University of Aden Journal of Natural and Applied Sciences., vol.30(1) (2026) 71 – 86

University of Aden Journal of Natural and Applied Sciences

Journal homepage: https://uajnas.adenuniv.com

Research Article

Thermal degradation and estimation of fatty acids and acid values in local and commercial vegetable oils used in Yemen

Mokhtar S. S. Al-Salimi[1*], Abdul-Rahman Alawi Bin Yahia[2], Dua'a Hussein Al-Maqdi[2]

1 Department of Chemistry, Yafea University College, University of Lahej, Yafea, Yemen

2 Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Aden, Yemen

https://doi.org/10.47372/uajnas.2026.n1.a05

ARTICLE INFO

Received: 27/03/2026

Accepted: 06/07/2026

Keywords:

Thermal degradation,
Free fatty acid,
Acid value,
Cholesterol,
Vegetable oils.

Abstract

This study evaluated the quality and thermal stability of local and commercial vegetable oils by analyzing fatty acid-related indicators, acid value, and cholesterol content. The findings showed that all samples' fatty acid-related values with temperature. Local oils displayed comparatively low values, with Abyani sesame oil ranging from 0.193±0.017 to 0.267±0.056% and Yemeni almond oil ranging from 0.073±0.012% at 25 °C to 0.099±0.044% at 90 °C. Commercial oils showed higher susceptibility to thermal deterioration with higher values and quicker rises, especially commercial Saudi black oil (0.829 ±0.178 to 1.040±0.241) and Somalia sesame oil (0.146 ± 0.032 to 0.324 ± 0.062 %). Local oils had lower acid values; Yemeni almond oil increased from 1.571% mg KOH/g at 30 °C to 2.149±0.150% mg KOH/g at 90 °C, while Abyani sesame oil increased from 3.330±0.245 to 5.554±0.461 mg KOH/g. Commercial oils, displayed much higher values. For instance, commercial Somalia sesame oil from 7.254±1.787 to 8.964±2.456 mg KOH/g, while Saudi black oil stayed extremely high (16.69±4.365to 16.83±2.986 mg KOH/g), indicating greater hydrolysis and the generation of free fatty acids. Tehama sesame and Abyani Sesame oils had cholesterol contents of 26.53±1.735 and 26.34±2.489 ppm, respectively, which were comparatively constant and lower than other local oils. Commercial oils showed more variety, ranging from 22.42±1.676 Indian linseed to 27.28±1.983 ppm Saudi black oil. Local Yemeni fenugreek oil 38.13±1.897 ppm. Based on these results, this study compares thermal stability and quality indicators (free fatty acids, acid value, and cholesterol) of local versus commercial vegetable oils in Yemen as reliable indicators for assessing the quality and oxidative stability of sesame seed oils, with implications for quality and consumer health awareness.

1. Introduction

Under the influence of temperature, fat and oils are susceptible to oxidation primarily leading to the formation of hydroperoxides. Due to their high reactivity, these hydroperoxides especially at high temperatures rapidly react with secondary oxidative products e.g. aldehydes, ketones, peroxides, hydrocarbons as well as cyclic compounds that exhibits very different possible toxic or carcinogenic properties. The products formed during this oxidative process can be determined by chemical analysis and one of the frequently used tests employed to predict the quality of oils is the determination of free fatty acid percent value and acid value [1-4]. The

*Corresponding author: Department of Chemistry, Yafea University College, University of Lahej
E-mail address: mokhtarsalim93@gmail.com

chemistry of oxidation at high temperature is very complex since both thermal and oxidative reaction are involved, the chemical mechanism of the thermal oxidation is principally the same as the autoxidation mechanism, but the thermal oxidation is faster than the autoxidation [5-9]. The previous research mention that the acid value of oil increase by increasing temperature, heating time as well by the addition of additive as ferric stearate and ferrous octanoate, the literature also demonstrating that transition metals accelerate oxidation at ambient and elevated temperatures [10]. Cholesterol is a hydrophobic compound, with a single hydroxyl group - located at carbon 3 of the ring to which an even more hydrophobic cholesteryl ester. There are two types of cholesterol include chylomicron, very low-density lipoprotein (VLDL), low density lipoprotein (LDL) and high-density lipoprotein (HDL) [11,12]. Cholesterol and lipid, plays a vital role in the physiological regulation of membrane fluidity and proper functioning of cells. It is also a major precursor in the production of bile acids, steroid hormones as well as vitamin D [13]. Cholesterol is a fatty substance that your body needs to work, it is synthesized by virtually all human tissue, although primarily by liver, intestine adrenal cortex, reproductive tissues. Cholesterol can be eliminated from the body either by conversion to bile salts or by secretion in to the bile. Intestinal bacteria can reduce cholesterol to coprostanol and cholestanol, which together with cholesterol make up the bulk of natural fecal sterols [12]. Cholesterol has been of great medical importance in recent years, because its high level in the body has been associated with coronary heart diseases [13]. Due to the changes on the physicochemical properties of oils as free fatty acids and acid value, these changes gave method to study the kinetics of oil oxidation. Free fatty acids are usually presenting in oils along with the triglycerides. It increases during heating. The present study addresses this gap by investigating the effect of different temperature levels on the stability of various vegetable oils local and commercial. It postulates that the resistance of vegetable oils to thermal deterioration varies depending on their chemical makeup and that rising temperatures speed up the thermal breakdown of triglycerides, leading to a notable increase in free fatty acids and acid value. The main objective of this study is to evaluate the impact of temperature on the chemical stability of vegetable oils through monitoring changes in free fatty acids and acid value as primary indicators of degradation. The study also aimed to quantify the cholesterol content in vegetable oils in order to determine whether they contain any adulteration with animal-derived fats, using UV visible spectrophotometer by Liebermann-Burchard method.

