



Understanding the Adulteration of Golden Spice Turmeric (*Curcuma longa*)

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Abstract

Turmeric, known as the “golden spice” of India, is valued for its vibrant color, unique flavor and numerous health benefits. However, the spice is frequently adulterated with fillers, synthetic dyes and mislabeling of origin. These practices compromise the purity and quality of turmeric, posing health risks and economic consequences. This article explores the causes and effects of turmeric adulteration, as well as the methods used to detect adulterants. Strategies to ensure the purity of turmeric, such as purchasing from trusted sources and visual inspection, are also discussed. Overall, safeguarding the purity of turmeric is essential to protect public health and maintain consumer trust in the market.

Keywords: Adulteration, Contamination, Safety, Turmeric

Introduction

Known as the “golden spice” of India, turmeric has long been valued for its vivid hue, unique flavour and an abundance of health advantages. *Curcuma longa*, the scientific name for turmeric, is a flowering plant that belongs to the ginger family and is native to Southeast Asia and the Indian subcontinent. The main reason it is grown is for its rhizomes, which are taken out, dried and ground into a fine powder to make a spice that is frequently used in traditional medicine and cooking (Sharma, 2022). Curcumin, the key ingredient that gives turmeric its distinctive yellow colour and health benefits, is a powerful antioxidant and anti-inflammatory. But beneath its glossy exterior comes a sobering truth: this precious spice is frequently adulterated. Turmeric is adulterated when foreign materials are added to it in an effort to make it heavier, more colourful, or less expensive; this compromises the spice’s purity and quality (Sonal, 2023).

This article examines the causes of turmeric adulteration, the effects it has on the environment and human health and the primary techniques used to mislead customers. Turmeric adulteration is mostly motivated by financial gain. Because turmeric has a high market value, unethical vendors might

benefit more by selling lower-quality or adulterated turmeric at the same price as the real thing. Turmeric has been in high demand both domestically and internationally, which has encouraged adulteration to keep up with the demand.

Methods of Adulteration

Addition of Fillers

- **Starch:** Starch is frequently used as a filler in turmeric powder and can be obtained from rice, corn or wheat. It is inexpensive and readily combines with turmeric, making it hard to see.
- **Chalk:** Another filler that is occasionally used to turmeric is chalk, also known as calcium carbonate. It may imitate the look of the spice and is used to make turmeric powder heavier.
- **Sawdust:** Turmeric powder occasionally contains sawdust as a filler, especially from hardwoods. It has no nutritional value, but it gives the spice more body.
- **Additional Plant Matter:** To make turmeric powder heavier, some dishonest vendors may include additional plant-based ingredients, like ground lentils or legumes.

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Addition of Organic Components

Adulterants come in various forms, including organic substances like different wild species of turmeric, or chemicals that pose significant health risks. Among the organic contaminants are those from the *Curcuma* species, closely resembling turmeric, such as *Curcuma xanthorrhoea*, *Curcuma malabarica* and *Curcuma aromatica* (Yan, 2023).

Addition of Synthetic Dyes

Another prevalent way that turmeric is adulterated to try to improve its colour is by adding artificial dyes to it. Turmeric gets its vivid yellow colour from substances found in it called curcuminoids. However, some manufacturers could use artificial colours to make inferior or outdated turmeric look better. Typical synthetic colours that are employed are:

- **Metanil Yellow:** One of the most often used synthetic colours in turmeric is called metanil yellow. It is added to the spice to give it a vivid yellow hue that resembles turmeric's natural hue. On the other hand, over consumption of metanil yellow might have detrimental consequences on one's health as it is recognised as a carcinogen.
- **Sudan Red:** Sudan Red, commonly employed in textile and plastic sectors, has found illicit use in commercial turmeric powder to intensify its color. However, this unauthorized addition poses severe health risks due to its carcinogenic properties, potentially increasing the risk of DNA damage and cancer.
- **Lead Chromate:** Another artificial dye that is occasionally used to intensify the colour of turmeric is lead chromate. However, lead is a hazardous heavy metal that, especially in young children and pregnant women, can build up in the body over time and result in major health issues.

Mislabelling of Origin

- **False Geographical Indications (GIs):** In order to fetch a better price, certain regions' turmeric may be mistakenly labelled to originate from a well-known GI. For instance, turmeric from another nation or area can be referred to as "Indian turmeric," which is highly regarded.
- **Combining Turmeric from Various Origins:** Occasionally, turmeric is blended and marketed under a single origin label, even when it comes from multiple states or nations. Customers who are specifically searching for turmeric from a certain area recognised for its high quality may be misled by this technique.
- **False Labelling or Packaging:** Although the product may not come from that area, turmeric may be labelled or packed to imply a certain origin. Customers may be misled into thinking they are getting a high-end product as a result.

