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Contents of cholesterol and some physicochemical parameters in edible oils commercially available in East and West Gojjam, Ethiopia

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Abstract
Evaluating cholesterol and quality parameters indicates edible oil quality and compliance with health standards. This study analyzed cholesterol in branded and non-branded oils from East and West Gojjam and Debre Markos markets using the Liebermann-Burchard method with UV-visible spectrophotometry at 640 nm. All vegetable oils, except those from Finoteselam town, contained detectable cholesterol, ranging from 37.19±0.03 to 87.36±0.40 mg/L. Cholesterol detected in vegetable oils suggests poor processing or adulteration. Simple analytical methods limited precision, but measured levels were below permissible limits, indicating low potential risk of heart disease. The physicochemical parameters measured include moisture (0.06-1.35%), density (0.868-0.892 mg/mL), acid value (0.28-4.16 mg KOH/g of oil), peroxide value (1.47-7.88 meq O_2/kg), and saponification value (52.42-210.97 mg KOH/g). Oil from Mota town exhibited the highest moisture content, and all samples had elevated acid values, likely due to poor handling and storage. Branded oils generally had lower saponification values than unbranded oils, with Bichena, Debre Markos (Biabil), Dembecha, and Finote Selam towns exceeding the maximum permissible limit. The findings highlight the importance of proper oil production, storage, and quality control to ensure consumer health and safety.

Introduction
Oils find diverse applications in various industries, including chemicals, pharmaceuticals, cosmetics, paints, and most notably, the food industry (Olabiyi *et al*., 2019). Edible oils are primarily sourced from olives, palm, soybeans, canola, cottonseed, peanuts, sunflower, castor, and rapeseed (Sadoudi and Ahmed 2017; Yusuf and Ajayi 2017). These oils are composed of triacylglycerol molecules, which consist of glycerol esterified with three fatty acid chains, both saturated and unsaturated (Flores *et al*., 2023; Siudem *et al*., 2022; Xue *et al*., 2023).
Atherosclerosis, a condition characterized by the build-up of plaque in the arteries, is a major contributor to heart disease, stroke, and other serious health issues. Elevated cholesterol levels, smoking, and high blood pressure are primary risk factors for heart disease (Rehan *et al.*, 2016; Montesqrit *et al*., 2024). The liver produces cholesterol from saturated fats in the diet, and high cholesterol levels increase the risk of heart disease, stroke, and peripheral arterial disease (Ganesan *et al*., 2018; Kolaric *et al.*, 2024). Cholesterol, a fatty substance, cannot travel through the bloodstream alone. In conjunction with proteins, it forms lipoproteins, the primary carriers of cholesterol in the body, which are responsible for transporting cholesterol throughout the body. High-density lipoprotein is considered “good” cholesterol as it helps remove excess cholesterol from the bloodstream. Low-density lipoprotein (LDL), or “bad” cholesterol, contributes to plaque buildup in arteries (Chiesa and Charakida, 2019; Das and Ingole, 2023; Diaz and Bielczyk-Maczynska, 2025). While high cholesterol levels can be harmful, cholesterol also plays a vital role in the body. It is a crucial component of cell membranes and serves as a precursor for essential substances like bile acids, steroid hormones, and vitamin D (Nurlatifah *et al*., 2024). To maintain optimal health, it is important to balance cholesterol intake and lifestyle factors like appropriate dietary intake and exercise (Claas and Arnett, 2016; Kaminsky *et al.*, 2022; Singh *et al*., 2024).
Consumers are increasingly aware of the health implications of dietary cholesterol and prefer cholesterol-free oils. This study aimed to assess the cholesterol content of locally produced edible oils. Additionally, various physicochemical properties, saponification value (SV), peroxide value, acid value, density, and moisture content were measured to evaluate overall oil quality. Studying physicochemical parameters of edible oils would provide information about their quality, purity, nutritional value, shelf life, and appropriate use, making it essential for food science, quality control, and consumer protection (Alemayhu *et al*., 2019; Hashim *et al*., 2023; Yudianto *et al*., 2024).

