



## Understanding the Detection of Mustard Oil Adulteration: Prospective and Challenges

Charchika Sahu<sup>1</sup>, Bishnupriya Das<sup>1</sup>, Bijayalaxmi Mohanty<sup>1</sup>, Swetpadma Dash<sup>1</sup>, Amrita Priyadarshini Mohanty<sup>1</sup>, Jyoti Prakash Sahoo<sup>1\*</sup> and Kailash Chandra Samal<sup>2</sup>

<sup>1</sup>Faculty of Agriculture and Allied Sciences, C.V. Raman Global University, Bhubaneswar, Odisha (752 054), India

<sup>2</sup>College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, Odisha (768 026), India



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### Corresponding Author

Jyoti Prakash Sahoo

✉: jyotiprakashsahoo2010@gmail.com

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### Abstract

Mustard oil holds a distinguished status among oils, favored for its diverse applications. Renowned for its delightful taste and health-enhancing properties, it remains a staple choice, despite the abundance of alternative edible oils. Abundant in monounsaturated and polyunsaturated fats, mustard oil serves as a boon for heart health by lowering bad cholesterol levels. Enriched with omega-3 fatty acids and antioxidants, it boasts anti-inflammatory properties. However, recent observations reveal a troubling surge in adulteration and counterfeit oils are being intentionally blended with authentic mustard oil on a significant scale, resulting not only in compromised food flavor, but also posing health risks to consumers. This article summarizes health effects and industry-wide consequences of adulterated mustard oil, proposing collaborative strategies and stringent regulations to safeguard consumer well-being. By raising awareness, this article aims to ensure the quality and authenticity of mustard oil for consumers.

**Keywords:** Adulterations, Detection technique, Health hazards, Mustard oil

### Introduction

In recent years, the mustard oil adulteration has emerged as a major issue, casting a shadow over its reputation as a healthy and flavorful cooking staple. Mustard oil, cherished for its distinct taste and purported health benefits, has long been favored by consumers across diverse culinary cultures. However, the increasing prevalence of adulterants in mustard oil poses significant risks to both the palates and well-being of consumers. Despite the availability of numerous edible oils in the market, mustard oil retains its popularity, particularly in rural regions where it is deeply ingrained in culinary traditions. Its distinctive flavor and believed health-promoting properties have made it a preferred choice for many households.

However, this cherished oil is now facing a grave threat due to adulteration practices that compromise its purity and safety. Studies have highlighted the detrimental effects of adulterated mustard oil on consumer health. Adulterants such as cheaper oils, colorants and even harmful chemicals

are being surreptitiously mixed with genuine mustard oil, deceiving consumers and posing serious health risks. Consuming adulterated mustard oil not only undermines the flavor and nutritional value of food but also exposes individuals to potential health hazards ranging from digestive issues to long-term health complications. The consequences of mustard oil adulteration extend beyond individual health concerns. The integrity of the food supply chain is compromised, eroding consumer trust and confidence in the quality of products available in the market. Furthermore, the economic ramifications are significant, as genuine mustard oil producers face unfair competition from unscrupulous vendors selling adulterated products at lower prices.

The Food Safety and Standards Authority of India (FSSAI) undertook a nationwide survey on cooking oils in August 2020, analysing 4,461 samples for safety, quality and misbranding. Results showed 2.42% of samples failed safety standards due to aflatoxins, pesticide residues and heavy metals, while 24.2% failed quality metrics, indicating possible

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adulteration. FSSAI assessed parameters like refractive index, fatty acid profile and iodine value to detect adulteration or blending. Furthermore, 12.8% of samples were misbranded regarding fortification claims or FSSAI labeling requirements. The survey covered various oil types across India and was conducted in FSSAI notified labs. FSSAI emphasized the need for stronger enforcement by states and union territories to combat oil adulteration, recommending collaboration with agriculture and food processing ministries to tackle contamination issues.

Addressing the scourge of mustard oil adulteration requires concerted efforts from various stakeholders, including regulatory bodies, industry players and consumers. Enhanced surveillance and enforcement measures are needed to detect and deter adulteration practices. Additionally, public awareness campaigns can empower consumers to make informed choices and demand genuine, unadulterated mustard oil. In this article, we delve into the complex issue of mustard oil adulteration, exploring its causes, consequences and potential solutions. From its cultural significance to the economic implications of adulteration, this article aims to shed light on the concern that affects consumers, producers and regulatory authorities alike.

