ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

A Review of Food Adulteration and Its Impact on Human Health

Received: 26 October 2022, **Revised:** 23 November 2022, **Accepted:** 27 December 2022

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Keyword

Food, Nutrition, Food Adulteration, Human Health, Food Quality

Abstract

Food the very essential source for life is a necessity to every living entity which plays a crucial role in health. It can be consumed in any form for nutrition by the humans and animals. Food adulteration has been a great concern since the start of civilization. It refers to any substance addition in food by any means which can alter the safety and quality of the food and will lead to risks in human health. Adulteration is a legal term which is used to state that the food which is adulterated does not pass the legal standards. Food adulteration can be spontaneously, accidental or deliberately and it can be performed to exceed the quantity of raw and prepared product, which ultimately altered the food quality. This review compiles the types of adulteration made in different types of food, its effects on human health, and detection using different kinds of methods and how to limit the adulteration.

1. Introduction

Food is essential for survival. It provides energy for the day to day routine. Demand for food is continually increasing due to the high population. Highly populated countries like India and China are continuously producing processed food to overcome the food crisis. Over the past fifty years, there has been a strong focus on food quality and safety [1]. Nowadays, food industries are using advanced techniques such as automation of machinery to reduce contamination. High demand for food causes a food crisis which ultimately leads to food adulteration. Adultery is the intended or unintended way of replacement or mixing of some inferior foreign particles in the food [2].

The Indian organization named Food Safety and Standards Act of India abbreviated as FSSAI defines "adultery" as "any substance used or potential to make food harmful, substandard, improperly labeled, or with external content. The Food and Drug Administration administers the Federal Food, Drug, and Cosmetic Act. Under this law, food is considered hybrid if a) Hazardous

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
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substances are added to food, b) Cheap or low quality food is added to food, c) Any useful substance is taken from the original food product, d) Food quality is below demand and e) Any item added to improve mass or weight [3]. However, some foods are naturally toxic, and using high doses of these can cause major diseases. *Lathyrus sativus* (Grass Pea) contains a neurotoxin called N-oxalyl-amino-L-alanine (NOAA). Its excessive consumption causes lathyrism which is a disabling condition. Another example is the many harmful mushroom species, such as the toxic fungus Amanita, which can cause liver and kidney damage [4].

In September 1998, the Canadian government addressed its citizens that food from India should not be consumed as it contained argemone. Hundreds of people were either dead or maimed in northern parts of India following the mixing of mustard oil with argemone oil by some unscrupulous traders [5]. Food contamination or adultery occurs for a variety of reasons such as financial gain. As a result, the consumer is deceived or becomes a victim of illness. Such adultery is common in lands with limited resources. Consumers should understand the most common forms of adultery and its effects on life. The market consists of a large number of food producers, and food is imported in large quantities, allowing the producers to mislead and deceive consumers. Some manufacturers use legal restrictions while others commit adultery, and distinguishing between the two can be difficult [6].

Eating adultery not only undermines our social values but also our morals. Consumer education is important in preventing food adulteration. Ignorance and poor market behavior can damage the health of consumers, and deception can lead to poisoning. Food adultery is a deceptive practice when food consumers are misled into making financial gain [7]. It has been a major source of concern for the health risks, as well as declining food or nutritional content. The food scam has angered the food industry and has attracted public attention since the last century. It seems that existing food safety measures cannot address this problem. As a result, new and modern quality management systems must be created that can be used by the general public or less experienced staff in the field. Methods and equipment should be easy to use and affordable in order to assess food quality and achieve the intended goal [3].

1.1 Why Food Adulteration?

The major motivation for adulteration is to increase its financial flow by increasing its volume. Although some selfish manufacturers, processors, and merchants launched adulteration in order to increase their profit margins, the major cause of adulteration is the absence of quality methods of evaluation of questionable items and dishonesty [8]. Contamination of food generally happens to fulfill the demands and feed the world population that continues to grow at an alarming rate. Outsourcing to overseas producers is another reason for counterfeiting and adulteration of goods and services [9,13].

Outsourcing became feasible due to cheap labor in few countries, which results in increased incidents of producing fake products since the production cost is less than the abnormally high profits earned [10]. Adulteration has been in society for a very long time, but it left unnoticed because of its minimal influence and financial gain. However, in the modern era, adulteration is a

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ISSN: 2309-6152 (Online)
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longterm issue that has to handle on priority basis as it adversely affect human health [11].

2. Types of Adulteration

2.1 Deliberate adultery

Intentional adultery is a form of adultery where food is deliberately spoiled. It is an addition of low-quality ingredients that are comparable to those of foods presented in it. As a result, it is difficult to see them [4]. Adultery can be physical or organic. The motive is to boost the quality of essential ingredients even after reducing the amount given and still earn huge margins of profit by using several chemicals such as melamine, urea, etc. The volume can be increased too by using substances such as chicory, ground papaya seeds, roasted barley powder, skim milk, vegetables, flour, chalk powder, starch, sugar cane, oil, sand, molasses, stone, brick powder, ergot, water, etc. in many foods [11, 12].

This method of adulteration is really harmful because of the amount of nutrients that gets depleted and foreign chemicals that are added in food products by business-oriented people who forget their personality behind their idea of making money [5]. The first US based public website designed to compile information on the dangers of food fraud published in the Journal of Food Science analyzed that apple juice, coffee, orange juice, saffron, honey, milk and olive oil are seven possible alternatives [13].