Inferior Grade Turmeric

Another type of adulteration is inferior grade turmeric, which is the sale of lower-quality or contaminated turmeric under a higher-grade product label. This procedure may damage the spice's flavour, fragrance and medicinal properties (Gite, 2024). Typical problems linked to inadequate turmeric quality include:

- **Reduced Curcumin Content:** Turmeric's primary bioactive

ingredient, curcumin, is what gives it its health advantages. Turmeric of inferior quality may contain less curcumin, which would lessen its effectiveness.

- **Higher Contamination Levels:** Turmeric of a lower quality may have higher concentrations of pollutants including pesticides, heavy metals, or microorganisms. Such turmeric use over time may be harmful to one's health.
- **Bad Flavour and Aroma:** Turmeric of a lower grade might lack the rich flavour and aroma of turmeric of a higher grade. This may have an impact on the general quality of food made with the spice.
- **Diminished Nutritional Value:** Turmeric is appreciated for both its taste and nutrients. Turmeric of a lower grade could be less nutritious than turmeric of a higher grade.

Consequences of Turmeric Adulteration

Adulteration of turmeric has the potential to have serious and wide-ranging effects on the economy, society and health (Anonymous, 2022). Among these the main consequences are:

- **Health Risks:** Turmeric adulterants, including artificial colouring, fillers and pollutants, can be extremely harmful to your health. Lead poisoning, for instance, can result from pollutants like lead, whereas artificial colours like metanil yellow are carcinogenic. Long-term use of tainted turmeric can lead to a number of health problems, particularly in susceptible groups like children, pregnant women and the elderly.
- **Diminished Quality:** By diluting the spice's active ingredients, such curcumin, adulteration might lessen the spice's effectiveness. Reduced concentrations of these substances may lessen the health advantages of consuming turmeric, including its antioxidant and anti-inflammatory qualities.
- **Economic Impact:** Adulteration can affect manufacturers' and consumers' bottom lines. Because of unfair competition from contaminated items, real producers may lose business and consumers may wind up paying higher prices for inferior products. Additionally, this may result in farmers and other supply chain participants losing money from growing turmeric.
- **Consumer Deception:** Adulteration is lying to customers about the product's origins or quality. This may weaken customer confidence in the market and encourage fraud. Because some items may be contaminated, consumers may not receive the anticipated health advantages from turmeric products and may experience other problems.
- **Legal and Regulatory Issues:** Adulteration may give rise to difficulties with the law and regulations. To stop adulteration, regulatory bodies might have to spend money on oversight and enforcement of laws. Legal proceedings against adulterators may be expensive and time-consuming.
- **Impact on the Environment:** Adulteration may have an adverse effect on the environment, particularly if toxins or fillers are discharged into the environment during processing or disposal. Ecosystems may be harmed and pollution may result from this.

• **Impact on Culture and Society:** In many countries, turmeric has cultural and social importance. Adulteration has the potential to undermine traditional uses of turmeric and reduce its cultural significance.

Techniques for Detecting Adulterant in Turmeric

Turmeric adulteration can be found using a number of methods. These methods frequently centre on examining the spice's chemical, biological and physical characteristics. Typical methods of detection include the following:

Microscopic Analysis

Microscopic analysis in horticulture involves examining turmeric samples for quality and purity. It helps assess particle size, shape and curcumin content. Detection of adulterants and microbial contamination ensures product safety. Microscopy is crucial for quality control, aiding in maintaining standards and ensuring consumer satisfaction.

Chemical Analysis

Chemical analysis of turmeric involves assessing curcumin content, which gives its characteristic yellow color. Methods include spectrophotometry, HPLC and TLC for quality evaluation and purity determination. Other tests examine volatile oils, ash and heavy metals for safety.

Thin-Layer Chromatography (TLC)

Thin-layer chromatography (TLC) is used in turmeric to analyze its purity by separating and identifying its components. A sample is applied to a thin layer of adsorbent material on a plate. After the plate is dried, the separated components are visualized under UV light or by using a suitable chemical reagent. By comparing the resulting pattern with known standards, the presence and purity of specific compounds, such as curcumin in turmeric, can be determined.