2. Materials and Methods:

2.2. Samples collection

Oil vegetable's were sampled in 2024 from Aden, Lahej, and Abyan governorates-Yemen including; Yemeni almond (YA), Abyani sesame (AS), Yemeni fenugreek (YF), Laheji sesame (LS), Tehama sesame (TS), Saudi black seed (SB), Somalia sesame (SS), Indian linseed (IL), and Ethiopian black seed (EB). Oils samples were transferred into the laboratory and kept at the room temperature until the contents were analyzed.

2.3. Study of thermal stability

The water bath was heated up to required temperature, then 20 ml of oil sample taken in conical flask and heated for 2 hours in water bath (the zero-time calculated when the water bath attained the required temperature). Then 2 g of heated oil taken and 10 ml of ethanol added after that titrated with NaOH, then addition of few drops of phenolphthalein as indicator until the color change to pink [14]. The free fatty acids calculated by below equation:

$$\text{Free Fatty Acid \%} = \frac{V \times M \times 2.82}{W} \qquad (1)$$

Where: V = Volume of standard NaOH solution in ml, W = Weight of sample oil in grams and M = Molarity of standard NaOH solution.

2.4. Reagents and Standards

Potassium hydroxide and sodium hydroxide solutions at 0.1 N concentration were prepared, with standardization performed using oxalic acid. Phenolphthalein indicator was prepared by dissolving one gram in 100 mL of 95% ethanol. Hydrochloric acid at 0.5 N was standardized using sodium carbonate 0.5 N. Methyl orange indicator was prepared by dissolving 0.1 g in 100 mL of ethanol, then diluting to volume with distilled water. The standard deviation (± SD) was calculated after replication at least three times.

2.5. Estimation of cholesterol

1 g of oil sample dissolved in 10 ml chloroform and diluted to 50 ml. By taken 5 ml of this diluted sample mixed with 2 ml of chloroform and 2 ml of Liebermann-burchard reagent, covered by black carbon and put on ice in dark place, the chloroform in the Liebermann-Burchard reagent reacts with cholesterol in the sample, which gave a green-blue color whose

absorbance was determined by SCINCO spectrophotometer at 640 nm [15]. The calibration curve was constructed using cholesterol standard solutions Table 1 and Figure 1 in the concentration range of 50–250 ppm. A good linear relationship was observed between concentration and absorbance, with the regression equation: Y=0.0059X-0.0257 and a correlation coefficient of (R2 = 0.987), indicating excellent linearity, (obtained by using Liebermann-Burchard method, which was done in Supreme Board of Drug and Medical Appliances-Quality Control Laboratory, Khormaksar–Aden.

Table 1. Standard cholesterol solutions and absorbance

Cholesterol solution	0.5 ml	1 ml	1.5 ml	2 ml	2.5 ml	-
Lieberman Burchard	2	2	2	2	2	2
Chloroform	7.5	7	6.5	6	5.5	8
Solution conc.	50 ppm	100 ppm	150 ppm	200 ppm	250 ppm	blank
Absorbance	0.24	0.59	0.97	1.21	1.52	-

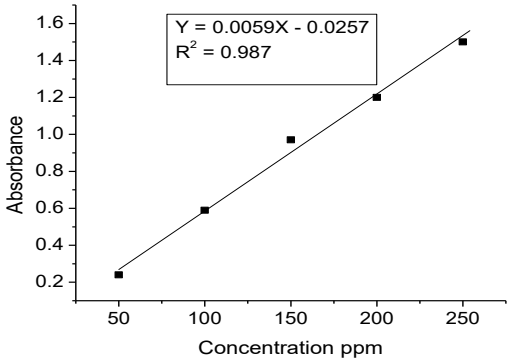


Figure 1: Calibration curve of standard cholesterol solutions

3. Results and Discussion

3.1. Free fatty acid %

Since the 1880s, oil scientists have been aware that the amount of free fatty acids (FFA) in crude oil is a reliable predictor of its quality. Free fatty acids, di and mono-acylglycerols, and ultimately free glycerol are produced when the triacylglycerol molecule splits at the ester bond due to hydrolysis. Heat usually speeds up this reaction, which is typically triggered by the presence of moisture. Some enzymes (lipases) can also encourage it. When the fatty acid chain length is less than 14 carbons, the released free fatty acids have a distinct flavor and odour that are more undesirable [16]. The measured parameter and its response to rising temperatures

