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Be Cautious of Counterfeit Flavours: Delving Into The Realm of Food Adulteration

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Abstract: *Food Adulteration is the act of adding adulterants to food or contaminating food ingredients with chemicals. Adulteration is the illicit act of incorporating inferior or less expensive components into high-quality items to boost the overall quantity. Consuming this contaminated food is extremely harmful and can result in various health problems, such as specific nutrient deficiencies, kidney troubles, and the malfunction of vital organ systems including the heart, kidneys, and liver. This article aimed to address the impact of food adulteration and discuss safety measures.*

Keywords: *Food adulteration, artificial ripening agents, Preservatives, Fraud mislabelling, health affects.*

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I. Introduction:

An adulterant is the result of adulteration, which is the clandestine mixing of a substance with another. Various substances, such as food, cosmetics, medications, gasoline, and other chemicals, are commonly contaminated, which can jeopardize their safety or efficacy. It is unlikely to be found in specifications or declared ingredients as a result of accidents or negligence, rather than intentional actions, and also owing to the introduction of undesired compounds after the product's production. Adulteration suggests that the adulterant was intentionally added during the manufacturing process or was in the raw materials but not properly removed. An adulterant is different from authorized food preservatives. There is a subtle distinction between adulterant and additive. Chicory can be added to coffee to save costs or enhance flavor. This practice is considered adulteration if not disclosed, although it can be mentioned on the product label. Chalk is commonly used with bread flour to lower expenses and enhance whiteness. The calcium in chalk has health advantages, thus a small amount may be added to modern bread as a supplement. During wartime, adulterants are added to food to increase its quantity and avert shortages. The German term "ersatz" is well-known for such actions during World War II. Adulteration was occasionally concealed from the public to avoid diminishing morale and for propaganda purposes. Luxury items like coffee in the Soviet Bloc were often diluted to be more accessible to the mass people.[2]

Discussion

History

During wartime, adulterants are added to food to increase quantity and avert shortages. The German term "ersatz" is well known for such activities during World War II. Adulteration was occasionally concealed from the public to avoid demoralization and for propaganda purposes. Luxury items like coffee in the Soviet Block were often diluted to be more accessible to the common people. Historically, the practice of using adulterants has been prevalent, with potentially hazardous compounds being employed at times. During the Victorian era in the United Kingdom, adulterants were frequently used, such as lead being used to color cheeses. Adulteration problems were also observed in American industry during the 19th century. There is a debate on whether these activities decreased mainly because of government regulation or due to heightened public awareness and concern. During the early 21st century, instances of hazardous adulteration took place in the People's Republic of China. In many African nations, robbers frequently vandalize power transformers to steal transformer oil, which is later sold to roadside food vendors for deep frying purposes. Transformer oil has a longer lifespan than conventional cooking oil when used for frying. The improper usage of transformer oil poses a risk to consumers' health because it contains PCBs. Adulterant use was initially examined in 1820 by the German chemist Frederick Accum, who discovered numerous poisonous metal colorings in food and beverages. His work angered food suppliers, and he was eventually discredited due to a scandal involving his supposed defacement of books in the Royal Institution library. Physician Arthur Hill Hassall conducted thorough research in the early 1850s, reported in The Lancet, which resulted in the 1860 Food Adulteration Act and subsequent

laws.[6] John Postgate spearheaded an additional campaign that resulted in the passing of another Act in 1875. This Act laid the foundation for contemporary legislation and established a group of public analysts responsible for detecting adulteration.[7]

Overview of Food Adulteration

Food adulteration aims to modify the quality of food items for financial gain. These acts typically involve replacing higher quality or more valuable food with lower quality alternatives and increasing the weight or volume by adding undisclosed additives. This includes enhancing appearance through the insertion of synthetic chemicals and colorants [8,9]. The main purpose of food replacement is to save costs by using cheaper ingredients. Food items undergo many modifications that alter their physical qualities and taste. Artificially ripening fruits is a prevalent kind of food adulteration. Food adulteration procedures commonly include the addition of preservatives, colorants, and artificial sweeteners. Falsification of origin is considered an adulteration, which involves making false claims about the product's superior origin. Outlines the primary types of deliberate food adulteration, which will be briefly addressed in the subsequent sections [10-12].

