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Adulteration of food: A hidden poison on our plates

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ABSTRACT

Food adulteration — the intentional addition, substitution, or contamination of food with inferior, harmful, or undeclared substances — remains a major public-health problem worldwide. This review synthesizes definitions, common adulterants, health consequences, detection techniques, regulatory frameworks, and practical recommendations for clinicians and students engaged in research or clinical practice. We highlight gaps in surveillance and suggest study designs and laboratory approaches suited to cross-disciplinary teams (medicine, public health, analytical chemistry). The aim is to equip readers with a compact, evidence-oriented understanding and practical next steps for research and diagnosis.

KEYWORDS: food adulteration, contaminants, detection methods, public health, surveillance, clinical toxicology

INTRODUCTION

Food is meant to nourish, not to harm. Yet, in today's fast-paced world, the food that reaches our plates is not always pure. Adulteration—the deliberate or accidental addition of harmful substances to food—has become one of the most pressing public health concerns. [1] What may look like golden turmeric, rich milk, or juicy fruits often conceals silent threats to human health. For doctors, this is more than a food issue; it is a medical reality. It is a reminder that the food industry intersects with science, ethics, and health.

DEFINATION

Food adulteration refers to the intentional or unintentional addition, substitution, dilution, removal, or contamination of food with substances that alter its composition, quality, safety, purity, or nutritional value. [8, 10]

TYPES OF ADULTERATION

1. **Chemical adulteration** – Adding toxic chemicals like metanil yellow in turmeric, formalin in fish, or urea in milk to increase shelf life or weight.
2. **Biological adulteration** – Food contaminated with microorganisms, insect parts, or animal waste.
3. **Intentional adulteration** – Mixing chalk powder in flour, water in milk, or washing powder in pulses to increase profit margins.
4. **Accidental adulteration** – Pesticide residues, packaging contaminants, or heavy metals entering food unknowingly.
5. **Dilution/substitution:** Replacing high-value ingredients (olive oil, honey, milk) with cheaper alternatives (vegetable oils, sugar syrups, starch).
6. **Addition of inferior substances:** Adding water, starch, flour or cheap fillers to increase weight/volume.
7. **Contaminant adulteration:** Presence of pesticides, heavy metals (lead, arsenic, cadmium, mercury), persistent organic pollutants, or microbial toxins.
8. **Intentional toxic adulterants:** Non-food substances added maliciously or negligently — e.g., industrial dyes (Sudan dyes), melamine to boost apparent protein content, or illegal preservatives.
9. **Mislabeling/undeclared additives:** Allergens or drug residues (antibiotics, hormones) not declared on labels.
10. **Adulteration for appearance/processing:** Bleaching agents, whitening powders (in spices), unlawful colourants. [3,4]

CLINICAL SYMPTOMS

- **Acute toxicity:** Gastroenteritis, vomiting, neurological signs (depending on agent), acute heavy-metal poisoning.
- **Chronic effects:** Neurodevelopmental impairment (lead, mercury), renal dysfunction (cadmium), carcinogenesis (certain dyes and nitrosamines), endocrine disruption (plasticizers, hormonal residues).
- **Allergic and immunologic reactions:** Undeclared allergens

and antibiotic residues can provoke severe reactions.

- **Antimicrobial resistance risk:** Exposure to low levels of antibiotics in food can select for resistant organisms, with clinical implications.
- **Vulnerable populations:** Children, pregnant women, the elderly and immunocompromised patients are at higher risk of both acute and long-term effects. [1,2,5]
- **Silent damage**: Continuous low-dose exposure weakens immunity, impairs child growth, and burdens the healthcare system.

Clinical implication: Obtain a targeted food history for unexplained symptoms, consider heavy-metal testing, and notify public-health authorities when multiple cases with similar exposures occur. For doctors, every unexplained case of persistent gastrointestinal distress or metabolic dysfunction could have roots in adulterated food.

DETECTION: FROM KITCHEN TESTS TO RESEARCH LABS

- **Simple household tests**:

  - Water float test for rice,
  - Iodine test for starch in milk,
  - Blotting paper test for oils.

- **Advanced scientific methods**:

  Gas chromatography, mass spectrometry, DNA barcoding, biosensors, and nanotechnology-based kits that provide precise and rapid detection.
  The shift from kitchen wisdom to molecular research shows how science empowers food safety.

Laboratory detection spans rapid screening to confirmatory instrumentation. For research projects and clinical surveillance, combine field-feasible tests with centralized laboratory confirmation.

- **Rapid field tests:** Test strips for certain pesticides, pH and refractometry for milk adulteration, handheld allergen lateral-flow assays. Useful for screening and outbreak triage.
- **Immunoassays (ELISA):** Sensitive for specific toxins (mycotoxins, some antibiotics); good for moderate throughput.
- **Chromatography techniques:**
  - **HPLC / UHPLC** for pesticides, mycotoxins, food dyes, and certain veterinary residues.

- **GC-MS (gas chromatography–mass spectrometry)** for volatile contaminants and many organic pollutants. [3,6,7]

- **Mass spectrometry (LC-MS/MS):** It is highly sensitive and specific confirmatory or quantitative technique widely use for multi-residue screening (pesticides, veterinary drugs) with high sensitivity and specificity. [3,6,7]
- **Atomic absorption spectroscopy (AAS) / ICP-MS:** For quantitative heavy-metal analysis; ICP-MS offers multi-element detection at trace levels. [3,6,7]
- **DNA barcoding / PCR:** For species authentication (fish substitution, meat fraud). [3,6,7]
- **Stable isotope analysis / NMR / FTIR:** For origin verification and detection of sophisticated adulteration (e.g., adulterated honey, olive oil authentication).
- **Microbiological culture and PCR:** For pathogen detection in outbreaks.

Study design note: choose methods balancing sensitivity, cost, throughput and available expertise. For resource-limited settings, combine inexpensive screening with targeted confirmatory testing.

DISCUSSION

If food is the "medicine of life," then adulteration is the slow poison that corrupts this medicine. [8] Every grain of rice, every drop of milk is a story—either of health or of harm. It depends on how vigilant we remain as a society.

CONCLUSION

Food adulteration is not just a problem of commerce—it is a health emergency. For students, it is a field to research, innovate, and reform. For doctors, it is a reminder to trace the disease back to the dining table. Together, awareness, science, and responsibility can ensure that our food remains what it was always meant to be: nourishment, not poison.

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