clearly differ between local and commercial oils, according to the results. First, local oils Yemeni almond and Abyani sesame frequently demonstrated lower values compared to commercial samples at all temperatures. The Yemeni almond local oil demonstrated excellent stability, with only a little increase from 0.073±0.012% at 25 °C to 0.099±0.044% at 90 °C, demonstrating high resistance to thermal deterioration. On the other hand, compared to Yemeni almond oil, Abyani sesame oil showed a moderate increase with occasional volatility but stayed within a reasonably low range, indicating acceptable but lesser stability. Second, the overall values of commercial oils were significantly higher. The local Yemeni fenugreek oil showed a sharp increase with temperature (from 0.356 to 1.211%), indicating a high susceptibility to thermal degradation or formation of secondary oxidation products; the Saudi black oil showed elevated and fluctuating values (0.829±0.178 to 1.040±0.241%) show Table 2, indicating poor thermal stability; the commercial oils (Somali, Indian, and Ethiopian) showed moderate and gradual increases, suggesting intermediate stability; and the Laheji sesame and Tehama sesame oils showed moderate values with a steady increase, indicating a relatively balanced thermal behavior. Finally, all samples exhibited an increase in values as the temperature Figures 2 and 3, which is consistent with the acceleration of oxidation and thermal degradation reactions. But compared to local oils, the pace of rise was significantly higher for commercial oils. These results imply that indigenous oils especially Yemeni almond oil have superior quality and greater thermal stability than local oils, which seem more prone to deterioration and might contain additives or components that affect their thermal behavior.

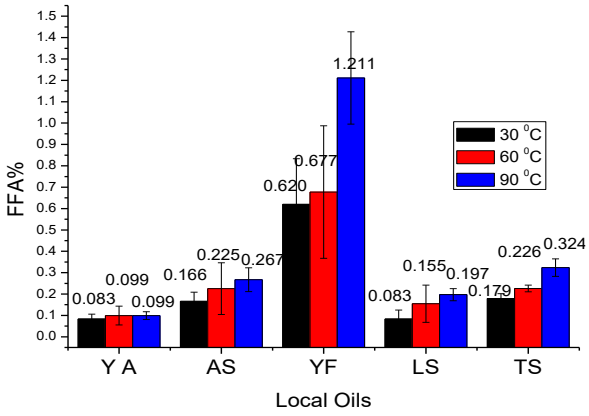


Figure 2: Effect of heating on FFA of local oils at 30 ,60 and 90 °C

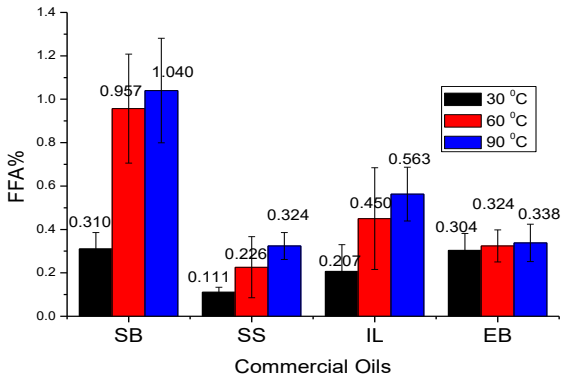


Figure 3: Effect of heating on FFA of commercial oils at 30 ,60 and 90 ℃

The relationship between temperature and oxidative or thermal deterioration of oils are related, and that the type and fatty acid makeup of an oil greatly influence its ability to withstand heat. An increase in free fatty acid (FFA) content and a decrease in total unsaturation are important markers of oxidative and chemical degradation during heating [17]. The main component of oils, fatty acids, have a major impact on their oxidative stability. Of the oils examined, groundnut oil had the highest FFA values, ranging from 7.854 to 10.261%, while palm kernel oil had the lowest, ranging from 1.122 to 4.448%. Interestingly, only palm kernel oil and palm olein oil remained below the maximum allowable FFA limit of 3.5 mg KOH/g for edible oils even after seven hours of continuous heating [18]. The observed rise in FFA values, which reflects the chemical alterations and oxidative transformations that take place in oils with prolonged heating, is in good accord with the equivalent rise described in the current study.

The findings reported by Majchrzak et al. [19] findings, extended heating of canola and olive oils speeds up the processes of oxidation and hydrolysis, which are important markers of thermal deterioration. The hydrolysis of triglycerides into their component parts is reflected in the rise in free fatty acids (FFA), which increases dramatically with temperature and heating time. In a similar vein, the peroxide value shows a distinctive pattern, first rising as primary oxidation products form and then falling as these molecules break down into more stable secondary oxidation products. Interestingly, it was discovered that canola oil produced more oxidation products than olive oil, indicating that the latter had better heat stability. In a related study, Lee et al. [20] showed a significant correlation between an oil's resistance to thermal degradation and its initial quality. When repeatedly fried at 180°C, the acid value and total polar compounds of both soybean and canola oils gradually increased. But under the same circumstances, canola oil showed better chemical stability and less rancidity susceptibility than

soybean oil. Additionally, after roughly five frying cycles, both sensory and chemical quality significantly declined, underscoring the quick deterioration in oil quality with repeated use.

