

REVIEW ARTICLE

# Understanding the health implications of spice adulterations

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ABSTRACT

Spice adulteration is a growing concern in India, with recent reports indicating that 15-20% of spices in the market are adulterated. This study explores the various types of spice adulteration prevalent in India, including substitution, color, weight, non-edible substance, quality degradation, chemical, and flavor adulterations. The impact of spice adulteration on human health is also examined, with a focus on the potential risks associated with consuming adulterated spices. The study draws insights from Ayurveda, which emphasizes the importance of using pure and authentic spices for their medicinal properties. The adulteration of spices not only compromises their quality and flavor but also poses significant health risks, such as exposure to toxic substances, gastrointestinal issues, and long-term health complications. The globalization of the spice trade and inadequate enforcement of regulations are identified as factors contributing to the persistence of this issue. The study highlights the need for stringent quality control measures, regular testing, and consumer awareness to combat spice adulteration.

**Keywords:** Spice adulteration, Health, Ayurveda, Consumer awareness.

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## INTRODUCTION

Spices have been an essential part of Indian cuisine and culture for centuries, adding flavor, aroma, and color to our dishes (Ravindran, 2024). Spices add flavor to our meals and can even boost our health. From the fiery kick of chili peppers to the earthy warmth of cumin, spices have been used for centuries to enhance the taste of our food. The spice market can be a bit tricky, with prices varying widely based on quality and demand. However, the spice market is not without its challenges, one of the most significant being adulteration. Some sellers look for quick profits, leading to adulteration.

This is like trying to pass off a lemonade made with sugar water as fresh-squeezed juice. It might look the same, but the taste and health benefits are miles apart.

Spice adulteration refers to the practice of mixing lower-quality or cheaper ingredients with genuine spices to increase profits (Sahoo & Samal, 2024). One of the most common forms of spice adulteration is the addition of artificial colors to enhance the appearance of spices (Sudhabindu & Samal, 2020). For example, turmeric, a popular spice known for its vibrant yellow hue, is often adulterated with lead chromate or metanil yellow, both of which are harmful to health. In addition to artificial colors, spices are also frequently adulterated with fillers such as sawdust, flour, and chalk powder to increase volume and bulk. Adulteration can compromise the quality, flavor, and safety of the spices, leading to potential health risks.

The prevalence of spice adulteration in the market is a growing concern, with various studies and reports highlighting the extent of the problem. The adulteration of spices not only deceives consumers but also has a significant impact on the spice industry as a whole. Authentic spice producers who take pride in delivering high-quality, pure products are undercut by unscrupulous traders who engage in adulteration. This not only tarnishes the reputation of genuine spice producers but also affects consumer trust in the industry.

To combat spice adulteration, various measures have been put in place by regulatory authorities and industry stakeholders. Stringent quality control standards, regular testing of spice samples, and traceability systems are some of the steps taken to ensure the authenticity and purity of spices. Consumers are also encouraged to buy spices from reputable sources and familiarize themselves with the characteristics of pure spices to identify any signs of adulteration.

Despite these efforts, spice adulteration continues to be a complex and pervasive issue in the market. The globalization of the spice trade, coupled with inadequate enforcement of regulations, has created loopholes that allow adulteration to persist. Consumers must remain vigilant and proactive in seeking out pure and authentic spices to safeguard their health and well-being. In this article, we will delve into the spice adulteration in India, the types of spice adulteration, the impact of spice adulteration on health, what Ayurveda has to say about spice adulteration, and provide a discussion and conclusion on this pressing issue.

## **SPICE ADULTERATION IN INDIA**

Spice adulteration is a significant concern in India due to the country's large-scale production, consumption, and export of spices (Negi et al., 2021). Although specific statistics on spice adulteration can vary over time and across regions. According to recent reports, India is one of the largest producers and exporters of spices in the world (Babu, 2017). However, it is also plagued by a high incidence of spice adulteration. According to a 2021 report by the Food Safety and Standards Authority of India (FSSAI), about 15-20% of spices in the market are found to be adulterated (Haji et al., 2023). A 2018 study revealed that nearly 30% of turmeric samples tested in a particular region were found to be adulterated with metanil yellow, a non-permitted food color (Shannon et al., 2022; Verma et al., 2022).

