Emperor Journal of Applied Scientific Research

ISSN: 2581-964X **Mayas Publication®** **www.mayas.info**

Volume-VII **Issue-IX** **September 2025**

A Comprehensive Analytical Study on the Quality Assessment of Commercially Available Packaged Coconut Oils: pH, Saponification Value, Acid Value and Sterol Content

M. Mohamed Ismail,
Independent Researcher,
Tiruchirappalli,
Tamil Nadu, India.

Abstract

This study conducts a comprehensive quality assessment of five commercially available packaged coconut oils from local markets in Tiruchirappalli, India. Analytical parameters including pH, saponification value, acid value and sterol content were evaluated using standardized titrimetric and spectrophotometric methods to verify compliance with FSSAI standards and detect adulteration. Results indicated all samples had acceptable pH (5.25–5.57) and excellent acid values (1.24–3.07 mg KOH/g), confirming freshness and absence of rancidity. Saponification values (200.3–277.4 mg KOH/g) showed significant variation, with four samples deviating from FSSAI standards (235–270 mg KOH/g), suggesting potential adulteration with other oils. However, all samples contained high and consistent sterol levels (24–27 mg/g), indicating nutritional quality. The study concludes that while the oils are safe and nutritious, purity concerns remain, highlighting the need for stringent market surveillance.

Keywords: Coconut Oil, Adulteration, Quality Control, FSSAI, Saponification Value, Acid Value, Phytosterols.

I.INTRODUCTION

The coconut palm, revered as the 'Tree of Life', is a cornerstone of culture and commerce in tropical regions, especially in South and Southeast Asia. With its origins tracing back thousands of years to India's Malabar Coast, its cultivation is now global, yet it remains vital to countries like Indonesia, Philippines and India. India itself is a major global producer, contributing nearly 17% of the world's supply,

with the state of Kerala responsible for almost half of the nation's output. The coconut's name is deeply woven into the identity of the region, as the very name 'Kerala' is thought to mean 'the land of coconuts'. This versatile tree is celebrated for its wide range of uses; every part is utilized, from the hydrating water and edible kernel to the fibrous husk and hardy shell, which are used for coir and crafts. Among its most prized products is coconut oil, a fundamental element in South Indian cuisine, traditional Ayurvedic practices and cultural rituals, symbolizing both purity and prosperity.

The oil itself is extracted through two primary methods. The dry process involves drying the kernel to produce copra, which is then pressed to extract the oil. While efficient, this method often requires extensive refining, which can remove some of the oil's natural nutrients and flavor. In contrast, the wet process is used to create virgin coconut oil (VCO) by pressing or centrifuging fresh, undried kernel. This method preserves the oil's natural antioxidants, vitamins and distinctive coconut aroma. Nutritionally, coconut oil is unique, consisting of over 90% saturated fats. However, its fatty acid profile is rich in medium-chain triglycerides (MCTs), which are metabolized differently than other fats. They are transported directly to the liver for quick energy conversion and are less likely to be stored as body fat. A key component, lauric acid, is converted in the body into monolaurin, a compound with noted antimicrobial properties. Virgin coconut oil is also a valuable source of Vitamin E and polyphenols, which contribute to its antioxidant benefits.

Despite its significant benefits, the coconut oil industry faces a serious challenge with widespread adulteration. To maximize profits, unscrupulous producers often dilute pure coconut oil with cheaper alternatives like palm kernel oil, sunflower oil, or even non-edible mineral oils. Another common practice is mixing expensive virgin oil with cheaper refined coconut oil or using oil from stale or rotten copra. This economic fraud poses severe health risks; adulterants like argemone oil can cause epidemic dropsy and glaucoma, while rancid oils contain harmful free radicals. To combat this, rigorous quality control is essential. Regulatory authorities, such as India's FSSAI, enforce standards based on key analytical parameters. These include the acid value to detect rancidity, the saponification value to confirm the oil's identity and sterol content analysis, which acts as a fingerprint to identify adulteration with other vegetable oils. This project was therefore designed to analyze commercially available coconut oils in Tiruchirappalli, using these analytical techniques to assess compliance with standards, detect adulteration and evaluate nutritive value, ultimately aiming to provide scientific assurance for consumers.