While some differences in FFA values were noted, the current results are mostly consistent with earlier research. Differences in oil kind, unsaturation level, and heating circumstances could be the cause of these discrepancies. Due to the existence of double bonds, unsaturated fatty acid-rich oils are more vulnerable to oxidative destruction, while saturated or antioxidant-rich oils often show better resilience to oxidative and thermal stress [20]. Consequently, a trustworthy indicator of oil stability under thermal stress is the measurement of free fatty acids and acid value at different temperatures. Furthermore, when FFA levels above specific threshold limits (usually > 0.5–1.0% for edible oils), the oil develops an unpleasant taste and odour and potentially hazardous chemicals like acrolein, making it unfit for ingestion. The significance of methodological standardization in comparative study on edible oil stability is highlighted by the fact that variations between studies may also result from variations in storage circumstances, analytical techniques employed for acidity assessment, and refining levels.

3.2. Acid value

The data further demonstrate notable differences between local and commercial oils in terms of acid value (mg KOH/g) and their response to elevated temperature. The acid values of the two local oils, Yemeni almond and Abyani sesame, were relatively low at 30 °C (1.571 and 3.330 ±0.245 mg KOH/g, respectively) and moderately increased at 90 °C (2.149±0.150and 5.554 ±0.461 mg KOH/g) Figures 4 and 5. Yemeni Almond oil, in particular, showed lower acid values and a smaller rate of increase, indicating higher oxidative stability and better resistance to hydrolytic degradation, whereas Abyani sesame oil showed a more noticeable increase, indicating a higher susceptibility to thermal deterioration. and the Yemeni fenugreek oil reaching 11.220 ±3.543 mg KOH/g. Commercial oils, on the other hand, had far greater acid values at both temperatures. The Saudi black oil had the highest acidity at 30 °C, 16.69±4.365 mg KOH/g Table 3. All commercial samples showed an additional rise in acid value when heated to 90 °C, with the Saudi black oil reaching 16.83±2.986 mg KOH/g and the Ethiopian black oil reaching 10.100 ±2.451 mg KOH/g. This pattern indicates a higher degree of free fatty acid production and triglyceride hydrolysis in hot environments. The acid value calculated by equation:

Table 2. The mean percentage and standard deviation of FFA at 25, 30, 60 and 90 ℃ in local and commercial oil

Local oils						Commercial oils			
Sample oil	Yemeni Almond	Abyani Sesame	Yemeni Fenugreek	Laheji Sesame	Tehama Sesame	Saudi Black	Somalia Sesame	Indian Linseed	Ethiopian Black
25 ^{0}C	0.073±0.012	0.193±0.017	0.356±0.124	0.093±0.089	0.233±0.101	0.829±0.178	0.146±0.032	0.225±0.055	0.273±0.089
30 ^{0}C	0.083±0.023	0.166±0.043	0.620±0.213	0.083±0.042	0.179±0.023	0.310±0.076	0.111±0.023	0.207±0.123	0.304±0.078
60 ^{0}C	0.099±0.044	0.225±0.121	0.677±0.310	0.155±0.087	0.226±0.016	0.957±0.251	0.226±0.141	0.450±0.234	0.324±0.074
90 ^{0}C	0.099±0.018	0.267±0.056	1.211±0.216	0.197±0.028	0.324±0.041	1.040±0.241	0.324±0.062	0.563±0.124	0.338±0.086

Table 3. The mean concentration and standard deviation of acid value at 30 and 90 ℃ in local and commercial oils

	Local oils mg KOH/g					Commercial oils mg KOH/g		
Sample	Yemeni Almond	Abyani Sesame	Yemeni Fenugreek	Laheji Sesame	Tehama Sesame	Saudi Black	Somalia Sesame	Ethiopian Black
30 ^{0}C	1.571±0.102	3.330±0.245	8.295±2.123	2.553±0.987	6.311±2.114	16.69±4.365	7.254±1.787	5.890±1.879
90 ^{0}C	2.149±0.150	5.554±0.461	11.220±3.543	4.544±1.789	7.321±2.565	16.83±2.986	8.964±2.456	10.100±2.451

$$\text{Acid Value} = \frac{56.1 \times V \times M}{W} \qquad (2)$$

Where: V = volume of standard KOH solution in ml, M = Molarity of standard KOH solution, W = The weight of the oil sample in grams.