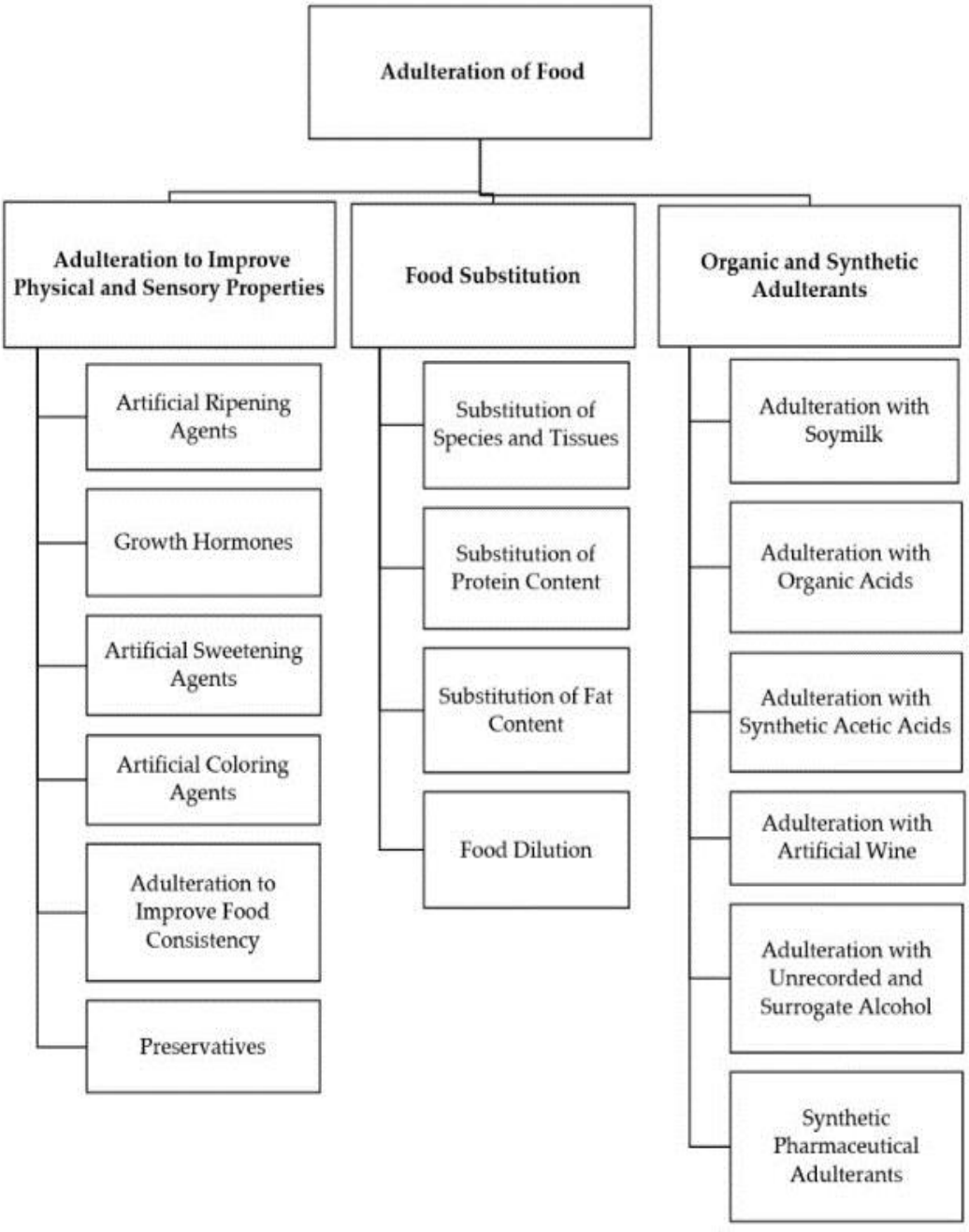


Fig 1. Flow chart indicating types of food adulteration

Adulteration to improve physical and chemical sensory properties

The taste and look significantly influence the commercial value of food goods. Prolonging the shelf life of food goods is financially advantageous. Artificial ripening and sweetening are employed to enhance the taste of food. Artificial colorants are used to enhance the visual appeal of food. Preservatives are added to food to maintain its freshness for an extended period. The upcoming sections will briefly outline several methods of adulteration used to enhance physical and sensory characteristics.