Review of Literature

The quality and health implications of edible oils, particularly coconut oil, are subjects of significant scientific debate, underscoring the necessity for rigorous analytical assessment. Foundational research by Al Majidi (2015) revealed critical discrepancies in edible oil quality, demonstrating that numerous brands contained detectable cholesterol levels and exhibited rancidity despite "cholesterol-free" claims, thereby highlighting pervasive issues with misleading labeling and adherence to international standards. This precedent establishes an urgent need for truthful product information and robust enforcement of quality controls, a primary concern that directly informs the objectives of the present study in evaluating coconut oil authenticity and purity.

The health profile of coconut oil remains contentious, with scientific reviews presenting a nuanced and often contradictory picture. Wallace (2018) and Lima & Block (2019) critically evaluated popular health claims, concluding that while topical and certain oral uses are supported, evidence for benefits regarding weight loss, Alzheimer's disease, or cardiovascular health is insufficient and often misapplied from studies on pure medium-chain triglycerides (MCTs). Crucially, both reviews affirmed that coconut oil consumption tends to elevate low-density lipoprotein (LDL) cholesterol, a known cardiovascular risk factor and cautioned against marketing unproven health allegations. Conversely, Pal et al. (2020) cataloged potential therapeutic uses and argued against its historical demonization, though they also conceded that more conclusive human trials are required. This dichotomy emphasizes that coconut oil's health impacts are not fully resolved and consumption should be moderate.

Consequently, robust analytical methodologies are paramount for verifying quality and nutritional content, moving beyond speculative health debates. The work of Bridgemohan, which quantified phytosterols in extra virgin coconut oil (EVCO) using UV-V is spectrophotometry, provides a relevant methodological framework for assessing a component with demonstrated cholesterol-lowering potential. Furthermore, studies such as that by Warsakoon et al. illustrate the importance of comprehensive food safety monitoring, including for contaminants like heavy metals. Collectively, the literature confirms that ensuring consumer safety and product integrity hinges on objective chemical analysis to validate purity and compliance with established regulatory benchmarks, which is the central aim of this research.

Materials And Methods

Sample Collection

Five different brands of packaged coconut oil were purchased from local retail markets in Tiruchirappalli, Tamil Nadu, India. The samples were coded as

Commercial Oil 1 (CO1), Commercial Oil 2 (CO2), Commercial Oil 3 (CO3), Commercial Oil 4 (CO4) and Commercial Oil 5 (CO5) to maintain anonymity and avoid commercial bias. All samples were stored in a cool, dark place at ambient temperature until analysis to prevent photo-oxidation and thermal degradation.

Analytical Methods

1. Determination of pH

The pH of each coconut oil sample was directly measured using a calibrated digital pH meter. The electrode was thoroughly rinsed with deionized water and wiped gently with a soft tissue between measurements to avoid cross-contamination.

2. Determination of Saponification Value

The saponification value is defined as the number of milligrams of potassium hydroxide (KOH) required to saponify one gram of fat or oil. It was determined as per the standard procedure outlined in the project file.

- Standardization of HCl (0.05N): A standard solution of sodium carbonate (Na_2CO_3) was prepared. 20 mL of this solution was titrated against HCl using methyl orange as an indicator until the color changed from golden yellow to red-orange. The normality of HCl was calculated.
- Saponification Reaction: Exactly 1g of oil was refluxed with 25 mL of alcoholic KOH solution (0.5N) for 30 minutes using a condenser.
- Titration: After refluxing, the mixture was titrated against the standardized 0.05N HCl using phenolphthalein as an indicator. A blank titration was conducted simultaneously without the oil.
- Calculation: The saponification value (SV) was calculated using the formula:

$$\mathrm{SV} = \frac{(B - A) \times N_{\mathrm{HCl}} \times 56.1}{W}$$

Where:
B = Volume of HCl used in blank titration (mL)
A = Volume of HCl used in sample titration (mL)
*N*HCl = Normality of HCl
W*W* = Weight of the oil sample (g)
56.1 = Molecular weight of KOH

3. Determination of Acid Value

The acid value is the number of milligrams of KOH required to neutralize the free fatty acids present in one gram of oil. It is a direct measure of hydrolytic rancidity.