High-oleic sunflower oil is more resistant to oxidative degradation than normal sunflower oil, mainly because it contains less linoleic acid, according to a study by Nagy et al. [22] on omega fatty acid-enriched vegetable oils. The results also showed that under extended heating, polyunsaturated fatty acids (PUFAs) significantly decreased while saturated fatty acids increased relative to PUFAs, indicating PUFAs' vulnerability to thermal oxidation. According to Mukhametov et al.,[23] higher temperatures have a significant impact on sunflower oil's acid value. Specifically, heating at 75°C caused acid values to rise quickly, surpassing acceptable threshold limits within about 40 minutes of treatment; in blended oil samples, the acid value exceeded the allowable limit (0.4 mg KOH/g) after 40 minutes at 40°C and after just 20 minutes at 75°C, indicating accelerated degradation under higher thermal conditions. These results are consistent with the current study's observed rise in acid value, which supports the gradual hydrolytic breakdown of triglycerides under heat stress. This trend emphasizes how sensitive edible oils are to temperature and heating time, highlighting the significance of managing processing and usage conditions to maintain oil stability and quality.

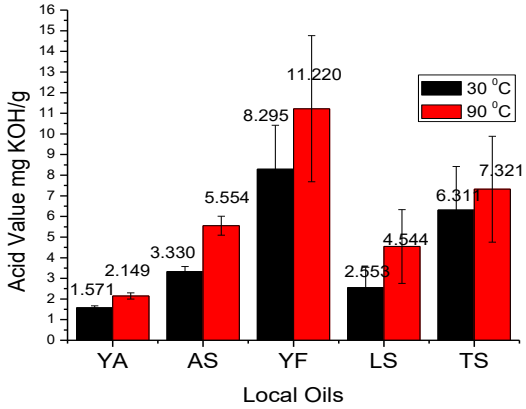


Figure 4: Effect of heating on acid value of local oils at 30 and 90 °C

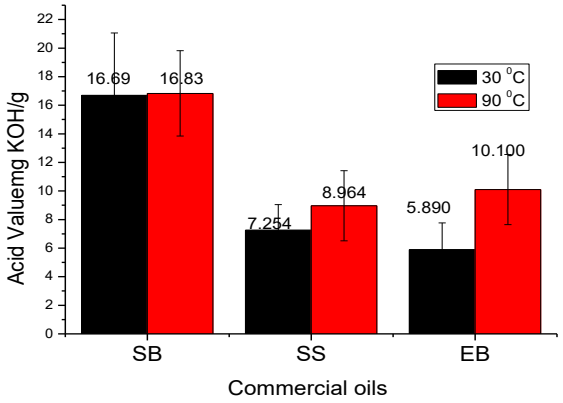


Figure 5: Effect of heating on acid value of commercial oils at 30 and 90 °C

Table 4. Mean concentration and standard deviation of cholesterol in local and commercial oils

Sample Oil	Yemeni Almond	Abyani Sesame	Yemeni Fenugreek	Laheji Sesame	Tehama Sesame	Saudi Black	Somalia Sesame	Indian Linseed	Ethiopian Black
Mean±SD	27.73±1.367	26.34±2.489	38.13±1.897	30.26±3.675	26.53±1.735	27.28±1.983	26.81±3.235	22.42±1.676	25.94±1.768

3.3. Estimation of cholesterol

Liebermann-Burchard test is used for colorimetric test to detect cholesterol, which gives a deep green color. This color begins as a purplish, pink color and progresses through to a light green then very dark green color. The color is due to the hydroxyl group (-OH) of cholesterol reacting with the reagents and increasing the conjugation of the unsaturation in the adjacent fused ring. In this reaction the acetic acid in the Liebermann reagent reacts with cholesterol in

the oil sample, which acid value a green color whose absorbance determined by UV-visible at 640 nm [24].

The findings displayed in Figure 6 and Table 4 demonstrate considerable differences in the content of cholesterol between commercial and local vegetable oils. At 27.73±1.367 and 26.34±2.489 ppm, respectively, the cholesterol levels for local oils Yemeni almond and Abyani sesame were comparatively low. This small range supports the hypothesis that sesame oil naturally contains very little cholesterol, indicating good purity and the lack of considerable adulteration. It also implies consistency in composition. On the other hand, the cholesterol content of commercial oils varied more. The greatest concentration was found in local Yemeni fenugreek oil 38.13±1.897 ppm, followed by Laheji sesame oil 30.26±3.675 ppm; samples from Tehama, Saudi Arabia, and Somalia ranged from roughly 26.53±1.735 to 27.28±1.983 ppm. Ethiopian black oil 25.94±1.768 ppm and Indian linseed oil 22.42±1.676 ppm had lower levels. sesame oil and other vegetable oils are naturally cholesterol-free, the cholesterol levels found in both commercial and local samples may suggest: Potential animal fat adulteration, particularly in samples with higher values (e.g., local Yemeni fenugreek oil). Or the presence of analytical interferences or trace contamination during processing and handling. While the comparatively lower and consistent findings in local oils imply better authenticity and purity, the noticeably higher cholesterol concentration in some commercial oils shows a larger chance of adulteration or quality difficulties. Previous studies have consistently demonstrated that pure vegetable oils contain negligible or undetectable levels of cholesterol, typically below 1 mg/100 g, as reported by Zhao et al. [25] adulterated oils, on the other hand, have considerably higher cholesterol concentrations, ranging from 20 to 150 ppm depending on the degree of adulteration, especially when combined with leftover cooking oils or animal fats.