Various crops, including Ethiopian mustard, Niger seed, sesame, sunflower, and linseed, are used to produce branded and non-branded edible oils in Ethiopia. These oils are locally made in East and West Gojjam (Figure 1), but their quality remains uncertain. While a previous study examined cholesterol and free fatty acids in Bahir Dar (Atinafu and Bedemo, 2011), a comprehensive assessment of oil quality in this region is lacking. Concerns exist about the potential use of substandard materials by illegal suppliers, posing health risks. To address these issues, this study evaluated the quality of non-branded edible oils in East and West Gojjam, comparing them to branded oils and the World Health Organization standards.

Materials and Methods

Study area and sample collection

East and West Gojjam, located in northwestern Ethiopia, are home to the cities of Debre Markos and Finoteselam, respectively. East Gojjam spans 10°19'72"N to 37°48'52"E at an elevation of 2,769 meters, while West Gojjam extends from 11°09'60"N to 37°14'60"E at 2,446 meters above sea level.
Non-branded Niger seed oil (Guizotia abyssinica) samples were collected from Bure, Finoteselam, Dembecha, Debre Markos, Lumame, Bichena, and Motta in 2021-2022, where it is a common crop. Branded oils (Maritu, Meri, Summer, Qal, Getu, and Yibelital) were sourced from Debre Markos supermarkets (Figure 1). All samples were stored at room temperature at Debre Markos University until analysis.

Chemicals and apparatus

The mixture of concentrated H_2SO_4 and glacial CH_3COOH acid/acetic anhydride was used to prepare the Liberman-Burchard reagent (LBR), which was used for colorimetric analysis. Standard cholesterol and chloroform were used to prepare a standard cholesterol solution. The UV-visible (UV-vis) spectrophotometer (optical mode – dual-beam and PC controlled; instrument version 2.00; model- Cary 60; manufacturer-Agilent technologies, Penang, Malaysia) at Bahir Dar University was used to determine the absorbance of the standard cholesterol and edible oils at 640 nm to estimate the contents of cholesterol in edible oils. Acetic acid, chloroform, potassium iodide, sodium hydroxide, ethyl alcohol, potassium hydroxide, and hydrochloric acid were used to determine other parameters.

Experimental procedures

Estimation of cholesterol contents

This study determined cholesterol levels in various edible oils. Standard cholesterol solutions of varying concentrations (0.4-1.2 mg/mL) were prepared in chloroform. LBR was added to each standard and sample solution, followed by incubation in the dark to prevent light-induced degradation of the reaction product. Absorbance of the standards and samples was measured at 640 nm using an Agilent Cary 60 UV-vis spectrophotometer. A standard curve was generated using a cholesterol stock solution. The absorbance of the samples was compared to the standard curve to determine their cholesterol concentration in mg/L (Daksha *et al*. 2010; Almajidi, 2015).

Determination of other physicochemical parameters

Density measurement

Densities of oil samples at room temperature (25°C) were measured by a relative density bottle with a capacity of 10 mL according to the following formula [Eq. 1]:

$$\textbf{Density}(\boldsymbol{\rho}) = \frac{\textbf{Mass of the oil sample (M)}}{\textbf{Volume of the R.D bottle (V)}}\ \textbf{g/mL} \qquad \textbf{[Eq. 1]}$$

Moisture content
10 g of oil sample was weighed in a crucible. The sample was dried at 105 °C in an oven to constant weight and allowed to cool in a desiccator for 15 minutes. Finally, the difference was calculated using the following equation (Zahir *et al*., 2017; Negash *et al*., 2019) [Eq. 2].

$$\textbf{Moisture} = \frac{\textbf{W1 x 10}}{\textbf{W2}} \qquad \textbf{[Eq. 2]}$$

Where W_1 = weight loss (g) upon drying and W_2 = weight (g) of the oil sample.