Uttar Pradesh is one of the leading producers of spices such as chili, turmeric, and cumin (Devi Priya & Thyagarajan, 2020). However, the state has also been identified as a hotspot for spice adulteration. The FSSAI has been actively working to combat spice adulteration through regular testing and public awareness campaigns. In 2019, the FSSAI launched the "Eat Right India" movement, which included a focus on detecting and eliminating adulterated food products, including spices (Kathuria & Anand, 2022). This initiative led to a significant increase in the number of samples tested and a higher rate of convictions for food adulteration.

## **TYPES OF SPICE ADULTERATION**

Spice adulteration can occur in various forms, depending on the motive, whether it's to enhance the appearance, increase weight, or extend the shelf life of the spice. Here are the common types of spice adulteration:

**Substitution Adulteration (Momtaz et al., 2023):**

Partial Substitution: Replacing a portion of the spice with a cheaper or inferior substance that resembles the original spice. Example: Mixing papaya seeds with black pepper.

Complete Substitution: The entire spice is replaced with another substance. Example: Using synthetic curcumin instead of natural turmeric powder.

**Color Adulteration (Khan et al., 2020; Sharma et al., 2017):**

Artificial Colorants: Adding synthetic dyes to improve or enhance the color of the spice, making it appear fresher or more vibrant. Example: Adding Sudan Red dye to chili powder.

Toxic Colorants: Using harmful substances to color spices. Example: Lead chromate in turmeric to give it a bright yellow color.

**Weight Adulteration (Momtaz et al., 2023):**

Addition of Heavy Substances: Adding materials that increase the weight of the spice, thereby increasing profit margins. Example: Adding chalk powder or brick dust to chili powder.

Moisture Adulteration: Adding water or moisture to increase weight. Example: Spraying water on dry spices like coriander to make them heavier.

**Adulteration with Non-edible Substances (Haji et al., 2023):**

Harmful Additives: Adding non-edible substances that may be harmful to health. Example: Adding sawdust to cumin seeds.

Inert Substances: Non-toxic but non-edible materials used to bulk up the spice. Example: Adding soapstone or other powdered stones to ground spices.

**Quality Degradation:**

Addition of Spoiled or Old Spices: Mixing old or inferior quality spices with new ones. Example: Mixing old, moldy turmeric with fresh turmeric powder.

Use of Waste Materials: Adding waste by-products from spice processing to the final product. Example: Using chili seed husks and stems instead of pure chili powder.

**Chemical Adulteration (Puri, 2023):**

Preservatives: Adding unauthorized or excessive amounts of preservatives to extend shelf life. Example: Using sulfur dioxide in excess to preserve dried spices.

**Pesticide Residues:** Leaving or adding harmful pesticide residues in spices. Example: Excessive pesticide use in the cultivation of spices that aren't properly washed or cleaned before processing.

**Flavor Adulteration (Chan, 2015):**

**Addition of Synthetic Flavors:** Using artificial flavors to mimic the taste of the original spice. Example: Adding synthetic vanillin to mimic the flavor of natural vanilla.

**Dilution with Flavors:** Adding low-quality spices or other flavor agents to dilute the original flavor. Example: Mixing cheap varieties of cinnamon with premium Ceylon cinnamon.

**Adulteration with Filth and Contaminants (Rather et al., 2017):**

**Foreign Matter:** Accidental or intentional inclusion of dirt, stones, insects, or other contaminants during the processing or packaging stages. Example: Presence of rodent hair or droppings in ground spices due to poor hygiene practices.

**Pathogenic Contaminants:** Inclusion of harmful bacteria, molds, or toxins due to improper storage conditions. Example: Spices contaminated with aflatoxins, which are harmful to human health.

**Adulteration through Irradiation (Bisht et al., 2021):**

**Excessive Irradiation:** Using high levels of irradiation to sterilize spices, which may lead to the degradation of flavor and nutritional content. Example: Over-irradiation of black pepper to eliminate microbial contamination, affecting its pungency.

These types of adulteration not only diminish the quality and authenticity of spices but also pose significant health risks to consumers.

