

A Review on Edible Oil Sources, Health Impacts, and Current Techniques of Oil Adulteration Detection

Snigdha Paul, Paromita Mukherjee*

Department of Food and Nutrition, Swami Vivekananda
University, Barrackpore, West Bengal

*Corresponding email: paromitam@svu.ac.in

Abstract

Edible oils are an essential part of daily nutrition and contribute to modern societies' culinary, health, and economic aspects. With diverse sources, including plants, seeds, and animal products, edible oils are rich in essential fatty acids, vitamins, and antioxidants. However, concerns regarding adulteration, which involves the addition of inferior substances to oils to increase profit margins, have prompted the development of various detection techniques. Adulteration poses significant health risks, including the intake of harmful compounds, which can lead to chronic diseases such as cardiovascular diseases, obesity, and diabetes. This review explores the major sources of edible oils, their health impacts, and the current methods employed to detect adulteration. Through the synthesis of recent studies and technological advancements, we aim to provide a comprehensive overview of edible oil sources, their benefits and risks, and the effectiveness of adulteration detection methods, with a focus on improving food safety and public health.

1. Introduction

Edible oils are vital in human diets, providing a source of energy, essential fatty acids, and fat-soluble vitamins that are integral to maintaining health (Calugar et al.,2024). They are derived from various sources such as plants, seeds, fruits, and animals. However, due to their widespread consumption and high economic value, edible oils are often subjected

to adulteration. Oil adulteration refers to the practice of adding cheaper or lower-quality substances to high-quality oils, often for economic gain. This practice can compromise the nutritional integrity and safety of oils, with potentially severe health implications for consumers (Shifat & M.M.U, 2023). The detection of adulterated oils has become an area of significant interest for food safety authorities and researchers, resulting in the development of several advanced techniques for identifying oil adulteration.

This review provides an in-depth analysis of the different edible oil sources, their health impacts, and the latest methods used for detecting adulteration. We aim to highlight the importance of addressing oil adulteration for both consumer safety and public health.

2. Sources of Edible Oils

Edible oils are derived from a variety of sources, each contributing different nutrient profiles, including fatty acid composition, vitamins, and antioxidants. The most common sources of edible oils are:

2.1 Plant-Based Oils

Plant-based oils are the most widely used edible oils globally. They are primarily composed of unsaturated fatty acids, which are considered healthier compared to saturated fats. Some common plant-based oils include:

- **Olive Oil:** Extracted from the fruit of the olive tree, olive oil is rich in monounsaturated fatty acids (MUFA), particularly oleic acid. It is also high in antioxidants, such as polyphenols and vitamin E, which contribute to its anti-inflammatory properties. Olive oil is widely associated with the Mediterranean diet and has been linked to cardiovascular health benefits, including the reduction of blood pressure and cholesterol levels (Santa-Maria et al., 2023).
- **Canola Oil:** Derived from the seeds of the canola plant, this oil is rich in both monounsaturated and polyunsaturated fats, including omega-3 fatty acids. It is considered heart-healthy and is commonly used for frying,

baking, and sautéing. Canola oil has a favorable balance of omega-6 to omega-3 fatty acids, making it beneficial for maintaining heart health (MacIntosh et al.,2021).

- **Sunflower Oil:** Obtained from sunflower seeds, sunflower oil is high in vitamin E and linoleic acid, a polyunsaturated omega-6 fatty acid. While it offers health benefits, excessive consumption of omega-6 fatty acids, relative to omega-3, has been linked to increased inflammation and the risk of chronic diseases (Alagawany et al.,2019).

- **Coconut Oil:** Extracted from the meat of coconuts, coconut oil contains a high proportion of saturated fatty acids, particularly medium-chain triglycerides (MCTs), which are metabolized differently from long-chain fatty acids (Silalahi , 2020). Though controversial due to its high saturated fat content, coconut oil has been promoted for its potential antimicrobial properties and metabolic benefits.

- **Palm Oil:** Palm oil, derived from the fruit of the oil palm tree, is one of the most commonly used oils worldwide. It is rich in saturated fats and vitamin E, though its health effects have been debated due to its higher content of saturated fatty acids. Palm oil is also a highly efficient crop in terms of yield per hectare, making it a major commodity for food production (Mahlia et al., 2019).

2.2 Animal-Based Oils

Animal-based oils are typically more saturated than plant-based oils and may contain additional compounds such as cholesterol. Some common animal-based oils include:

- **Butter:** Derived from cream, butter is rich in saturated fats and cholesterol. While it provides essential vitamins such as vitamin A and D, excessive consumption of butter has been linked to an increased risk of cardiovascular disease due to its saturated fat and cholesterol content (Paszczyk ,2022).