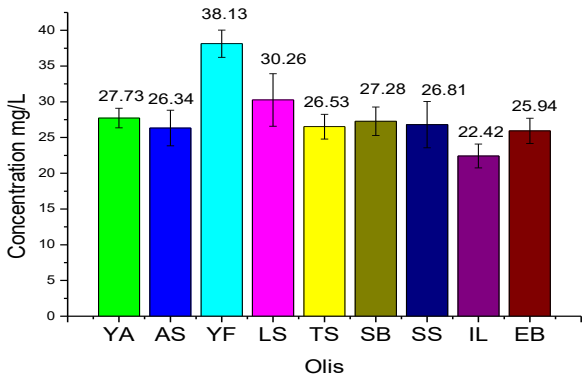


Figure 6. Concentration of cholesterol in local oils and commercial oils

This distinction highlights cholesterol as a reliable marker for detecting oil adulteration. A number of analytical methods have been put out to detect adulteration in vegetable oils by measuring phytosterols and cholesterol. Tan [26], for example, found that pure olive oil had very little cholesterol (less than 1 mg/100 g), but counterfeit samples may have amounts as high as 100 mg/g, indicating significant contamination. With a detection threshold as low as 5% adulteration, another experimental investigation [27] showed a linear increase in cholesterol content with increasing levels of adulteration, reaching roughly 120 ppm. Cholesterol levels as high as 120 ppm were found in oils containing animal fats in that investigation, further demonstrating the diagnostic use of cholesterol as a sensitive sign of adulteration. In contrast to these results, the current study's cholesterol levels were less than 38.13±1.897 ppm, indicating a low amount of animal-derived lipid contamination. These values are far lower than those linked to highly contaminated samples, even if they are still higher than those documented in the literature for pure vegetable oils. This suggests that rather than substantial mixing with animal fats, the examined oils may have had modest adulteration or contamination. Variations in plant species, variations in extraction techniques, and the effectiveness of oil separation and purification procedures are some of the reasons why the current results differ from those published in earlier studies. Additionally, while interpreting the results, storage conditions and thermal exposure should be taken into account as they may potentially affect the cholesterol content. Overall, the relatively low concentrations found here support the conclusion that the samples show limited adulteration and maintain acceptable quality standards, even though the cholesterol levels reported in the literature are generally lower for pure oils than those observed in the current study.

4. Conclusions

The present findings collectively demonstrate that local vegetable oils, especially Yemeni almond oil, physicochemical quality, higher purity, and more thermal stability than their commercial counterparts. Their improved resistance to oxidation, hydrolysis, and thermal degradation is demonstrated by their lower fatty acid-related indicators, decreased acid values, and negligible changes upon heating. Commercial oils exhibited considerably higher acidity, increased temperature sensitivity, and more noticeable thermal deterioration in addition to cholesterol content fluctuation. These variations could be explained by storage circumstances, processing techniques, or even adulteration with outside ingredients. Overall, the findings highlight the need for strict authentication and quality control procedures to guarantee the stability, safety, and purity of edible oils. Recommended strategies include confirming cholesterol levels using GC-MS or HPLC-MS to differentiate it from phytosterols and to assess contamination. Perform frying simulations at 170–190 °C over multiple cycles, and measure parameters such as peroxide value, total polar compounds (TPC), and volatile toxicants (via GC-MS aldehyde profiling). Additionally, analyze the fatty acid profile using GC-FAME before and after heating to correlate changes in free fatty acids (FFA) and acid value with the composition of polyunsaturated, monounsaturated, and saturated fatty acids.

Conflict of interest

Not applicable. We have no colleagues to exclude due to conflicts of interest.

Acknowledgments

We thank the Supreme Board of Drug and Medical Appliances-Quality Control Laboratory, Aden, Yemen, for providing the UV-vis spectroscopy instrument to complete this research.