Peroxide value
10 mL oil sample and acetic acid/chloroform (3:2 ratios) solution were mixed. The solution was reacted with 0.5 mL of 15% potassium iodide (KI). 0.5 mL of starch indicator was added to the solution, and the liberated iodine was titrated with 0.1 N sodium thiosulfate. A blank titration was also performed. The peroxide value was calculated as follows [Eq. 3] (Zahir *et al.*, 2017; Negash *et al*., 2019; Hagos *et al*., 2023).

$$\textbf{Peroxide value} = \frac{\textbf{(S−B) x N x 1000}}{\textbf{W}} \qquad \textbf{[Eq. 3]}$$

Where S is the volume of sodium thiosulfate consumed by the oil sample, B is the volume of sodium thiosulfate used for the blank, W is the weight of the oil sample and N is the normality of sodium thiosulfate.

Acid value
10 mL of oil sample and 100 mL of ethyl alcohol were mixed and heated until boiling. The solution was cooled and titrated with 0.1N KOH solution in the presence of a phenolphthalein indicator. The acid value was calculated as follows [Eq. 4] (Zahir *et al.*, 2017; Negash *et al*., 2019; Hagos *et al*., 2023).

$$\textbf{Acid value} = \frac{\textbf{V x N x M.wt}}{\textbf{W}} \qquad \textbf{[Eq. 4]}$$

Where V = volume of standard KOH solution in mL, N = normality of standard KOH solution, W = weight of the oil sample in grams, M.wt. (molecular weight) of KOH = 56.1 g/mol.
The free fatty acid is calculated as oleic acid by dividing the acid value by 2 (acid value/2).

Saponification value
1.0 g of oil sample and 25 mL of 0.5 N alcoholic KOH were added to a conical flask. The solution was heated under a reserved condenser for 30-40 min until completely dissolved. After cooling the solution, phenolphthalein was added and titrated with 0.5 N HCl until a pink endpoint was reached. The blank was determined under the same time conditions (Zahir *et al.*, 2017; Negash *et al*., 2019; Hagos *et al*., 2023) [Eq. 5].

$$\textbf{Saponification Value} = \frac{\textbf{(B−T)x N x 56.1}}{\textbf{W}} \qquad \textbf{[Eq. 5]}$$

Where B = mL of HCl required by blank, T = mL of HCl required by oil sample, N = normality of HCl, and W = weight of oil in grams.

Data analysis

Statistical analysis was performed using IBM SPSS version 25.0 (IBM Corp., Armonk, NY, USA). ANOVA was used to identify significant differences in the characteristics of vegetable oils across producers or locations. LSD post hoc tests were conducted at the 0.05 significance level to further explore these differences. All data were expressed as mean± standard deviation from three replicates.

Results

The physicochemical properties of edible oils were evaluated by measuring very important parameters such as density, moisture content, acid value, peroxide value, SV, and cholesterol content. The obtained results of different parameters are tabulated and discussed in Tables 1 and 2.

Discussion

Edible oils are versatile, used in cooking, food processing, cosmetics, pharmaceuticals, biofuel, and chemical industries. While they offer numerous benefits, a concerning trend involves the illegal substitution of natural oils with harmful, waste-derived materials, posing significant health risks.

Cholesterol content

The cholesterol content of edible oils in this study was measured using a UV-Vis spectrophotometer at the entire wavelength.

The equation of the calibration curve was determined by plotting absorbance against standard concentration (mg/L) (Table 3) and analysing the data using Origin 6.0 software (Figure 2), where the linear regression formula is $y = 0.0041x - 0.1499$ and $R^2 = 0.9996$.

This study analyzed the cholesterol content of various branded and unbranded edible oils, and the results are described in Table 1. Unbranded oil sourced from Finoteselam town contained no detectable cholesterol, while unbranded oil from Lumame town showed the highest (53.70±0.50 mg/L). Among branded oils, Yibeltal demonstrated the highest cholesterol content (87.36±0.40 mg/L), while Maritu had the lowest (54.40±0.15 mg/L). Notably, unbranded oils generally had lower cholesterol levels than branded oils. These findings are consistent with previous research (Atinafu and Bedemo, 2011), suggesting that branded oils tend to exhibit elevated cholesterol levels compared to unbranded ones. This discrepancy could be attributed to the use of different seed types. While unbranded oils are primarily derived from Niger seeds, renowned for their cholesterol-reducing phytosterols content, information regarding the specific seed sources of branded oils was often unavailable. Our analysis revealed the existence of cholesterol in the examined oils, although in minimal quantities, suggesting a low risk of heart disease. This finding contradicts the common claim by oil producers that their products are “cholesterol-free”. Although cholesterol is primarily of animal origin, its detection in vegetable oils could result from multiple factors, including raw material contamination during harvesting, transport or storage, poor processing and refining techniques, intentional or unintentional adulteration of animal fats or recycled frying oils (Sudhakar *et al*., 2023; Srivastava *et al.*, 2024; Özdikicierler *et al*., 2025). Edible oil producers in developing country mixes the low-cost oils with high-cost oils to get more profit, which encourages them to do adulteration (Yadav, 2018; Huq *et al*., 2022; Parthasarathy *et al.*, 2023).