(a)Artificial ripening agents:

To prevent economic losses from rotting of climacteric fruits during harvesting, processing, and shipping, fruit marketers pick the fruits early and artificially ripen them with chemicals immediately before selling. Artificial ripening is necessary when fruit sellers want to sell fruits before their natural season to increase profits. Various chemicals such as ethylene, ethanol, methanol, propylene, methyl jasmonate, ethylene glycol, ethephon, and calcium carbide are utilized for the artificial ripening of fruits and vegetables [13-19].

(b)Growth Hormones:

Farmers employ gibberellic acid, alpha naphthyl acetic acid, and oxytocin as growth hormones to stimulate the growth of fruits and vegetables. Oxytocin, a mammalian hormone and veterinary medication, is not appropriate for use on vegetable crops. It is commonly utilized to improve the size and color of bottle gourds, bitter gourds, pumpkins, and cucumbers. [17]

(c) Artificial repening agents:

Various natural colors including chlorophyll, annatto, and caramel have been frequently observed in fruits and vegetables. Synthetic dyes are preferred by vendors over natural dyes due to their superiority in various aspects. These are chemically produced, more durable, glossy, and very effective. Their affordability and widespread availability are significant issues as well. Rhodamine B, auramine, Metanil yellow, Congo red, Orange II, malachite green, and several authorized and unauthorized colors are utilized in fresh fruits and vegetables. Watermelons are infused with red color to make them more appealing to consumers. Malachite green is commonly utilized to enhance the green color of vegetables including green chile, green peas, bitter gourds, lady finger, and pointed gourds, making them appear fresher, brighter, and more vibrant. Bitter gourd and lady finger are often immersed in a copper sulfate solution, which appears vivid blue when hydrous and pale green when anhydrous. Brinjals, tomatoes, cauliflowers, and cabbages are injected with mobile oil for coloring and carbofuran to give them a fresh purple appearance. Phosphomidone, methyl parathion, monocrotophos, and formaldehyde are injected to achieve a fresh white look [17]. Azodyes are used to artificially color eggs. Traders are motivated to add unlawful synthetic dyes to eggs because consumers use the color of the egg yolk to assess its nutritional content and freshness. Sudan dyes are synthetic azo dyes utilized in industry and printing. Para red, another azo dye, shares chemical similarities with Sudan dye I and is employed for printing. Consumers prefer eggs with a yellow-orange hue. Sellers frequently feed hens food containing dyes to intensify the color of egg yolks.[20]

(d)Preservatives:

Preservatives are commonly included to extend the longevity of food products. Adding preservatives is a common form of adulteration currently. Fruits, vegetables, fish, shellfish, meat, processed meat, milk, dairy goods, and beverages are the most appealing items for theft.Formaldehyde is the most commonly utilized preservative in fruits and vegetables. Formalin hinders microbial development by reacting with the amino groups of adenine, cytosine, and guanine and causing them to denature. It can enter bacterial spores, avoiding microbial contamination and extending the shelf life of food. The World Health Organization (WHO) estimated the daily consumption of formaldehyde from food for an average adult to be in the range of 1.5–14 mg/d, with a mean of 7.75 mg/d. There is no established standard for this intake. The European Food Safety Authority (EFSA) recommends a maximum daily oral exposure to formaldehyde of 100 mg per day[21].

5. Food Substitution:

Substitution is a varied method of deliberate food adulteration involving the direct modification of a portion or entirety of a food item, or the external inclusion of lower-quality food products or counterfeit nutritional substances. Various types of food substitution are addressed in the next section.

(a) Substitution of spices and tissue:

Inter-species substitution in meat products involves replacing one type of meat with another that has a similar color, making it challenging to visually differentiate between them when frozen or processed into a different form. Sausage is a popular processed meat product enjoyed globally, typically prepared from intestines or produced synthetically. Fraudulent species substitution is common in dishes made from beef, chicken, or pork

[22]. Replacement in dairy items: Dairy goods are often made from milk sourced from cows, sheep, goats, and buffaloes. Cow milk is commonly consumed worldwide, although some people avoid it owing to allergies, religious beliefs, ethical concerns, cultural reasons, personal choice, or intolerance to particular foods. Substituting costly milk with cow milk fraudulently is widespread. She-donkey milk, which is highly valuable in the market, is frequently replaced with cow or goat milk. Individuals with allergies to cow's milk like goat's milk for its digestibility and low lactose levels. Another kind of misconduct involves misrepresenting cow's milk as goat's milk [23]. Cheese products like feta, manchego, and pecorino are made from a blend of sheep and goat milk or just sheep milk. Seasonal production and higher prices of ovine and caprine milk render these cheese items susceptible to being replaced by cheaper bovine milk. Cheese items labeled as "pure buffalo mozzarella" frequently contain cow milk. Cheese products made from a single species and with protected designation of origin are seldom verified as legitimate and require periodic monitoring [24].