- Standardization of KOH (0.05N): A standard oxalic acid solution was prepared. 20 mL of this solution was titrated against the KOH solution

using phenolphthalein indicator until a permanent pale pink color appeared. The normality of KOH was calculated.

- Titration of Sample: Exactly 1g of oil was dissolved in 5 mL of neutral absolute alcohol. The mixture was titrated against the standardized 0.05N KOH solution using phenolphthalein as an indicator.
- Calculation: The acid value (AV) was calculated using the formula:

$$\mathrm{AV} = \frac{V \times N_{\mathrm{KOH}} \times 56.1}{W}$$

Where:
V = Volume of KOH solution used (mL)
NKOH = Normality of KOH solution
W = Weight of the oil sample (g)

- Spectrophotometric Determination of Sterol Content
- The sterol content was estimated using a UV-Vis spectrophotometer based on the reaction with a color-developing agent (Liebermann-Burchard reaction principle), which produces a characteristic green color.
- Preparation of Standard Curve: A standard solution was prepared. A series of dilutions were made and their optical density (OD) was measured at 530 nm (as per the project method) to prepare a calibration curve of concentration versus OD.
- Analysis of Samples: Each coconut oil sample was dissolved in an appropriate solvent and treated to develop the color. The optical density of each sample solution was measured at 530 nm against a reagent blank.
- Calculation: The sterol content in the unknown samples was calculated by comparing their OD values with the standard calibration curve. The results were expressed in mg of sterol per gram of oil (mg/g).

pH Analysis

The pH of an oil, though not a conventional parameter, can indicate the presence of acidic breakdown products or processing residues. The results of the pH analysis for the five coconut oil samples are presented in Table 1.

Table 1
pH Values of Commercial Coconut Oil Samples

Sample Code	pH Value
Commercial Oil 1 (CO1)	5.25
Commercial Oil 2 (CO2)	5.37
Commercial Oil 3 (CO3)	5.34
Commercial Oil 4 (CO4)	5.57
Commercial Oil 5 (CO5)	5.49

The pH values for all samples ranged from 5.25 to 5.57, falling within a narrow, mildly acidic range. This is typical for coconut oil, as it contains small amounts of free fatty acids. There was no significant deviation from the expected range (typically 5-6 for pure coconut oil), suggesting the absence of substantial acidic contaminants or severe degradation products. Sample CO4 showed the highest pH (5.57), while CO1 showed the lowest (5.25). These minor variations could be attributed to differences in the initial quality of copra, the efficiency of the refining process (for refined oils), or natural batch-to-batch variations.

Saponification Value

The saponification value is a key identity parameter that reflects the average chain length of the fatty acids in the triglyceride molecules. Oils with shorter-chain fatty acids require more KOH per gram to saponify and thus have higher saponification values. Coconut oil, rich in medium-chain fatty acids like lauric acid (C12), characteristically has a high saponification value. The results are detailed in Table 2.