Previous studies have also documented the presence of cholesterol in various branded vegetable oils. A study conducted in Bangladesh (Hasan *et al.*, 2019) found that unbranded black cumin oil had the highest cholesterol content (525.49 mg/L), and branded sunflower oil contained significantly lower cholesterol levels (145.36 mg/L) than the others. In contrast, our study showed that unbranded edible oils had lower cholesterol levels than branded ones. Research from Iraq (Almajidi, 2015) reported that Zakera-branded vegetable oil had the highest cholesterol content (331 mg/L), while Alkhair oil had

lower cholesterol levels (99.6 mg/L). These findings accentuate the importance of regularly assessing cholesterol levels in both branded and unbranded edible oils. Such information can help consumers make informed choices and potentially mitigate cardiovascular risk associated with elevated LDL cholesterol. Moreover, informing cholesterol levels in edible oils is important for both policy and industry, as it supports nutrition policy development to reduce cardiovascular disease risk and enhances industry quality control by improving refining processes and detecting contamination or adulteration.
It's crucial to note that, despite the presence of cholesterol, the levels detected in our study and other reported studies remained below the permissible limits set by the Codex Alimentarius Commission (FAO and WHO, 1999). These limits are 1250-2000 mg/L for adults aged 20 and older, and 1700 mg/L for those aged 19 and younger.

Method validation of cholesterol determination

The calibration curve (Figure 2) showed excellent linearity over the studied range with $R^2 = 0.9996$, indicating a very strong linear relationship between concentration and response. The slope also reflected good method sensitivity with a small negative y-intercept (-0.1499), suggesting minimal systematic bias at low concentrations.
Precision describes how close repeated measurements are to each other under the same conditions. It reflects the repeatability and consistency of a method. In this study, the low residual standard deviation ($\sigma = 0.00862$) indicates good repeatability and acceptable analytical precision (Table 4).

Limit of detection and limit of quantification

Limit of detection (LOD) is the lowest analyte concentration that can be reliably distinguished from background noise, confirming the analyte's presence in the sample with acceptable confidence, while limit of quantification (LOQ) is the minimum analyte concentration in a sample that can be measured quantitatively with acceptable accuracy and precision (Adu *et al*., 2019; Kolaric and Simko, 2020). The LOD (6.94 mg/L) represents the lowest concentration reliably detected, while the LOQ (21.02 mg/L) is the lowest concentration that can be quantified with acceptable accuracy and precision (Table 4). Since all measured concentrations exceeded the LOQ, quantification was performed with acceptable accuracy and precision

Moisture content

The moisture content of edible oils measured in this study ranged widely from 0.06% (from Finoteselam town) to 1.35% (Mota edible oil) as described in Table 2. Notably, only Mota oil exhibited a statistically significant difference in moisture content compared to other samples ($p<0.05$). Edible oils from Debre Markos town (Taye) and Mota exceeded the acceptable moisture limit of (0.2%), while those from Lumame and Bichena town were close to the standard. Elevated moisture content in certain samples might be due to incomplete separation of water, improper treatment during processing, and contamination during handling or storage (Flores *et al.*, 2021; Osaili *et al*., 2025). Branded oils generally displayed lower moisture content than unbranded edible oils, adhering to permissible limits. Comparative studies from Bahir Dar supermarkets, in Ethiopia (Mengistie *et al*., 2018) reported a wider range (0.266% for USA and sunlit oils to 1.133% for Niger oil) exceeding the 0.2% limit. A report in Ambo, Ethiopia (Tesfaye and Mengistie 2016) found lower moisture levels (0.123% for avena palm oil to 0.173% for Selam nuog oil) all within acceptable ranges. High moisture content in edible oils accelerates hydrolysis and oxidation, promoting microbial growth, reducing shelf life and quality (Cui et al., 2025; Pattnaik and Mishra, 2020; Zhang *et al*., 2023).