**COMMON ADULTERER SPICES AND THEIR ASSOCIATED RISK**

Several spices are commonly subjected to adulteration due to their high demand and market value. Here are some of the most frequently adulterated spices:

- **Turmeric:** Common Adulterants: Lead chromate (for color enhancement), metanil yellow (a non-permitted dye), starch, and synthetic curcumin. Risks: Lead chromate is highly toxic and can cause serious health issues, including neurological and kidney damage (Wani et al., 2015).
- **Chili Powder:** Common Adulterants: Brick powder, salt powder, artificial colors (such as Sudan dye), and synthetic capsaicin extract. Risks: Sudan dye is a carcinogen, and other adulterants can cause gastrointestinal problems and allergic reactions (Fonovich, 2013).
- **Black Pepper:** Common Adulterants: Papaya seeds (which look similar but lack pungency), dried blackberries, and powdered stones. Risks: Consumption of adulterated black pepper can reduce the spice's efficacy and cause digestive issues (Momtaz et al., 2023).
- **Cumin Seeds:** Common Adulterants: Grass seeds, colored starch granules, and other non-edible seeds. Risks: Adulterants in cumin can lead to reduced flavor intensity and potential allergic reactions (Anagaw et al., 2024).
- **Coriander Powder:** Common Adulterants: Sawdust, husk powder, and starch. Risks: Ingesting adulterated coriander powder can result in digestive discomfort and reduced nutritional value (Choudhary et al., 2020).
- **Ginger Powder:** Common Adulterants: Starch, chalk powder, and other white powders. Risks: Adulteration can significantly

dilute the medicinal properties of ginger and cause digestive issues.

- **Asafoetida (Hing):** Common Adulterants: Chalk powder, soapstone, and synthetic resins. Risks: Adulterated asafoetida may cause indigestion and reduce the effectiveness of its digestive properties.
- **Cardamom:** Common Adulterants: Exhausted or low-quality seeds, and artificial flavoring agents. Risks: Adulteration reduces the aromatic quality and medicinal benefits of cardamom.
- **Saffron:** Common Adulterants: Colored corn silk threads, safflower, and turmeric. Risks: Adulterated saffron can cause allergic reactions and lacks the potency and flavor of real saffron.
- **Cloves:** Common Adulterants: Exhausted or low-grade cloves, artificial clove oil, and lead salts. Risks: Consuming adulterated cloves can lead to reduced efficacy in medicinal and culinary use, as well as potential health risks from toxic substances.
- **Mustard Seeds:** Common Adulterants: Argemone seeds (toxic), colored seeds, and other non-edible seeds. Risks: Argemone seeds are highly toxic and can lead to severe health issues, including dropsy and poisoning (Sharma et al., 1999).
- **Fennel Seeds:** Common Adulterants: Grass seeds, colored stones, and artificial colorants. Risks: Adulteration reduces the flavor and health benefits of fennel and can cause allergic reactions (Anagaw et al., 2024; Momtaz et al., 2023).

These commonly adulterated spices highlight the importance of buying spices from reputable sources and being aware of potential adulteration practices. Consuming adulterated spices can pose significant health risks, ranging from mild allergic reactions to severe toxicity.

## IMPACT OF SPICE ADULTERATION ON HEALTH

Spice adulteration can have serious and sometimes severe impacts on human health. The effects depend on the type of adulterant used, the amount consumed, and the duration of exposure. Here's a breakdown of the potential health impacts of spice adulteration:

### 1. Toxicity and Poisoning

- **Lead Chromate in Turmeric:** Lead chromate, often used to enhance the yellow color of turmeric, is a potent neurotoxin (Wani et al., 2015). Chronic exposure can lead to:
  - **Neurological damage:** Cognitive impairments, developmental delays in children, and behavioral issues.
  - **Kidney damage:** Long-term exposure can impair kidney function.
  - **Anemia:** Lead interferes with hemoglobin production, leading to anemia.
- **Sudan Dye in Chili Powder:** Sudan dyes are industrial colorants that are carcinogenic (Fonovich, 2013). Consuming spices adulterated with these dyes can increase the risk of:
  - **Cancer:** Especially liver and bladder cancer.
  - **DNA damage:** Mutagenic effects leading to long-term health risks.

