the effect of diet on blood cholesterol levels. Polyunsaturated fatty acids (PUFA) can reduce low-density lipoprotein cholesterol (LDL-C) and reduce serum cholesterol levels, while saturated fatty acids (SFA) tend to increase serum cholesterol levels. Therefore, the higher the PUFA/SFA ratio, the greater the positive impact on cardiovascular health is thought to be. In the study by Aghili *et al.* (2023), the PUFA/SFA ratio in Iranian sesame oil was about 2.39, indicating a relatively high PUFA content compared to SFA. The PUFA/SFA ratio in the samples of this study was also calculated for comparison: WSO had a ratio of about 2.70, YSO about 3.21, and BSO about 2.54. These ratios are all higher than the recommended level of greater than 0.4, which is considered ideal for reducing the risk of cardiovascular disease (Kavle *et al.*, 2023). These findings highlight the importance of compositional profiling in guiding industrial utilization, including food processing, nutraceutical development, and storage strategies.

**Principal component analysis (PCA) of fatty acids in oils from three sesame varieties**

PCA analysis (Figure 2b) was performed to better understand the relationships between fatty acids in the samples, based on the fatty acid composition data presented in Figure 2a. The results showed that the two main dimensions (Dim 1 and Dim 2) explained the majority of the variation in the data. The first dimension (Dim 1) played the most important role, accounting for 68.8% of the total variance, indicating that it was the main factor determining the differences between oil samples in fatty acid composition. The second dimension (Dim 2) explained an additional 31.2% of the variance, adding important information about other aspects of variation that were not captured by the first dimension. The eigenvalues and percentage of explained variance of the principal components are presented in Table 4.



**Figure 2** Comparison of chemical composition of different sesame oils using PCA in R software (a: The variables' factor map from PCA, b: PCA graph of variables)

**Table 4** Eigenvalues and explained variance of principal components

Principal component	Eigenvalue	Variance explained (%)	Cumulative variance (%)
Dim 1	5.50	68.75	68.75
Dim 2	2.50	31.25	100.00

The PCA results (Figure 2a and 2b) reflect clear differences in fatty acid composition among the three oil samples. WSO is distinctly separated from the other two samples along the first principal component (Dim 1), primarily due to its relatively high content of oleic acid (47.45%) and the exclusive presence of fatty acids such as heptadecanoic acid (0.06%), 11-octadecenoic acid (1.02%), cis-11-eicosenoic acid (0.18%), and arachidic acid (0.48%), which were absent in YSO and BSO. These components significantly contribute to WSO's unique position on the factor map.

In contrast, YSO is positioned on the opposite side of Dim 1 and slightly higher on Dim 2. This placement corresponds to its highest linoleic acid content (42.76%) and slightly lower oleic acid level (43.91%), setting it apart from the other samples. BSO, meanwhile, is located near the center of Dim 1 and Dim 2, indicating a more intermediate fatty acid composition. It contains the highest amount of oleic acid (51.30%), slightly lower linoleic acid (34.93%) compared to YSO, and similar levels of palmitic acid (6.73%) and stearic acid (7.04%).

Overall, the PCA reveals that oleic acid and linoleic acid are the major contributors to the observed differences between samples. The presence of minor fatty acids also plays a role in distinguishing WSO from YSO and BSO. The loading values of individual fatty acids contributing to Dim 1 and Dim 2 are summarized in Table 5.

**Table 5** Loading values of fatty acids in principal components

Fatty acid	Dim 1	Dim 2
Palmitic acid	-0.998	-0.071
Linoleic acid	-0.488	0.873
Oleic acid	0.267	-0.964
Stearic acid	0.730	-0.683
Heptadecanoic acid	0.957	0.291
11-octadecenoic acid	0.957	0.291
cis-11-eicosenoic acid	0.957	0.291
Arachidic acid	0.957	0.291

**Determination of the antioxidant capacity (AC) of sesame oils**

This study evaluated the antioxidant capacity (AC) of three sesame oils (WSO, YSO, and BSO) by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging ability assays (Table 6). Significant differences were observed among the oil samples. YSO exhibited the highest AC with a value of 88.03%, followed by BSO with 86.58%, while WSO showed lower activity, reaching 75.54%.

**Table 6** Antioxidant capacity of sesame oils

AC	WSO	YSO	BSO
DPPH <sub>RSA</sub> (%)	75.54 <sup>a</sup> ± 1.03	88.03 <sup>b</sup> ± 0.73	86.58 <sup>b</sup> ± 0.80

Different letters in the same row indicate significant differences (p ≤ 0.05) between samples.