Density

The density of vegetable oils is dependent on fatty acid composition, minor components, and temperature. Oils with a lower density are generally preferred by consumers (Hasan *et al*., 2016). In this study, the density of edible oil samples ranged from 0.868 to 0.892 g/mL (Table 2). Statistical analysis (LSD tests at the 0.05 level) revealed no significant differences ($p>0.05$) among the densities of the various oil samples. Notably, all oil samples exhibited densities lower than that of water (1 g/mL). A study conducted by Zahir *et al.* (2017) reported a higher density, 0.922 mg/mL for corn oil and 0.969mg/mL for mustard oil. However, the densities of both branded and unbranded edible oils examined in this study were below the maximum permissible limit of 0.920 g/mL, which is important for consumer safety and satisfaction.

Acid value

Acid value, free fatty acid content in oil, directly impacts its quality and suitability for cooking. Higher acid values indicate lower quality and reduced cooking potential. In this study area, acid values ranged from 0.28±0.04 mg KOH/g (Finote Selam town) to 4.16±0.14 mg KOH/g (Mota town) as listed in Table 2. Most of the acid values were above the maximum permissible limit of 0.6 mg KOH/g for edible oils while two unbranded edible oils (Finoteselam and Lumame town) and two branded edible oils (Meri and Getu) met the standard. Free fatty acid, closely related acid value, varied from 0.14% to 2.08%. While some variations existed based on processing location, the overall trend was a significant number of samples with elevated acid values. These findings align with previous studies in Bahir Dar, Ethiopia (Mengistie et al. 2018) which reported high free fatty acid levels in Niger oil (7.98%). The elevated acid values might be a result of poor extraction techniques, damaged seeds, and lengthy storage, adulteration, and temperature fluctuation (Pineda *et al.*, 2011; Naz and Saeed, 2018). The higher acid number is also attributed to the age of oil, because triglycerides would change into glycerol and fatty acids in prolonged storage (Hagos *et al.*, 2023; Osaili *et al*., 2025). Therefore, the oils require further treatment or reduced storage time to lower acidity, while proper storage, controlled processing temperatures, and moisture reduction are essential to maintain the oil quality and extend shelf life.

Peroxide value

When exposed to oxygen and light, oils undergo oxidation, leading to increased peroxide value. Oils with the lowest peroxide value are suitable for consumption. Oils with peroxide levels higher than 10 meq O_2/kg are considered to be less stable and have shorter shelf lives (Zahir *et al.*, 2017; Konuskan et al. 2019). In this study area, the peroxide values ranged from 1.47 meq O_2/kg (Maritu branded oil) to 7.88 meq O_2/kg (Dembecha town), as shown in Table 2. Edible oils from Debre Markos town (Biable and Enqu), Dembecha, and Meri revealed the highest peroxide values (5.19 - 7.88 meq O_2/kg), indicating a higher susceptibility to oxidative rancidity compared to other samples. These oils with higher peroxide values require careful storage and consumption to minimize deterioration. However, all values remained below the 10 meq O_2/kg oil threshold limit. These findings align with other studies; for instance, edible oils in the eastern Mediterranean region (Konuskan *et al*., 2019) had peroxide values ranging from 4.19 to 9.46 meq O_2/kg, with rapeseed and peanut oils showing the highest values and shortest shelf lives. Similarly, in Gonder city, Ethiopia (Negash *et al*., 2019), the peroxide value ranged from 3.4 meq O_2/kg for Chief oil to 16.25 meq O_2/kg for Niger seed oil, exceeding the limits for some oils. High peroxide values are associated with greater unsaturation and increase with storage time, temperature, light, and exposure to oxygen (Nduka *et al.*, 2021; Ali and Zageer, 2022). The study informs regulatory limits and food safety guidelines while supporting industry quality control, optimized processing and storage, improved oil stability, reduced waste, and safer edible oil products.