- **Lard:** Lard is fat derived from pigs and is commonly used in cooking, especially in baking and frying. Lard

contains a high proportion of monounsaturated fats, but its high saturated fat content has led to concerns about its impact on heart health.

- **Fish Oil:** Rich in omega-3 fatty acids, fish oil is obtained from fatty fish such as salmon, mackerel, and sardines. Omega-3s are essential for cardiovascular health, brain function, and reducing inflammation. Fish oil is often used as a supplement or incorporated into cooking oils.

3. Health Impacts of Edible Oils

The health impact of edible oils is influenced by their fatty acid composition, as well as the presence of bioactive compounds such as antioxidants and vitamins. Below, we explore the general health impacts of different types of edible oils.

3.1 Cardiovascular Health

The consumption of oils high in monounsaturated fats (e.g., olive oil and canola oil) and polyunsaturated fats (e.g., sunflower oil and fish oil) has been associated with improved cardiovascular health by reducing cholesterol levels, lowering blood pressure, and decreasing inflammation (Yahay et al., 2021). In contrast, oils high in saturated fats (e.g., coconut oil, butter, and palm oil) can raise LDL cholesterol levels and increase the risk of heart disease when consumed in excess.

3.2 Weight Management

Oils rich in medium-chain triglycerides (MCTs), such as coconut oil, have been linked to potential benefits for weight management, as MCTs are metabolized quickly and may promote fat oxidation. On the other hand, oils high in omega-6 fatty acids, such as sunflower and soybean oil, when consumed in excessive amounts, may contribute to obesity and related metabolic disorders by promoting inflammation and insulin resistance (Nimbkar et al., 2022).

3.3 Anti-Inflammatory and Antioxidant Effects

Many plant-based oils, such as olive oil, are rich in antioxidants and polyphenols that can reduce oxidative stress and inflammation in the body. These properties may help protect against chronic conditions like arthritis, type 2 diabetes, and

cancer. Oils like fish oil, which are high in omega-3 fatty acids, are also known to possess anti-inflammatory properties that benefit joint health and reduce the risk of cardiovascular diseases (Duranova et al., 2024).

4. Oil Adulteration and Detection Techniques

Adulteration of edible oils is a widespread issue that compromises the quality and safety of oils. The practice involves mixing pure oils with cheaper, lower-quality oils or other substances to increase volume and profits. Adulteration is particularly common in low-cost oils such as palm, sunflower, and olive oils. Common adulterants include cheaper oils like soy oil, cottonseed oil, and palm stearin.

4.1 Health Risks of Oil Adulteration

Adulterated oils can pose various health risks to consumers, including:

- **Toxicity:** Some adulterants, especially industrial oils, contain harmful compounds that can be toxic to the liver and kidneys.
- **Nutritional Deficiencies:** Adulteration can reduce the nutritional quality of oils, depriving consumers of essential fatty acids, vitamins, and antioxidants.
- **Chronic Diseases:** Long-term consumption of adulterated oils may contribute to obesity, metabolic syndrome, cardiovascular diseases, and even cancer.

4.2 Detection Methods for Oil Adulteration

Given the potential health risks of adulterated oils, accurate and reliable detection methods are essential. Several techniques are currently used to detect adulteration in edible oils, including:

- **Physical and Chemical Methods:** These involve the analysis of physical properties such as viscosity, refractive index, and melting point, as well as chemical composition, including fatty acid profile and saponification value. Gas chromatography (GC) and high-performance liquid chromatography (HPLC) are commonly used to detect

specific adulterants (Banti, 2020).

- **Spectroscopic Methods:** Techniques like Fourier Transform Infrared (FTIR) spectroscopy, ultraviolet-visible (UV-Vis) spectroscopy, and nuclear magnetic resonance (NMR) spectroscopy can identify the chemical fingerprint of oils and detect adulteration by comparing the spectral data with reference oils (Sudhakar et al., 2023).
- **Sensor-Based Methods:** Emerging technologies such as electronic noses and electronic tongues, which use arrays of sensors to detect specific volatile compounds or taste attributes, are gaining popularity for the rapid detection of adulterated oils (Mahanti et al., 2024).
- **DNA-Based Methods:** Genetic markers and polymerase chain reaction (PCR) techniques are being explored for detecting adulteration in oils derived from plant or animal sources. These methods offer a high level of specificity for identifying adulterants like animal fats in plant-based oils (Kotasnopoulos et al., 2021).