References

1. Keshavarz, S., Moslehishad, M. (2020). Advantages of thermal stability of virgin olive oil over canola and frying oil. Journal of Food and Bioprocess Engineering, 3(1), 41–46.
2. Tsai, Y. H., Chiang, D., Li, Y. T., Perng, T. P., Lee, S. (2023). Thermal degradation of vegetable oils. Foods, 12(9).
3. Szabo, Z., Marosvolgyi, T., Szabo, E., Koczka, V., Verzar, Z., Figler, M., Decsi, T. (2022). Effects of repeated heating on fatty acid composition of plant-based cooking oils. Foods.
4. Atulthakkar, A. (2014). Study of effect of temperature on shelf stability of soybean corn oil blends. International Journal of Theoretical & Applied Sciences. 6(1), 14-19.
5. Dupain, X., Costa, D. J., Schaverien, C. J., Makkee, M., Moulijn, J. A. (2007). Cracking of a rapeseed vegetable oil under realistic FCC conditions. Applied Catalysis B: Environmental, 72(1–2), 44–61.
6. Naz, S., Sheikh, H., Siddiqi, R., Sayeed, S. S. (2004). Oxidative stability of olive oil, corn and soybean oil under different conditions, Food Chemistry. 88(2), 253-259.
7. Cam, A., Oyirifi, A. B., Liu, Y., Haschek, W. M., Iwaniec, U. T., Turner, R. T., Engeseth, N. J., Helferich, W. G. (2019). Thermally abused frying oil potentiates metastasis to lung in a murine model of late-stage breast cancer. Cancer Prevention Research, 12(3), 201–210.
8. Moulodi, F., Qajarbeigi, P., Rahmani, K., Haj Hosseini Babaei, A., Mohammad poorasl, A. (2015). Effect of fatty acid composition on thermal stability of extra virgin olive oil. Journal of Food Quality and Hazards Control, 2(2), 56–60.
9. Chen, J., Zhao, Y., Wu, R., Yin, T., You, J., Hu, B., Jia, C., Rong, J., Liu, R., Zhang, B. (2023). Changes in the quality of high-oleic sunflower oil during the frying of shrimp (Litopenaeus vannamei). Foods, 12(6), 1332.
10. Coscione, A. R., Artz, W. E. (2005). Vegetable oil stability at elevated temperatures in the presence of ferric stearate and ferrous octanoate. Journal of Agricultural and Food Chemistry. 53 (6), 2088–2094.
11. Attarde, D., Pawar, J., Chaudhari, B., Pal, S. (2010). Estimation of sterols content in edible oil and ghee samples. International Journal of Pharmaceutical Sciences Review and Research, 5(1), 135– 137.
12. Laker, M. (2003). Understanding Cholesterol. Family doctor Publications Ltd, Dorset, United Kingdom., pp:116.

13. Okpuzor, J., Okochi, V. I., Ogbunugafor, H. A., Ogbonnia, S., Fagbayi, T., Obidiegwu, C. (2009). Estimation of cholesterol level in different brands of vegetable oils. Pakistan Journal of Nutrition, 8(1), 57–62.
14. ASTM International. (2011). Standard test method for thermal stability by thermogravimetry (ASTM E2550-11). West Conshohocken, PA: Author. Retrieved from (http://www.astm.org).
15. Dimberu, G. A., Atinafu, A. (2012). Estimation of total free fatty acid and cholesterol content in some commercial edible oils in Ethiopia. New Clues in Sciences, 2, 82–89.
16. Bailey, A. E. (1948) Cottonseed oil, in Cottonseed and Cottonseed Products (ed A.E. Bailey), Interscience Publishers, Inc., New York, NY, pp. 364–408
17. Perkin, E.G., (1992). Effect of lipid oxidation on oil and food quality in deep frying. In: Angels, A.J.S. (Ed.), Lipid Oxidation in Food, Chapter 18, ACS Symposium Series no. 500 ACS, American Chemical Society, Washington DC, pp. 310–321.
18. Nduka, J. K., Omozuwa, P. O., Imanah, O. E. (2021) Effect of heating time on the physicochemical properties of selected vegetable oils. Arabian Journal of Chemistry. 2021 (14); 202104.
19. Majchrzak, T., Lubinska ,M., Różańska, A., Dymerski , T., Gębicki, J., Namieśnik , J. (2017). Thermal degradation assessment of canola and olive oil using ultra-fast gas chromatography coupled with chemometrics. Monatsh Chem.148(9):1625-1630.
20. Lee, J., Boo, C.;,Hong, S.-j., Shin, E.-C. (2021). Chemosensory Device Assisted-Estimation of the Quality of Edible Oils with Repetitive Frying. Foods. 10, 972.
21. Stachowiak, G. W., Batchelor, A. W. (2005). Engineering tribology (3rd ed.). Butterworth-Heinemann. pp. 39-40.
22. Nagy, K., Iacob, B.-C., Bodoki, E.; Oprean, R (2024). Investigating the Thermal Stability of Omega Fatty Acid-Enriched Vegetable Oils. Foods, 13, 2961.
23. Mukhametov, A., Dautkanova, D., Kazhymurat, A., Yerbulekova, M. Gulsim Aitkhozhayeva, G. (2023). The effects of heat treatment on the oxidation resistance and fatty acid composition of the vegetable oil blend. Journal of Oleo Science 72, (6) 597-604.
24. Burke, R. W., Diamondstone, B. I., Velapoldi, R. A., Menis, O. (1974). Mechanisms of the Liebermann-Burchard and Zak color reactions for cholesterol. Clinical Chemistry, 20(6), 794–801.
25. Zhao, H., Wang, Y., Xu, X., Ren, H., Li, L., Xiang, L., Zhong, W. (2015). Detection of adulterated vegetable oils containing waste cooking oils based on the contents and ratios

of cholesterol, β-sitosterol, and campesterol by gas chromatography/mass spectrometry. Journal of AOAC International, 98(6), 1645-1654.

26. Tan, C.H., Kong, J., Irfan,U., Solihin, M. J., Pui1,L. P. (2021). Edible Oils Adulteration: A Review on Regulatory Compliance and Its Detection Technologies. Journal of Oleo Science. 70, (10) 1343-1356.