### 2. Gastrointestinal Disorders (Anagaw et al., 2024; Momtaz et al., 2023)

- **Brick Powder and Salt Powder in Chili Powder:** These adulterants are non-digestible and can cause:
  - **Gastrointestinal irritation:** Leading to symptoms like nausea, vomiting, and abdominal pain.
  - **Constipation or diarrhoea:** Depending on the nature of the adulterant.
- **Sawdust in Coriander Powder:** Sawdust, when ingested, can cause:
  - **Digestive discomfort:** Including bloating, gas, and constipation.
  - **Intestinal blockage:** In extreme cases, leading to severe health complications.

### 3. Allergic Reactions (Haji et al., 2023)

- **Papaya Seeds in Black Pepper:** While papaya seeds are not toxic, they can trigger allergic reactions in sensitive individuals, causing:
  - **Rashes:** Skin irritations and hives.
  - **Breathing difficulties:** In severe cases, leading to anaphylaxis.
- **Artificial Flavors and Colors:** These synthetic additives can cause:
  - **Skin reactions:** Rashes, itching, and redness.
  - **Respiratory issues:** Wheezing, shortness of breath, and asthma attacks.

### 4. Carcinogenic Effects (Haji et al., 2023; Momtaz et al., 2023; Vasu & Martin, 2023)

- **Synthetic Dyes like Metanil Yellow:** Used in turmeric and other spices, these dyes are not approved for food use and can:
  - **Increase cancer risk:** Particularly liver and gastrointestinal cancers.
  - **Disrupt cellular function:** Leading to DNA mutations over time.
- **Argemone Seeds in Mustard Seeds:** Argemone oil is toxic and can cause:
  - **Epidemic dropsy:** A condition characterized by swelling, glaucoma, and heart failure.
  - **Chronic toxicity:** Leading to long-term organ damage and increased cancer risk.

### 5. Nutritional Deficiencies (Anagaw et al., 2024; Momtaz et al., 2023)

- **Dilution with Non-nutritive Substances:** Adulteration with substances like starch, husk, or fillers reduces the nutritional content of spices, leading to:
  - **Micronutrient deficiencies:** For example, iron deficiency if black pepper is adulterated.
  - **Reduced efficacy:** Spices like turmeric and ginger, known for their health benefits, lose their potency when adulterated, leading to reduced therapeutic effects.

### 6. Hormonal and Endocrine Disruption (Anagaw et al., 2024; Sharma et al., 2017; Thangaraju et al., 2021)

- **Pesticide Residues:** Spices contaminated with pesticide residues can disrupt the endocrine system, leading to:
  - **Hormonal imbalances:** Affecting reproductive health, growth, and metabolism.
  - **Increased risk of cancers:** Especially hormone-sensitive cancers like breast and prostate cancer.

### 7. Immune System Compromise (Momtaz et al., 2023)

- **Chronic Exposure to Adulterants:** Over time, the immune system can be weakened by constant exposure to low-level toxins, leading to:
  - **Increased susceptibility to infections:** Due to a weakened immune response.
  - **Autoimmune disorders:** Triggered by chemical adulterants that alter normal immune function.

### 8. Neurological Effects (Wani et al., 2015)

- **Neurotoxins like Lead:** Found in adulterants such as lead chromate can cause:
  - **Cognitive impairments:** Particularly in children, leading to learning difficulties.
  - **Peripheral neuropathy:** Tingling, numbness, and pain in the extremities.

### 9. Impact on Children and Pregnant Women (Anagaw et al., 2024; Thangaraju et al., 2021)

- **Heightened Sensitivity:** Children and pregnant women are more vulnerable to the effects of adulterants due to their

developing bodies and immune systems. Potential impacts include:

- **Developmental delays:** In children, due to exposure to neurotoxins.
- **Fetal harm:** In pregnant women, certain adulterants can cross the placenta and affect fetal development, leading to birth defects or miscarriage.

#### 10. Long-term Health Risks (Momtaz et al., 2023)

- **Chronic Diseases:** Regular consumption of adulterated spices increases the risk of chronic conditions such as:
  - **Cardiovascular diseases:** Due to the accumulation of toxic substances in the body.
  - **Chronic kidney and liver diseases:** Resulting from long-term exposure to toxic adulterants.