### The Impact of Mustard Oil Adulteration

The contamination of mustard oil not only compromises its quality but also poses significant health risks. Consumption of adulterated oil can lead to a spectrum of health issues, spanning from minor digestive discomfort to more severe conditions such as cardiovascular diseases and cancer. Furthermore, the ramifications of mustard oil adulteration stretch beyond individual health implications to encompass broader economic concerns. It erodes consumer confidence in the reliability of food products and disrupts fair trade practices. Authentic mustard oil producers, especially small-scale ones, face unfair competition from manufacturers who resort to shortcuts by adulterating their goods. This perpetuates a cycle of deception within the industry and adversely affects businesses that prioritize quality and authenticity. By increasing awareness about mustard oil adulteration and empowering consumers to discern pure oils, we can collectively address this issue. Government regulations and stringent enforcement mechanisms are pivotal in deterring adulteration practices and holding accountable those involved in fraudulent activities.

### Major Health Risks Associated with Mustard Oil Adulteration

**Digestive Issues:** Adulterants such as cheaper vegetable oils or industrial oils may be difficult to digest and can lead to gastrointestinal discomfort, including nausea, vomiting, diarrhea and abdominal pain.

**Cardiovascular Problems:** Adulterated mustard oil contains high levels of trans fats and it can contribute to increased LDL cholesterol and decreased HDL cholesterol, which in turn raises the risk of cardiovascular diseases like heart attacks and strokes. It's essential to avoid consuming adulterated oils and opt for pure, unadulterated oils for better health outcomes.

**Toxicity:** Certain adulterants like argemone oil, a common additive in counterfeit mustard oil, contain toxic alkaloids that can cause poisoning symptoms such as liver damage, jaundice and even death in severe cases.

**Allergic Reactions:** Some individuals may be allergic to specific adulterants used in mustard oil, leading to allergic reactions such as skin rashes, itching, swelling and respiratory problems like asthma or difficulty breathing.

**Cancer Risk:** Adulterants containing harmful chemicals, such as industrial oils or dyes, may increase the risk of cancer due to their carcinogenic properties and the accumulation of toxic compounds in the body over time.

**Neurological Disorders:** Certain adulterants, particularly those containing heavy metals like lead or arsenic, can cause neurological disorders such as cognitive impairment, developmental delays and nerve damage, especially in children and pregnant women.

**Endocrine Disruption:** Adulterants containing synthetic compounds or hormones may disrupt the body's endocrine system, leading to hormonal imbalances, reproductive issues and metabolic disorders.

**Long-term Health Effects:** Continuous consumption of adulterated mustard oil over time may result in chronic health conditions, including obesity, diabetes, hypertension and compromised immune function, due to the cumulative impact of adulterants on the body's physiology.

### Methods for Detection of Adulteration in Mustard Oil

#### Easy Home Tests

*i) Freezing Test:* Place a sample of mustard oil in a cup or bowl and refrigerate it for several hours. If the oil freezes and develops white spots, it indicates adulteration with other substances, signaling its counterfeit nature.

*ii) Rubbing Test:* Take a small amount of oil in your palms and rub it vigorously. If it leaves behind any unusual coloration or emits a chemical odor, it suggests adulteration with spurious substances.

*iii) Nitric Acid Test:* Mix a tablespoon of oil with 5 ml of nitric acid. A yellowish-orange or crimson coloration of the mixture indicates the presence of Argemone oil, a common adulterant.

*iv) Barometer Test:* Pure mustard oil typically yields a barometer reading of 58 to 60.5. Any deviation from this range suggests adulteration with counterfeit substances.

*v) Acidified Petroleum Ether Test:* Combine 1 ml of mustard oil with 10 ml of acidified petroleum ether. After two minutes, add a drop of molybdate. A muddy appearance of the solution indicates adulteration with castor oil.

#### Chemical Analysis

Utilizing chromatographic techniques such as GC *i.e.*, gas chromatography and HPLC *i.e.*, high-performance liquid chromatography, chemical analysis can identify the presence of adulterants by analyzing the composition of the oil. By comparing the chromatographic profiles of genuine mustard oil with suspected samples, adulterants such as other

vegetable oils or synthetic compounds can be detected.

