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PHYTOCHEMICAL PROFILING OF SESAME (Sesamum indicum L.) SEED OIL USING UV-Vis AND FTIR SPECTROSCOPY

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ABSTRACT

Consumption of defective or poor-quality oils can pose health and environmental risks. Phytochemicals derived from plant oils provide natural protection to plants and confer several therapeutic and nutritional benefits in humans, including antioxidant, antimicrobial, and anticancer activities. Conventional phytochemical analysis is often laborious, time-consuming, and less sensitive, hence the need for rapid, efficient, and non-destructive methods. Spectroscopic techniques such as Ultraviolet-Visible (UV-Vis) and Fourier Transform Infrared (FTIR) spectroscopy offer alternatives with higher precision and minimal sample preparation.

This study investigated the phytochemical constituents of sesame (*Sesamum indicum*) seed oil using UV-Vis and FTIR spectroscopy. Oil was extracted by cold press and n-hexane solvent methods. UV-Vis analysis was performed to identify conjugated dienes and phenolic compounds, while FTIR spectra were obtained to determine functional groups associated with phytochemicals. The UV-Vis spectra revealed prominent absorption peaks at 230–280 nm and 320–360 nm, indicative of phenolic compounds, conjugated dienes, flavonoids, lignans (sesamin), and sesamol. FTIR spectra showed characteristic peaks at 1742, 2853, 2920, 1465, 1160–1100, 1600–1500, and 3400 cm^{-1}, corresponding to C=O (ester carbonyl), C–H (alkanes), CH_2 bending, C–O stretching, aromatic C=C, and O–H vibrations. These findings confirm the presence of bioactive components such as triglycerides, fatty acids, flavonoids, lignans, alcohols, and phenolic groups, which possess strong antioxidant potential.

This study establishes sesame oil as a rich source of phytochemicals with nutritional and therapeutic significance, highlighting the utility of UV-Vis and FTIR in rapid phytochemical profiling.

Keywords: Phytochemicals, Sesame oil, UV-Vis, FTIR, Functional groups

INTRODUCTION

Plant-derived oils are not only dietary fats but also reservoirs of phytochemicals that provide significant health benefits. Phytochemicals such as lignans, phenolic acids, flavonoids, and sterols exhibit antioxidant, antimicrobial, anti-inflammatory, and anticancer properties (Akbari *et al.,* 2021). Their consumption has been linked to reduced risks of cardiovascular diseases, metabolic disorders, and neurodegenerative conditions.

Sesame (*Sesamum indicum* L.), one of the oldest oilseed crops, is highly valued for its oil content, which is rich in unsaturated fatty acids and bioactive phytochemicals such as sesamin, sesamolin, and sesamol (Dossou *et al.,* 2024). Traditionally, phytochemical analyses rely on chemical extraction and chromatographic separation, but these methods are time-consuming, require large solvent volumes, and may lead to compound degradation (*Wen et al.,* 2023).

Modern spectroscopic techniques like UV-Vis and FTIR spectroscopy provide rapid, accurate, and non-destructive methods of detecting bioactive compounds and functional groups (Ichu *et al.,* 2019). UV-Vis is useful for assessing conjugated systems and phenolic compounds, while FTIR identifies functional groups indicative of specific classes of phytochemicals (Malavi *et al.,* 2023).

This study aims to profile the phytochemical constituents of sesame seed oil using UV-Vis and FTIR spectroscopy, thereby establishing a simple and efficient method for assessing its nutritional and therapeutic potential.

MATERIALS AND METHODS

Sesame (*Sesamum indicum*) seeds were procured from a local market and authenticated at the Department of Botany, Federal University of Agriculture, Abeokuta. N-Hexane (analytical grade) was obtained from Sigma-Aldrich. Distilled water was used for sample preparation.

Oil Extraction

Two extraction methods were employed:

Cold Press Method: Sesame seeds were first cleaned to remove dust, stones, and other impurities. Seeds were lightly dried to reduce moisture content and improve oil yield. The cleaned seeds were pulverized and mechanically pressed using a screw press and hydraulic press. No external heat was applied; the process occurs at temperatures below 50°C to prevent degradation of bioactive compounds. The extracted oil was collected while the solid residue (oil cake) was separated. The crude oil was filtered to remove suspended particles and impurities. The pure sesame oil was stored in airtight, dark containers to protect it from light and oxidation until further analysis.

Solvent Extraction (n-Hexane): Seeds were grinded and soaked in n-hexane for 48 hours, followed by filtration and solvent evaporation under reduced pressure. The extracted oils were stored in amber bottles at 4 °C until analysis.

UV-Vis Spectroscopy

Oil samples were diluted (1:10 v/v) in ethanol and scanned within 200–400 nm using a UV-Vis spectrophotometer. Peaks corresponding to conjugated dienes, polyphenols, and lignans were recorded.