Table 2
Saponification Values of Commercial Coconut Oil Samples

Sample Code	Saponification Value (mg KOH/g oil)	FSSAI Standard Range (mg KOH/g oil)
Commercial Oil 1 (CO1)	231.1	235 - 270
Commercial Oil 2 (CO2)	277.4	
Commercial Oil 3 (CO3)	204.2	
Commercial Oil 4 (CO4)	277.4	
Commercial Oil 5 (CO5)	200.3	

The FSSAI standard specifies a saponification value range of 235–270 mg KOH/g for coconut oil. The results show a mixed compliance:

- **Samples CO2 and CO4** exhibited a value of 277.4 mg KOH/g, which is slightly above the upper limit of the standard. A higher-than-standard SV can indicate the presence of shorter-chain fatty acids than typically found in coconut oil. This could be a sign of adulteration with oils that have very high SVs, such as coconut testa oil or palm kernel oil (which also has a high SV, often overlapping with coconut oil). It could also result from the hydrolysis of triglycerides into free fatty acids and mono/diglycerides, which would also increase the SV, though this is usually accompanied by a high acid value.
- **Samples CO3 and CO5** showed values (204.2 and 200.3 mg KOH/g) significantly below the standard range. A low SV suggests the presence of longer-chain fatty acids or higher molecular weight triglycerides. This is a stronger indicator of potential adulteration with cheaper, long-chain vegetable oils like soybean, sunflower, or rice bran oil, which have lower saponification values.
- **Sample CO1** (231.1 mg KOH/g) was just below the lower limit of the standard range but was the closest to being compliant.

This variance highlights the necessity of this parameter in quality control. While two samples (CO2, CO4) might be borderline acceptable, the significantly low values

of CO3 and CO5 raise concerns about their purity and adherence to identity standards.

Acid Value

The acid value is a critical measure of oil quality and freshness, indicating the extent of hydrolytic rancidity. It quantifies the amount of free fatty acids (FFAs) released from triglycerides due to the action of moisture, heat, or lipase enzymes. A high AV denotes poor-quality raw materials (rancid copra) or improper storage conditions. The results are summarized in Table 3.

Table 3
Acid Values of Commercial Coconut Oil Samples

Sample Code	Acid Value (mg KOH/g oil)	FSSAI Standard Range (mg KOH/g oil)
Commercial Oil 1 (CO1)	1.53	1.99 - 12.80
Commercial Oil 2 (CO2)	2.76	
Commercial Oil 3 (CO3)	1.24	
Commercial Oil 4 (CO4)	3.07	
Commercial Oil 5 (CO5)	2.46	

The FSSAI permits a maximum acid value of 12.80 mg KOH/g for coconut oil (a wider range than for some other oils due to its natural FFA content). A lower AV is always desirable, indicating a fresh, well-processed and properly stored oil. All five samples demonstrated excellent results in this parameter:

- All acid values were well within the permissible limit, ranging from 1.24 to 3.07 mg KOH/g.
- Sample CO3 had the lowest AV (1.24), indicating superior freshness and quality.
- Sample CO4 had the highest AV (3.07), which, while still very good and within standards, suggests it may be from a slightly older batch or processed from copra of marginally lower initial quality compared to the others.

The low acid values across all brands are a positive finding, indicating that despite the concerns raised by the saponification values, the oils are not rancid and have been processed and packaged under conditions that minimized hydrolytic degradation.

Sterol Content

Phytosterols are bioactive compounds found in plant oils known for their cholesterol-lowering properties. They compete with dietary cholesterol for absorption in the intestines, effectively reducing serum LDL cholesterol levels. Estimating sterol content serves a dual purpose: assessing nutritional value and providing a fingerprint for detecting adulteration with oils that have a different sterol profile. The results from the spectrophotometric analysis are shown in Table 4.