High-Performance Liquid Chromatography (HPLC)

HPLC is crucial in turmeric purity testing, specifically for curcuminoids. In this process, a turmeric sample is dissolved in a solvent and injected into a column, where components separate based on chemical properties. Curcuminoids, responsible for turmeric's color and health benefits, are detected and quantified as they elute from the column. By comparing their quantities to known standards, the sample's purity and quality can be assessed.

Gas Chromatography-Mass Spectrometry (GC-MS)

Gas Chromatography-Mass Spectrometry (GC-MS) is utilized in turmeric purity testing by separating its chemical constituents for analysis. It identifies and quantifies compounds present in a sample, ensuring the absence of contaminants and confirming the presence of key compounds like curcumin. GC separates the mixture into individual components and MS identifies these components based on their mass and charge.

DNA Barcoding

DNA barcoding is a molecular technique used to identify and authenticate plant species. In the context of turmeric, DNA barcoding involves amplifying and sequencing a

specific region of the plant's DNA, often the ITS2 (Internal Transcribed Spacer 2) region. This sequence is compared to a reference database to confirm the presence of *Curcuma longa* and detect any adulterants or contaminants.

Spectroscopic Methods

Spectroscopic methods, such as UV-Vis spectroscopy, play a crucial role in testing the purity of turmeric. This technique involves shining ultraviolet and visible light through a sample and measuring the absorbance spectrum. Since curcumin, the primary bioactive compound in turmeric, exhibits distinct absorbance peaks, UV-Vis spectroscopy can quantify its concentration in a sample. Any deviations from the expected spectrum or lower-than-expected curcumin levels can indicate the presence of impurities or adulterants. This method provides a rapid and non-destructive way to assess the quality of turmeric, ensuring that products meet the required purity standards for safe consumption or use.

Elemental Analysis

Elemental analysis is used to assess the purity of turmeric by quantifying the presence of specific elements. Turmeric is expected to contain certain elements in specific amounts and deviations can indicate contamination or adulteration. Techniques like atomic absorption spectroscopy (AAS) or inductively coupled plasma mass spectrometry (ICP-MS) are employed to quantify elements like lead, arsenic and cadmium, which are common contaminants in turmeric.

Ensuring Purity of Turmeric

Turmeric's purity is ensured by a number of procedures designed to keep the spice pure and preserve its quality. Among the most important measures taken to guarantee the quality of turmeric are:

- **Purchasing from Trusted Vendors:** Invest in turmeric from trustworthy vendors who meet strict quality requirements. Seek certificates such as the organic certification, which guarantees that no artificial pesticides or chemicals are used in the production of the turmeric.
- **Look for Quality Seals:** On the package, look for certifications or seals that indicate that the turmeric has undergone testing and satisfies specific quality requirements. The logos of the Food Safety and Standards Authority of India (FSSAI) and organic certifying agencies are two examples.
- **Visual Inspection:** Examine the turmeric powder with your eyes. The colour of pure turmeric powder should be a vivid golden yellow and its perfume should be fresh and fragrant. Steer clear of turmeric that seems lifeless or smells musty, as these could be signs of adulteration or low quality.
- **Examine the Label Carefully to Look for Additives:** Look for any fillers or additives on the label. Steer clear of turmeric powders that include artificial colouring, starch, or chalk. Purchasing entire turmeric roots is a better option than purchasing powdered turmeric. Whole turmeric can be ground or grated at home as needed and it is less likely to be tampered with.
- **Buy in Small Quantities and become informed:** To guarantee freshness and reduce the chance of purchasing

contaminated goods that have been kept for a long time, buy turmeric in small quantities. Find out about the typical adulterants and adulteration techniques for turmeric. This will enable you to choose turmeric items with knowledge.

- **Encourage Local Producers:** Wherever you can, encourage regional producers of turmeric that adhere to morally and environmentally responsible standards. Turmeric grown locally is more likely to be genuine and of excellent quality.

Conclusion

Turmeric adulteration poses significant risks to public health, economic integrity and cultural heritage. Various adulteration methods, including fillers, synthetic dyes and mislabeling, compromise the spice's quality and safety. Harmful additives like lead chromate and metanil yellow can lead to severe health issues, particularly in vulnerable populations. Economic impacts include unfair competition and financial losses for genuine producers. To address turmeric adulteration, stakeholders must prioritize transparency, quality control and consumer education. Implementing stringent regulations, supporting local producers and raising awareness among consumers are crucial. By working together, we can protect public health, preserve cultural traditions and uphold the integrity of this valued spice.

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