Spice adulteration poses serious public health concerns, especially in regions with less stringent food safety regulations

### AYURVEDA AND SPICE ADULTERATION

Ayurveda, the ancient system of medicine from India, places great importance on the purity and quality of food, including spices, as they are integral to maintaining health and balance in the body. While Ayurveda doesn't specifically discuss modern concepts like "spice adulteration," its principles clearly emphasize the detrimental effects of consuming impure, contaminated, or low-quality substances. Ayurveda emphasizes that food (*Ahara*) (Payyappallimana & Venkatasubramanian, 2016; Rastogi, 2014) should be pure, unadulterated, and conducive to health. Spices, being a crucial part of the diet, are expected to be free from impurities to maintain their natural potency and therapeutic effects. Adulteration can alter spice tastes and disturb the balance of *doshas*, leading to health issues. Consuming adulterated spices can lead to an imbalance in the *doshas*, the fundamental energies that govern. Impure spices can weaken *Ojas*, (Patil & Baghel, 2021) reduce vitality, and make the body more susceptible to diseases. The *Virya* (potency) (Nishteswar, 2019) of spices, which refers to their inherent energy and therapeutic properties, is also compromised when they are adulterated. Adulterated spices can disrupt *Agni*, leading to poor digestion, the formation of *Ama* (toxins), and various digestive disorders like indigestion, gas, and bloating. Ayurveda states that impure and incompatible foods are key causes of disease (*Vyadhi*). Spices that are adulterated are viewed as incompatible (*Viruddha*), (Sabnis, 2012) leading to the development of diseases over time due to the accumulation of toxins.

### DISCUSSION

Spices have been an integral part of culinary traditions around the world for centuries. They not only add flavor and aroma to our dishes but also boast numerous health benefits. However, the sad reality is that the spice industry is plagued by the issue of adulteration, which poses serious health risks to consumers. Spice adulteration refers to the practice of adding inferior, harmful, or cheaper substances to spices in order to increase profits (Sahoo & Samal, 2024). Common adulterants include starch, sawdust, artificial colors, chemical dyes, and even harmful chemicals such as lead chromate. These adulterants not only compromise the quality and flavor of the spice but also have the potential to harm our health in various ways.

One of the major health implications of spice adulteration is the risk of foodborne illnesses. Adulterated spices may contain harmful bacteria, mold, or other pathogens that can cause food poisoning, stomach upset, diarrhoea, and other gastrointestinal issues (Sharma et al., 2017). Consuming such contaminated spices can have serious consequences, especially for vulnerable populations such as children, the elderly, and individuals with weakened immune systems. Furthermore, some adulterants used in spices are known to be allergens and can trigger allergic reactions in sensitive individuals. For example, artificial colors and chemical dyes added to spices can cause skin rashes, itching, breathing difficulties, and other allergic symptoms. People with known allergies or sensitivities to these substances need to be especially cautious when purchasing and consuming spices.

In addition to food safety concerns, spice adulteration can also have long-term health effects due to the presence of toxic substances. Lead chromate, a yellow pigment used to adulterate turmeric powder, is a known carcinogen and neurotoxin.

Prolonged exposure to lead can lead to serious health problems, including neurological disorders, developmental delays in children, and an increased risk of certain cancers. To protect consumers from the health risks associated with spice adulteration, it is crucial for food regulatory authorities to enforce strict quality control measures and regular testing of spices sold in the market. Consumers can also take steps to reduce their risk of exposure to adulterated spices by purchasing from reputable sources, checking labels for any added ingredients, and opting for organic or certified products whenever possible. Consumers can protect themselves from adulterated spices by buying from reputable sources, checking for quality certifications, and being vigilant about signs of adulteration such as unusual color, smell, or taste. It is essential to raise awareness about the health implications of spice adulteration and advocate for transparent labelling and traceability in the spice industry to safeguard public health.

## CONCLUSION

Understanding the health implications of spice adulterations is crucial for safeguarding our well-being and ensuring the purity and authenticity of the spices we consume.

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