(b) Substitution in protein content:

Meat products often have animal proteins like egg, gluten, and porcine gelatin added to them to boost their protein level. Soybean proteins and grain flours are utilized in sausages to restore specific meat-like characteristics, including emulsifying capability, emulsion stability, and water-binding capacity. Plasma protein is a diverse combination of serum albumin, globulins, and fibrinogen that may create and support foams and emulsions, as well as form gels when exposed to heat. The food sector uses it to regulate the texture and specific structure of processed meat products [25]. Protein replacement in milk: Milk protein is a precursor of several bioactive peptides with antibacterial properties and is a rich source of calcium, zinc, copper, and phosphate ions. It also aids in the absorption of other nutrients. Compounds rich in nitrogen can imitate a high concentration of protein. Non-protein nitrogen cannot be differentiated by Kjeldhal and Dumas methods, which are typically used to measure total protein content. Therefore, the practice of adding different nitrogenous substances to dairy products to artificially raise the perceived protein level is common. Melamine, urea, and whey are the most frequently mentioned substances in this scenario [26]. Protein replacement in basic dietary items: Basic foods experience different forms of substitution that include quality differentiation. One prominent example of replacement involves adding gluten-containing cereals to gluten-free products. Gluten triggers allergic reactions in many people, leading to the increased popularity of gluten-free meals. Many traders breach the legislation requiring the declaration of allergenic ingredients by fraudulently adding gluten-containing grains to gluten-free diets.

c) Food dilution : Food dilution involves adding a less expensive component to a premium food product without disclosure. Dilution and excessive dilution are common forms of adulteration. Both solid and liquid food items can be diluted with water or other liquids. This phenomena is typically verified using refractometric Brix determination or density measurements. Liquid milk adulteration is the most prevalent kind [29]. It impacts the density, refractive index of whey, and freezing point of tampered milk products.Honey and other sweeteners are frequently mixed with water, leading to a quicker deterioration of honey during storage. Thus, diluted honey lacks the appropriate consistency and nutritional value. Meat products are likewise susceptible to such behavior. Chopped lean meat has a high water-binding capacity, allowing it to absorb a significant amount of water, which is said to provide the required consistency for stuffing into thin casings. It was commonly found in frankfurters, bologna, and pork sausages [32].

6. Organic and Synthetic Adulterants:

(a)Adulteration with Organic acids:

Malic acid and other organic acids are included in apple juice concentrate to enhance its market worth. Illegitimate inclusion of organic acids like citric and tartaric acid can enhance the sensory characteristics and market worth of specific fruit juices due to increased acidity. Amino acids like glycine and glutamic acid, as well as protein hydrolysates, are included in food products to increase the overall amino acid levels. A blend of tastes, organic acids, and sugars is frequently included as a chemical mixture in fruit extract [33].

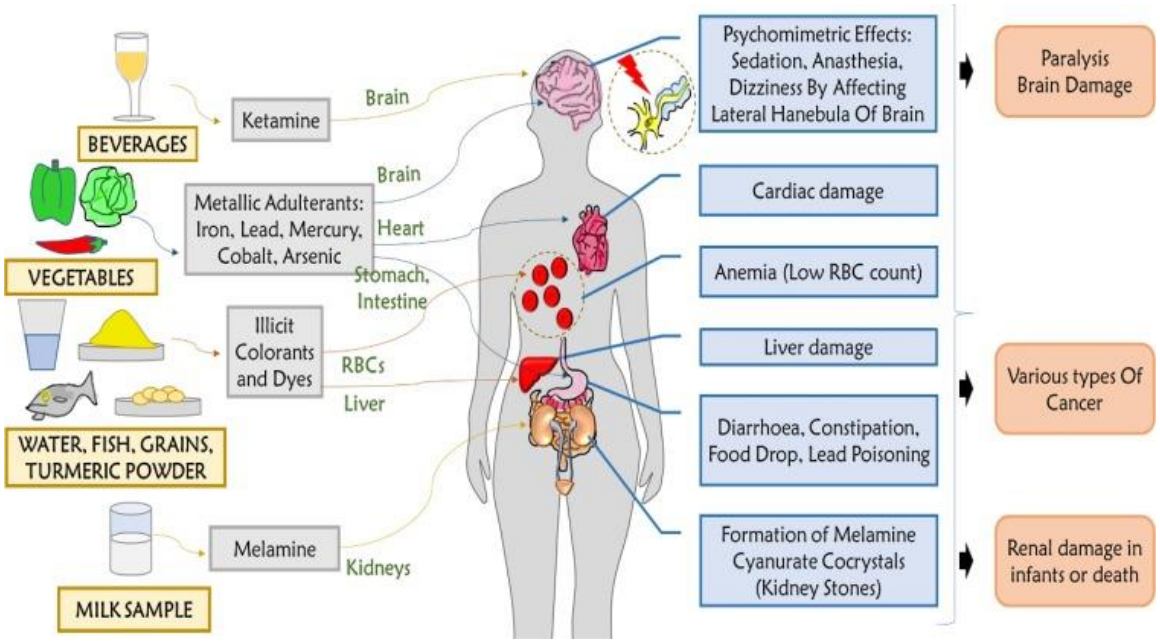
(b) Adulteration with Artificial Wine :