27. Minuceli , F. S., da Silva , J. M., da Silveira, R., Santos, O. O., (2021). UV-VIS methodology for the quantification of vegetable oil in adulterated olive oil. Research, Society and Development, 10(6) e50210612822, 2021.

University of Aden Journal of Natural and Applied Sciences., vol.30(1) (2026) 71 – 86

مجلة جامعة عدن للعلوم الطبيعية والتطبيقية

Journal homepage: https://uajnas.adenuniv.com

بحث علمي

التحلل الحراري وتقدير الأحماض الدهنية والقيم الحامضية في الزيوت النباتية المحلية والتجارية المستخدمة في اليمن

مختار سالم صالح السالمي[1،*]، عبد الرحمن علوي بن يحيى[2] و دعاء حسين المقدي[2]

1. قسم الكيمياء، كلية يافع الجامعية، جامعة لحج
2. قسم الكيمياء الصيدلانية، كلية الصيدلة، جامعة عدن

https://doi.org/10.47372/uajnas.2026.n1.a05

الملخص

قيّمت هذه الدراسة جودة الثبات الحراري لبعض الزيوت النباتية المحلية والتجارية المتداولة في أسواق محافظات عدن وأبين ولحج من خلال تحليل مؤشرات الأحماض الدهنية الحرة، وقيم الحموضة الناتجة عن تأثير درجة الحرارة على الزيوت، بالإضافة إلى تقدير محتوى الزيوت من الكوليسترول. أظهرت النتائج أن قيم المؤشرات المرتبطة بالأحماض الدهنية الحرة زادت في جميع العينات المدروسة مع ارتفاع درجة الحرارة. وقد سجلت الزيوت المحلية قيماً منخفضة نسبياً؛ حيث تراوحت قيم زيت السمسم الأبيني بين 0.017 ± 0.193 % و 0.056 ± 0.267 %، بينما تراوحت في زيت اللوز اليمني بين 0.012 ± 0.073 % عند 25 درجة مئوية و 0.044 ± 0.099 % عند 90 درجة مئوية. في المقابل، أظهرت الزيوت التجارية قابلية أكبر للتدهور الحراري، مع قيم أعلى وزيادة أسرع في التحلل، خاصة في زيت السمسم الأسود السعودي التجاري (0.241% ± 1.040 - 0.178 ± 0.829)، وزيت السمسم الصومالي (0.062 % ± 0.324 - 0.032 ± 0.146)، وهذا يعكس تحلل ثلاثي الجليسريد الى مكوناته، أما بالنسبة لقيم الحموضة، فقد كانت أقل في الزيوت المحلية؛ إذ كانت في زيت اللوز اليمني من (0.102mg KOH/g ± 1.571) عند 30 درجة مئوية إلى (0.150 mg KOH/g ± 2.149)عند 90 درجة مئوية، بينما تراوحت في زيت السمسم الأبيني من 0.245mg ± 3.330 (KOH/g) إلى (0.461 mg KOH /g ± 5.554). في المقابل، أظهرت الزيوت التجارية قيماً أعلى بكثير، فعلى سبيل المثال، زادت قيمة الحموضة في زيت السمسم الصومالي التجاري من (1.787 mg KOH/g ± 7.254) إلى (2.456 mg ± 8.964 KOH/g)، بينما بقيت مرتفعة للغاية في زيت السمسم الأسود السعودي (2.986 mg KOH/g ± 16.83 - 4.365 ± 16.69)، مما يشير إلى زيادة التحلل الحراري للزيت وتكوّن الأحماض الدهنية الحرة. وفيما يتعلق بمحتوى الكوليسترول، بلغت القيم في زيت سمسم تهامة وزيت اللوز اليمني (1.735 ppm ± 26.53) و (2.489 ppm ± 26.34) على التوالي، وكانت مستقرة نسبياً وأقل مقارنةً ببقية الزيوت المحلية. في حين أظهرت الزيوت التجارية تبايناً أكبر، حيث تراوحت القيم من (1.676 ppm ± 22.42) في زيت الكتان الهندي إلى (1.983 ppm ± 27.28) في زيت السمسم الأسود السعودي. أما زيت الحلبة اليمني المحلي، فقد سجل أعلى قيمة (1.897 mg KOH/g ± 38.13)، وبناءً على هذه النتائج، تؤكد الدراسة على أهمية تقييم المؤشرات الفيزيائية والكيميائية وخاصة الأحماض الدهنية الحرة وقيم الحموضة ومحتوى الكوليسترول كمعايير موثوقة لتقييم جودة واستقرار وتحلل زيوت النباتية، لما لذلك من تأثير مباشر على جودة الزيت وسلامة المستهلك.

مفاتيح البحث

التسليم: 27/ 03 / 2026

القبول : 06 / 07 / 2026

كلمات مفتاحية:

التفكك الحراري،
الاحماض الدهنية الحرة،
قيم الحموضة،
الكوليسترول،
الزيوت النباتية