### Spectroscopic Techniques

Spectroscopic methods like FTIR *i.e.*, Fourier-transform infrared spectroscopy and NMR *i.e.*, nuclear magnetic resonance spectroscopy can provide insights into the molecular structure of mustard oil. Changes or deviations in spectra compared to authentic samples can indicate adulteration.

### Physical Tests

Physical characteristics such as color, viscosity and specific gravity can be assessed to detect adulteration. For example, the addition of cheaper oils may alter the color or viscosity of mustard oil, providing visual cues for potential adulteration.

### Adulterant-Specific Tests

Some adulterants can be identified through specific chemical reactions or tests. For instance, the addition of argemone oil, a common adulterant in mustard oil, can be detected using the “cold test,” where the oil solidifies upon refrigeration due to the presence of stearic acid derivatives unique to argemone oil.

### DNA Analysis

DNA-based methods can be employed to detect the presence of DNA from other plant species, indicating the addition of adulterants such as soybean or palm oil. Polymerase chain reaction (PCR) techniques can amplify and identify specific DNA sequences characteristic of known adulterants.

### Sensor-Based Technologies

Emerging sensor technologies, including electronic noses and electronic tongues, offer rapid and non-destructive methods for detecting adulteration based on odor or taste profiles. These devices can differentiate between authentic and adulterated samples based on unique sensor responses. Moreover, some recent case studies of identification of adulteration in mustard oil are indexed in table 1.

### Regulations Imposed by Regulatory Bodies in India for Curbing Adulteration of Edible Oils

The Food Safety and Standards (Prohibition and Restriction on Sales) Second Amendment Regulations of 2021, effective from January 1<sup>st</sup>, 2022, stipulate that food products containing edible oils and fats must not surpass 2% industrial trans fatty acids by mass of the total oils/ fats. Additionally, the Food Safety and Standards (Prohibition and Restriction on Sales) Third Amendment Regulations, also enacted in 2021, forbid the blending of mustard oil for the production of Multi Sourced Edible Vegetable Oils (MSEVOs). Moreover, under the Food Safety and Standards (Fortification of Foods) Regulations of 2018, packaged refined edible vegetable oils weighing up to 15 kg are mandated to be fortified with Vitamin A and Vitamin D, meeting specified levels outlined in Clause (2) of Schedule - I. These regulatory measures aim to enhance public health by minimizing the intake of harmful trans fatty acids, maintaining the integrity of mustard oil and ensuring essential nutrient fortification in packaged vegetable oils.

Table 1: Some recent case studies of identification of adulteration in mustard oil

Identification of Adulteration	Technique used in the study	References
Mustard oil adulteration (Fried)	ATR-FTIR: Attenuated Total Reflection-Fourier Transform Infrared spectroscopy-chemometrics	Jamwal <i>et al.</i> , 2021
Adulteration in mustard oil (Butter yellow)	NIR: Near-infrared spectra	Amsaraj and Mutturi, 2023
Adulteration in mustard oil (Argemone oil)	ATR-FTIR: Total Reflectance–Fourier transform infrared spectroscopy with chemometrics	Amit <i>et al.</i> , 2020
Adulteration of mustard (Argemone oil)	Fluorescence spectroscopy with chemometrics	Shiv <i>et al.</i> , 2024
Detection of mustard oil adulteration (In virgin coconut oil)	ATR-FTIR spectroscopy with multivariate chemometric modelling	Jamwal <i>et al.</i> , 2021
Facile and rapid detection of adulteration in mustard oils	NMR: Nuclear Magnetic Resonance and unsupervised machine learning	Rachineni <i>et al.</i> , 2023

### Conclusion

The detection of mustard oil adulteration is a critical aspect of ensuring food safety and consumer trust. Through the use of advanced analytical techniques such as chromatography, spectroscopy and DNA barcoding, significant progress has been made in accurately identifying adulterants in mustard oil. However, challenges persist, including the diversity of adulterants used and the lack of standardized detection protocols and reference materials. Addressing these challenges requires collaborative efforts from researchers, regulatory bodies and industry stakeholders. By establishing robust quality standards, implementing regular monitoring and surveillance programs and fostering interdisciplinary research collaborations, these challenges and effectively combat mustard oil adulteration can be addressed. Ultimately, enhancing the detection of mustard oil adulteration is essential for safeguarding consumer health and confidence in the quality and authenticity of mustard oil products.

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