Table 4
Sterol Content of Commercial Coconut Oil Samples

Sample Code	Optical Density (OD) at 530 nm	Sterol Content (mg/g of oil)
Commercial Oil 1 (CO1)	0.0284	26
Commercial Oil 2 (CO2)	0.0236	24
Commercial Oil 3 (CO3)	0.0268	25
Commercial Oil 4 (CO4)	0.0347	25
Commercial Oil 5 (CO5)	0.0218	27

The sterol content across the samples was found to be remarkably consistent and high, ranging from 24 to 27 mg/g of oil. This is a significant finding:

- **Nutritional Quality:** A high sterol content enhances the nutritional profile of the oil, aligning with the claims of health benefits associated with coconut oil consumption, particularly concerning cardiovascular health by mitigating LDL cholesterol absorption.
- **Purity Indicator:** The consistency in sterol values, despite variations in other parameters, suggests that the base oil in all samples is indeed coconut oil. Adulteration with large quantities of other vegetable oils (e.g., sunflower, soybean) would likely have altered the sterol concentration and profile significantly, as these oils have different characteristic sterols (e.g.,

β-sitosterol, campesterol, stigmasterol) and concentrations. The fact that the values are clustered closely together argues against gross adulteration with other sterol-rich oils.

Sample CO5 showed the highest sterol content (27 mg/g), making it nutritionally the most potent among the tested samples, while CO2 showed the lowest (24 mg/g).

II.CONCLUSION

This comprehensive analytical study evaluated five commercially available packaged coconut oils obey the FSSAI standards with certain deviations. While all samples demonstrated excellent freshness with acid values well within the permissible limit (1.24–3.07 mg KOH/g), indicating no rancidity and consistently high phytosterol content (24–27 mg/g) suggesting good nutritional value and a primary base of genuine coconut oil, significant purity concerns were identified. Notably, four of the five samples exhibited saponification values that deviated substantially from the standard range; two exceeded the upper limit and two fell below the lower limit. These anomalies indicate potential non-compliance with identity standards, possibly due to adulteration with oils of different chain lengths or the use of non-standard coconut fractions. Consequently, while the oils are safe for consumption from a freshness perspective, they may not be entirely pure. These findings underscore the necessity for continuous regulatory monitoring using a multifaceted analytical approach and recommend advanced techniques like Gas Chromatography for definitive adulteration testing in future studies.

III.REFERENCES

1. Al Majidi, M. I. H. (2015). Estimation of Cholesterol Content and Free Fatty Acids in Edible Oils in Iraq. Journal of Food and Nutrition Sciences.
2. Assunção, M. L., Ferreira, H. S., dos Santos, A. F., Cabral, C. R., & Florêncio, T. M. M. T. (2009). Effects of dietary coconut oil on the biochemical and anthropometric profiles of women presenting abdominal obesity. Lipids, 44(7), 593–601.
3. Bridgemohan, P., Estimation of Phytosterol Content in Extra Virgin Coconut Oils (EVCO) Using UV-Vis Spectrophotometry. Journal of Agricultural Science.
4. Food Safety and Standards Authority of India (FSSAI). (2011). Manual of Methods of Analysis of Foods: Oils and Fats. New Delhi.
5. Lima, R. da S., & Block, J. M. (2019). Coconut oil: What do we really know about it so far? Food Quality and Safety, 3(2), 61–72.

6. Marina, A. M., Man, Y. C., & Amin, I. (2009). Virgin coconut oil: emerging functional food oil. Trends in Food Science & Technology, 20(10), 481–487.
7. Nevin, K. G., & Rajamohan, T. (2004). Beneficial effects of virgin coconut oil on lipid parameters and in vitro LDL oxidation. Clinical Biochemistry, 37(9), 830–835.
8. Pal, P., Rathva, D., Parmar, D., Patel, J., Upadhyay, S., & Upadhyay, U. (2020). A Review on Coconut oil: An Essential Oil for All. International Journal of Pharmaceutical Sciences Review and Research, 60(1), 129-133.
9. Wallace, T. C. (2018). Health Effects of Coconut Oil—A Narrative Review of Current Evidence. Journal of the American College of Nutrition, 38(2), 1–10.
10. Warsakoon, W.M.M.P.D.K., Wikramasinghe, I., Ranaweera K.K.D.S., & Purasinghe S.S. Preliminary Study on Heavy Metals in Coconut and Coconut Products. Sri Lankan Journal of Agriculture and Ecosystems.