Compared with previous studies, Chau *et al.* (2021) on sesame oil in Taiwan, using the DPPH assays, recorded free radical scavenging capacity ranging from 30.82% to 92.13%. In contrast, the study by Lu *et al.* (2025) in Shanghai recorded a DPPH scavenging value of 67.07%, which was significantly lower than the activity observed in YSO and BSO in this study.

The sesame oils (WSO, YSO, and BSO) showed significant AC, which may be related to the presence of unsaturated fatty acids, especially linoleic acid and oleic acid, which are known to support free radical scavenging activity and lipid stability (Coniglio *et al.*, 2023). Linoleic acid is a PUFA with free radical neutralizing ability, while oleic acid (MUFA) contributes to the oxidative stability of the oil (Kazlauskienė *et al.*, 2021). The difference in the ratio of these fatty acids may be the main factor responsible for the difference in AC between oils. In addition, the antioxidant capacity of sesame oil may also be attributed to the presence of bioactive compounds such as tocopherols and lignans, particularly sesamin and sesamol, which are known to contribute to the oxidative stability of sesame oil (Pathak *et al.*, 2014).

**Determination of the antibacterial activity (AA) of sesame oils**

Data from Table 7 shows a clear difference in the antibacterial activity between the antibiotic gentamicin and the tested sesame oils (WSO, YSO, BSO).

**Table 7** Antibacterial zones of sesame varieties

Test strains	Diameter of the inhibitory zones of gentamicin (mm)	Diameter of the inhibitory zones of sesame oil (mm)		
		WSO	YSO	BSO
<i>S. enteritidis</i>	21.63 <sup>a</sup> ± 0.80	-	-	-
<i>B. cereus</i>	23.41 <sup>b</sup> ± 0.83	-	-	-

Different letters in the same column indicate significant differences (p ≤ 0.05) between samples. Note: "--" not detected.

A notable finding was that three sesame oils tested (WSO, YSO, and BSO) did not show any signs of in vitro antibacterial activity against either *S. enteritidis* or *B. cereus*. This result is in contrast to some previous studies. Specifically, Saleem (2011) reported that sesame oil from India had a strong inhibitory effect on *Salmonella* with an inhibition zone of up to 25 mm. This difference may be due to the source of the raw material, cultivation conditions, extraction methods, or even sample handling in each study. In addition, factors such as the content and structure of bioactive compounds in the oil – such as lignans or polyphenols – may also vary significantly with sesame varieties and geographical conditions, influencing antibacterial properties. Due to their hydrophobic nature and relatively high viscosity, oils may diffuse poorly in agar media, which can reduce the formation of visible inhibition zones even when bioactive compounds are present.

The lack of antibacterial activity observed in this study may also be related to the fatty acid composition identified by GC-MS. The major components, including palmitic acid, oleic acid, and linoleic acid, are known to exhibit limited or weak antibacterial effects, particularly in their esterified form within triglycerides (Yoon *et al.*, 2018). Although unsaturated fatty acids such as oleic acid and linoleic acid have been reported to disrupt bacterial membranes, their activity is often reduced in complex oil matrices due to limited bioavailability and poor diffusion in agar media (Gómez-Llorente *et al.*, 2025). In addition, saturated fatty acids such as palmitic acid and stearic acid generally show lower antimicrobial activity compared to free phenolic compounds. Therefore, the dominance of these fatty

acids, together with their physicochemical properties, may explain the absence of observable inhibition zones in the present study (Yoon *et al.*, 2018).

Furthermore, this finding is also consistent with the report of Hao *et al.* (2025), who noted that *Camellia oleifera* oil did not inhibit many bacterial strains. This suggests that not all vegetable oils possess potent antibacterial properties, and their effects may be highly selective.

Although there are reports of AC of some other vegetable oils against certain bacterial strains, the lack of effectiveness of sesame oil against *S. enteritidis* and *B. cereus* in this study is also a characteristic property. In addition, the antibacterial activity of sesame oil may depend on the concentration of active compounds and the extraction of phenolic constituents, which were not specifically isolated or enriched in the present study. Therefore, the absence of inhibition zones may also be related to methodological factors rather than the complete absence of antibacterial compounds. This result contributes to the general understanding of the antibacterial potential of natural products.

## CONCLUSION

This study provided a detailed analysis of the physical and chemical properties, fatty acid composition, and antioxidant and antibacterial activities of three sesame oils (WSO, YSO, BSO). Significant differences in color, viscosity, acid value, and fatty acid composition among the samples indicate the diversity of sesame oil properties depending on the origin or variety. These findings not only enrich the scientific database of sesame oil but also hold practical significance in selecting suitable sesame oils for various applications, ranging from food to pharmaceutical and cosmetic use, based on their specific properties. Further research into the specific chemical composition of each sesame oil and its mechanisms of action will be a potential direction for future studies.

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