Saponification value

Saponification is the process of converting fats or oils into soap and alcohol using an alkali (like sodium hydroxide). It indicates the average molecular weight of fatty acids in the oil (Zahir *et al.*, 2017; Nduka *et al*., 2021). In this study, the SV of oil samples ranged from 52.42 mg KOH/g (Yibeltal branded oil) to 210.97 mg KOH/g (Bichena town unbranded oil), as shown in Table 2. Branded oils had lower SV compared to unbranded oils. A lower SV indicates fewer low molecular weight fatty acids or the number of ester bonds is low, as SV is inversely proportional to average fatty acid molecular weight (Nduka *et al.*, 2021; Hagos et al. 2023). Comparing these results to other studies, the SV of corn oil is 153.8 mg KOH/g, and mustard oil is 125.6 mg KOH/g (Zahir *et al*., 2017). The SV in Ambo, Ethiopia (Tesfaye and Mengistie, 2016) ranged from 143.05 mg KOH/g for Nur nuog oil to 190.27 mg KOH/g for avena palm oil, which was below the expected range of 195-205 mg KOH/g for edible palm oil. However, some of the unbranded oils in our study obtained from Bichena, Debre Markos (Biabil), Dembecha, and Finoteselam towns exceeded this limit, suggesting a higher proportion of low molecular weight fatty acids (Atinafu and Bedemo 2011). This study provides precise SV data, elucidating fatty acid composition, and guides industry processing, storage, and quality control.

Conclusions

This study found that branded edible oils generally contained higher cholesterol levels than unbranded oils. However, the cholesterol content in oil from Finoteselam town was undetectable, suggesting it might be cholesterol-free. Importantly, all oils, both branded and unbranded, were below the maximum permissible cholesterol limit. The oil from Motta town exhibited the highest moisture and acid values, indicating potential issues with processing, storage, or adulteration. While most oils showed elevated acid values, peroxide values remained within acceptable limits, suggesting low oxidative rancidity. Branded oils generally had lower saponification values than unbranded oils and were below the maximum permissible limit. Conversely, unbranded oils from Bichena, Debre Markos (Biabil), Dembecha, and Finoteselam exceeded the limit. To ensure accurate consumer information, it is recommended that branded oil producers accurately label their products, even if the cholesterol content is minimal. This study was limited to the aforementioned selected quality parameters of edible oils, and the analytical techniques employed might lack sensitivity to advanced techniques. Moreover, harvest season, storage conditions, and changes during heating were not considered in this study. Consequently, future studies should address these limitations by incorporating other quality parameters, considering different conditions, and employing high-resolution analytical techniques.

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Figure 1. Edible oils collected from different places and producers. YIB, Yibeltal; GET, Getu; QAL, Qal; MER, Meri; MAR, Maritu; SUM, Summer; BUR, Bure; FSE, Finote Selam.

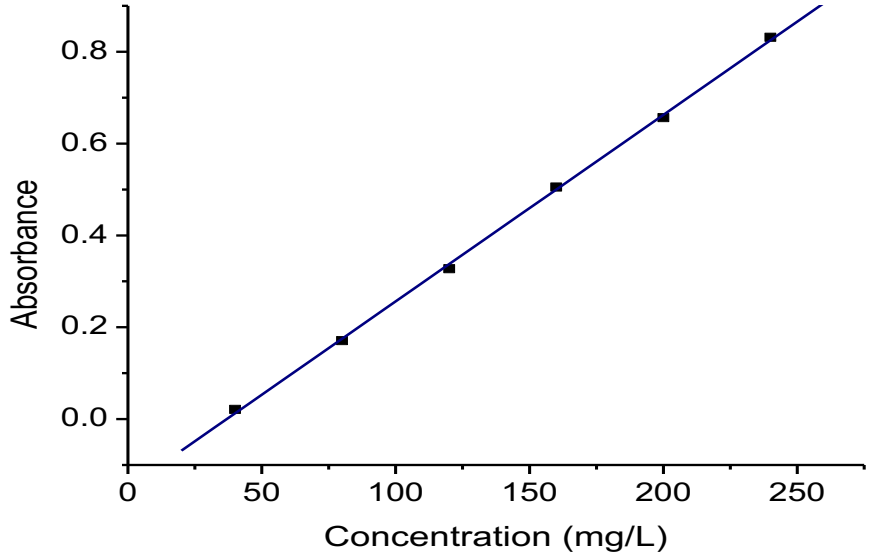

Figure 2. Calibration curve of cholesterol standard.