5. Conclusion

Edible oils are an essential component of a healthy diet, providing a variety of nutrients and health benefits. However, the risk of adulteration in the edible oil market poses significant threats to consumer health and safety. Adulterated oils can lead to the consumption of harmful substances and nutritional deficiencies, increasing the risk of chronic diseases.

The review of edible oil sources and their health impacts underscores the importance of selecting high-quality oils to maintain optimal health. Moreover, advanced detection techniques play a vital role in ensuring food safety and preventing fraudulent practices in the oil industry. Continued research and development of reliable and cost-effective adulteration detection methods will help safeguard consumers from health risks associated with oil adulteration, ensuring that edible oils meet the nutritional standards expected.

References

Alagawany, M., Elnesr, S. S., Farag, M. R., Abd El-Hack, M. E., Khafaga, A. F., Taha, A. E., ... & Dhama, K. (2019). Omega-3 and omega-6 fatty acids in poultry nutrition: effect on production performance and health. *Animals*, 9(8), 573.

Banti, M. (2020). Food adulteration and some methods of detection, review. *International Journal of Nutrition and Food Sciences*, 9(3), 86-94.

Calugar, L., Grozea, I., & Butnariu, M. (2024). Vegetable Oils in Maintaining Health. *Journal Med Clin Nurs Stud*, 2(2), 1-7.

Kotsanopoulos, K. V., Exadactylos, A., Gkafas, G. A., Martsikalis, P. V., Parlapani, F. F., Boziaris, I. S., & Arvanitoyannis, I. S. (2021). The use of molecular markers in the verification of fish and seafood authenticity and the detection of adulteration. *Comprehensive Reviews in Food Science and Food Safety*, 20(2), 1584-1654.

MacIntosh, S. C., Shaw, M., Connelly, M., & Yao, Z. J. (2021). Food and feed safety of NS-B5ØØ27-4 omega-3 Canola (*Brassica napus*): A new source of long-chain omega-3 fatty acids. *Frontiers in nutrition*, 8, 716659.

Mahanti, N. K., Shivashankar, S., Chhetri, K. B., Kumar, A., Rao, B. B., Aravind, J., & Swami, D. V. (2024). Enhancing food authentication through E-nose and E-tongue technologies: Current trends and future directions. *Trends in Food Science & Technology*, 104574.

Mahlia, T. M. I., Ismail, N., Hossain, N., Silitonga, A. S., & Shamsuddin, A. H. (2019). Palm oil and its wastes as bioenergy sources: a comprehensive review. *Environmental Science and Pollution Research*, 26, 14849-14866.

Paszczyk, B. (2022). Cheese and butter as a source of health-promoting fatty acids in the human diet. *Animals*, 12(23), 3424.

Shifat, M. M. U. (2023). Food Adulteration and Consumer Challenges in Bangladesh.

Silalahi, J. (2020). Nutritional values and health protective properties of coconut oil. *Indonesian Journal of Pharmaceutical and Clinical Research*, 3(2), 1-12.

Santa-María, C., López-Enríquez, S., Montserrat-de la Paz, S., Geniz, I., Reyes-Quiroz, M. E., Moreno, M., ... & Alba, G.

(2023). Update on anti-inflammatory molecular mechanisms induced by oleic acid. *Nutrients*, 15(1), 224.

Sudhakar, A., Chakraborty, S. K., Mahanti, N. K., & Varghese, C. (2023). Advanced techniques in edible oil authentication: A systematic review and critical analysis. *Critical reviews in food science and nutrition*, 63(7), 873-901.

Yahay, M., Heidari, Z., Allameh, Z., & Amani, R. (2021). The effects of canola and olive oils consumption compared to sunflower oil, on lipid profile and hepatic steatosis in women with polycystic ovarian syndrome: a randomized controlled trial. *Lipids in Health and Disease*, 20, 1-12.

Nimbkar, S., Leena, M. M., Moses, J. A., & Anandharamakrishnan, C. (2022). Medium chain triglycerides (MCT): State-of-the-art on chemistry, synthesis, health benefits and applications in food industry. *Comprehensive reviews in food science and food safety*, 21(2), 843-867.

Duranova, H., Kuzelova, L., Fialkova, V., Simora, V., Kovacikova, E., Joanidis, P., ... & Gabriny, L. (2024). Coconut-sourced MCT oil: Its potential health benefits beyond traditional coconut oil. *Phytochemistry Reviews*, 1-42.