FTIR Spectroscopy

FTIR analysis was carried out using ATR-FTIR spectrophotometer within the range of 400–4000cm^{-1}. Spectra were collected at a resolution of 4 cm^{-1} and assigned to specific functional groups based on standard IR absorption bands

RESULTS AND DISCUSSION

UV-Vis Spectroscopy

As shown in table 1 and figure 1, the UV-Vis spectra of sesame oil showed two distinct absorption regions:

230–280 nm (Conjugated dienes and Phenolic acids): This band indicates the presence of conjugated double bonds and phenolic compounds. These compounds are often associated with primary antioxidant activity, as they can neutralize free radicals and reduce oxidative damage. Their presence confirms that sesame oil contains naturally occurring protective phytochemicals.

The absorption of 320–360nm (Flavonoids, Lignans, Sesamol, Sesamolin), this absorption range corresponds to more complex antioxidant molecules such as flavonoids and lignans (sesamin, sesamolin), along with sesamol. These are well-documented bioactive compounds that provide strong antioxidant capacity. They help protect sesame oil from rancidity and also offer health benefits by reducing oxidative stress in the human body.

Wavelength Range (nm)	Phytochemicals Identified	Significance
230–280	Conjugated dienes, Phenolic acids	Indicators of antioxidant compounds
320–360	Flavonoids, Lignans (Sesamin, Sesamolin), Sesamol	Strong antioxidant capacity, protective effects against oxidative stress

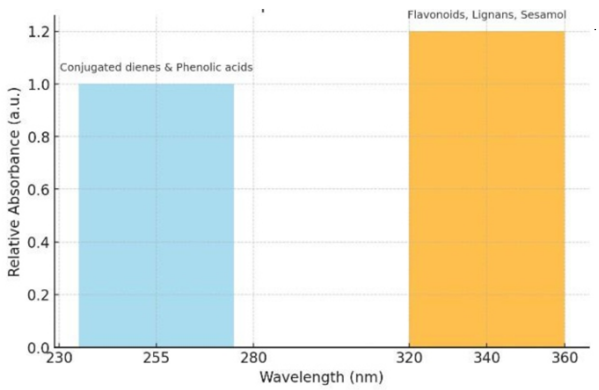

Figure 1: Graph of UV-Vis Spectrum of sesame oil

FTIR Spectroscopy

The FTIR spectrum of sesame (*Sesamum indicum* L.) seed oil revealed distinct absorption peaks corresponding to functional groups associated with phytochemicals (Table 2). A strong absorption band was observed at 1742 cm^{-1}, attributed to the stretching vibration of C=O ester carbonyl groups, confirming the presence of triglycerides (Masurkar, 2024).

Characteristic C–H stretching vibrations of aliphatic chains were recorded at 2853 cm^{-1} and 2920 cm^{-1}, indicating long-chain fatty acids. The band at 1465 cm^{-1} corresponded to CH_2 bending vibrations, typical of alkanes. Absorptions within1100-1160cm^{-1} were due to C–O stretching, confirming the presence of esters and alcohols. Peaks within 1500–1600 cm^{-1} were assigned to aromatic C=C stretching, indicating lignans and polyphenols. A broad band at 3400 cm^{-1} represented O–H stretching, confirming Sadatasl *et al.,* (2024) the presence of phenolic compounds and alcohols.

These bands confirm the presence of fatty acids, triglycerides, phenolics, flavonoids, and lignans, supporting the results of UV-Vis analysis. Together, they establish sesame oil as a phytochemically rich edible oil with potential therapeutic applications Kahrıman *et al.,* (2021).

Table 2: FTIR spectral peaks and functional group assignments of sesame oil

Wavenumber (cm^{-1})	Functional Group Assignment	Associated Phytochemicals/Compounds
1742	C=O stretching (ester carbonyl)	Triglycerides, phospholipids, fatty acids
2853, 2920	C–H stretching (alkanes)	Fatty acid chains, hydrocarbons
1465	CH_2 bending	Alkanes, saturated hydrocarbons
1160–1100	C–O stretching	Esters, alcohols

Implications

The combination of UV-Vis and FTIR spectroscopy provides a rapid, cost-effective approach to phytochemical profiling compared to chromatographic methods. The bioactive compounds identified are associated with health benefits such as antioxidant protection, cholesterol regulation, and anti-inflammatory effects, making sesame oil a functional food.

CONCLUSION

This study confirms that sesame (*Sesamum indicum*) seed oil is a rich source of bioactive phytochemicals including phenolic compounds, lignans, flavonoids, triglycerides, and fatty acids. UV-Vis analysis identified conjugated dienes and phenolic compounds, while FTIR spectra revealed functional groups corresponding to fatty acids, esters, alcohols, lignans, and polyphenols.

The findings from this study shows the nutritional, therapeutic, and industrial importance of sesame oil.

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