Table 1. Cholesterol content of different edible oil samples.

Sample name/place	Cholesterol (mg/L)	Sample name/place	Cholesterol (mg/L)	Permissible limit
Mota	43.61±0.18	Bure	38.91±0.14	1250-2000 mg/L for age ≥20 and <1700 mg/L for age ≤ 19
Bichena	37.19±0.03	Maritu	54.40±0.15	
Lumame	53.70±0.50	Meri	54.94±0.30	
Markos (Taye)	41.23±0.11	Summer	58.52±0.23	
Markos (Enqu)	44.63±0.20	Qal	76.06±0.38	
Markos (Biabil)	41.74±0.04	Getu	72.59±0.21	
Dembecha	46.52±0.35	Yibelital	87.36±0.40	
Finote Selam	ND			

Note: the values are mean±standard deviation.

Table 2. Density, moisture content, acid value (AV), peroxide value (PV) and saponification value (SV).

Sample name/place	Density (g/mL)	Moisture content (%)	AV (mg KOH/g)	PV (meq O_2/Kg)	SV (mg KOH/g)
Mota	0.868±0.033	1.35±0.18	4.16±0.14	2.85±0.24	196.60±0.92
Bichena	0.883±0.036	0.17±0.11	1.98±0.21	2.52±0.32	210.97±1.49
Lumame	0.886±0.034	0.19±0.02	0.43±0.05	1.97±0.27	144.91±1.72
Markos (Taye)	0.888±0.034	0.22±0.11	1.21±0.07	2.80±0.37	144.82±1.70
Markos (Enqu)	0.886±0.032	0.12±0.06	0.83±0.04	6.29±0.59	140.67±1.56
Markos (Biabil)	0.892±0.041	0.15±0.05	1.14±0.11	6.20±0.56	210.47±1.73
Dembecha	0.885±0.028	0.10±0.05	1.23±0.05	7.88±0.02	207.93±1.01
Finote Selam	0.883±0.032	0.06±0.05	0.28±0.04	3.09±0.3	209.46±1.60
Bure	0.885±0.028	0.13±0.03	1.97±0.08	2.32±0.24	204.36±1.98
Maritu	0.881±0.033	0.14±0.05	1.07±0.10	1.47±0.0.3	138.96±1.60
Meri	0.885±0.036	0.14±0.08	0.44±0.06	5.19±0.15	122.92±0.98
Summer	0.887±0.034	0.14±0.05	3.18±0.08	2.87±0.12	86.77±1.75
Qal	0.888±0.037	0.14±0.07	2.67±0.11	3.75±0.32	57.38±1.59
Getu	0.885±0.031	0.10±0.01	0.47±0.07	3.63±0.29	53.10±1.60
Yibelital	0.886±0.032	0.08±0.03	1.80±0.09	3.39±0.22	52.42±0.08
Permissible limit	(40°C/water at 20°C): 0.889-0.920	0.2%	0.6 mg KOH/g	Up to 10 meq O_2/kg oil	195-205 mg KOH/g

Note: the values are mean±std

Table 3. Absorbance of standard cholesterol solution.

Concentration (mg/L)	Absorbance
40	0.021025754
80	0.170952652
120	0.327375825
160	0.505225762
200	0.656473592
240	0.831485145

Table 4. Method validation tests for linearity, LOD and LOQ.

Parameter	Values
Slope	0.0041
Y intercept when X = 0.0	-0.1499
X intercept when Y = 0.0	36.56
R^2	0.9994
Residual SD (σ)	0.00862
LOD (3.3σ/S)	6.94mg/L
LOQ (10σ/S)	21.02mg/L