Adulterated wines known as artificial wine contain components that mimic the taste of grape wine. The common components of artificial wine include water, yeast, sugar, potassium tartrate, crystalline tartaric and citric acids, tannin, glycerol, ethanol, and ethyl esters of high fatty acids. Glycerol, diethylene glycol, citric acid, propylene glycol, sorbic acid, benzoic acid, rectified alcohols, non-grape components, and natural and synthetic flavor compounds are combined to enhance wine.[34]

(c) Synthetic Pharmaceutical Adulterants:
The inclusion of artificial pharmacological components in dietary supplements is currently a significant problem. Dietary supplements are deceptively blended with pharmaceutical ingredients to enhance their intended effects on the human body.Approved pharmaceutical medications and their equivalents, which can be challenging to identify, have been discovered in food supplements marketed as treatments for illnesses [35].

7. Faud and Mislabeling:
Consumers are highly concerned about the quality and origin of food products, as items cultivated in specific places and certain species hold greater economic value because of their exceptional quality. Geographical origins' environmental contamination is another significant aspect in this context. Traders frequently substitute and intentionally mislabel food items from superior batches, species, and cultures with lower grade ones to increase their profits. This misconduct infringes on customers' rights, diminishes the advantages of local growers, and fosters unfair commercial rivalry.[37,38]

8. Health Impact:
Abundant historical data exists regarding the health risks associated with food adulteration. Some food adulterants do not contribute to health deterioration. These factors only impact the nutritional value and diminish the quality of the food. Substituting one species of coffee for another in coffee products is one example of species substitution. Additional contaminants can cause mild to severe sickness. The financial costs related to hospitalization and medicines are significant. Consuming fruits contaminated with ripening chemicals has been shown to be carcinogenic to the human body.[25]



II. Conclusion

Food adulteration is a significant worldwide issue because of its effects on health and the economy. Food goods have long been adorned with synthetic colorants to appeal to consumers. Food dealers often use many preservatives to maintain the exterior freshness of products. Intentionally replacing premium meals with lower-quality food goods is a common problem. Manipulating nutritional factors by deceptive substitution has also proved significant. Food is intricately linked to health, and any modification to its natural composition should be forbidden. Analyze the opportunities for food contamination. Inadequate regulation and its lax enforcement are primary factors contributing to the escalating food adulteration problem. Despite global efforts by food officials to address food adulteration, there are still certain restrictions. Adulterated food is typically only recognized once it poses a health risk. Moreover, numerous developing nations continue to fall behind in terms of food adulteration analysis methods. Effective law enforcement and routine food quality inspections can lead to significant improvements. In contemporary times, the valuable contributions of scientists and researchers to the development of tools for detecting and quantifying food adulteration are commendable. It is essential to maintain current documentation of the rising fraudulent concepts and activities related to food in order to address food crimes effectively. Various types of food adulteration and their corresponding health effects should

be thoroughly documented and examined. Given the harmful health effects, ensuring food safety and quality is a pressing requirement. The regulation of food quality should be a top priority given the potential growth of the global food market. Food adulteration is a complex issue that cannot be solely addressed by politicians and enforcers. Food manufacturers, merchants, and customers should collaborate to ensure the safety of their country.

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