Intentional adultery is the deliberate introduction of low-quality items that are simmiler or mimic the food in which they mixed. As a result, it is difficult to see them. Instances of intentional adultery can be the addition of liquid milk, the addition of a powdered substance, among others [6]. Bananas and mangoes can be deliberately adulterated by the use of calcium carbide, rapid ripening of fruits by copper sulfate, rapid growth of cucumber, watermelon, pumpkin by hormone called oxytocin, addition of light to apples and pears by addition of glue, imparting new color to leafy vegetables and spicy beverages by the use of low cost green colors that contains chemicals such as iron lead. These are all examples of deliberate adulteration. Pesticides are also overused in the growth of fruits and vegetables and can also be considered adult if not otherwise [14]. Some adulterations are shown in table 1.

2.2 Accidental Adultery

The negligence to meet the standard of food products on account of resources is termed accidental adultery. The possible cause can be leaks from fertilizers and pesticides. These adultery practices may also occur due to improper handling of food and packaging procedures. As the name implies, spontaneous eating adultery occurs accidentally (spontaneously) and due to insufficient information [15]. The researchers suggest food shortages are due to the high levels of pollution and heavy metals in industrial areas which are absorbed by plants. Collected leaves are sold at a lower price in the market. Remnants of pesticides, rodent droppings, and worms in food are illustrations of accidental adultery [16].

Absence of good hygiene from manufacturing procedures to dining areas causes such adultery. Manufacturers and retailers may not include flavors themselves, yet the methods they use to manufacture, maneuver, relocate, stock, send, and advertise the product can be the site where they get contaminated and spoiled [17]. the original in the product is outside the product. These include preservatives, pesticide residues, mercury

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from water, tin cans, rat droppings, lead from water, and other pollutants [18, 19]. 3ppm is the maximum allowable value of D.D.T. which is often overlooked [16].

The Prevention of Food Adulteration Rules, 1955 (currently under FSS law) in India identified plant contamination to be other unintentional adultery in the food production (including crop farming, veterinary medicine and animal husbandry), production, preparing, treating, packing, transporting and handling those foods for natural reasons. These may be for a variety of detected species, such as foodborne or fungal contamination, rodent food, dust and stone infestation, toxic wastes from packaging materials [20, 21].

2.3 Metal Materials

Eatables can have small amounts of iron pollutants which enter the food chain supply during production and through pollution [22]. Metal pollutants such as arsenic from pesticides lead to water and disposal in chemical companies, and cans from cans are examples of the dangers of adultery. Mercury from contaminated water leads to water, with some toxicity compared to other examples of metal contamination [17]. Mercury, arsenic, cadmium and lead are less harmful as absorption is long-term. These can cause organ damage if they build up in the body [23].

2. 4 Natural Adultery

There are many radicals, organic compounds, chemicals found that are present naturally in food products. These are sometimes harmful to health and are not introduced intentionally or indirectly into the diet. Such adultery is referred to as natural adultery [21, 24].

3. Health Risks Associated with Adulteration

Eating adultery causes many disorders varying from moderate to even deadly scenarios such as skin diseases, liver problems, eye problems, and various abdomen ailments like diarrhea. Asthma, skin problems, and cancer are all common side effects of eating fish, fruit, meat, or milk contaminated with substances such as formalin. A person's health is at great risk for food spoilage, which can cause side effects such as diarrhea, vomiting and diarrhea. An instance of this is diarrhea that is caused when coffee powder is replaced by tamarind or date powder [17, 25].

Abdominal pains and vomiting may be caused by adultery in utensils filled with cream, baking supplies, and dairy products. Canned meat and poor milk can bring about intestinal discomfort, food poisoning, and different foodborne illnesses, often accompanied by heat and cold. In addition to the symptoms, unhealthy foods can have several long-term side effects. These effects such as liver diseases, peptic ulcers, colon such as liver disease and cirrhosis, blood disorders, failure of bone marrow, kidney damage and heart disease were detected due to contagious substances such as dye dye, calcium carbide, urea, oil of a burnt engine, even the maximum number of preservatives allowed. Because of concerns about adultery, the food products we use in our daily lives are unhealthy and unsafe to use [4, 26].

Food insecurity has been a major concern in recent decades, and the introduction of contaminated food causes serious illnesses such as cancer, diarrhea, asthma, and ulcers [27]. It has been found that vegetables and fruits contain dyes and chemicals that are harmful to human health. To speed up fruit

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ripening, chemicals are used often. In bananas and mangoes, calcium carbide is used, copper sulphate is used to speed up fruit ripening, and to accelerate the growth of watermelon, pumpkin, cucumber gourds and brinjal, a hormone called oxytocin is used [18]. Pears and apples shine due to the presence of wax. To provide a new color for spicy beverages and leafy vegetables, cheap green dyes with chemicals such as lead are added. Pesticides and herbicides are widely used during the farming of vegetables and fruits as they improve the yield. But these inorganically farmed fruits and vegetables are harmful to the human as they directly affect the several organs such as digestive system, liver and eyes in some cases [28]. Highly contaminated food by oxytocin linked to brain death [29].

In 1988, 600 people in Kolkata (West Bengal) consumed rapeseed oil that was adulterated by tricresyl phosphate that is obtained usually from hydraulic fluid and varnish paralyzed their hands [28, 30]. Dropsy was produced by mustard oil and Mexican prickly poppy / argemone oil (*Argemone mexicana*) in Lucknow (Uttar Pradesh) in 2002 and 2005, Gwalior (Madhya Pradesh) in 2000, Kannauj and in Delhi in 1998 respectively. Many clinical signs were identified, and people with severe cases even died as a result of heart failure and respiratory failure [31].

A bacteriological profile of street food in Mangalore was also developed, and the results were consistent [15, 32] and eating disorders cause many health problems in humans [22, 31]. A few health risks include abdominal discomfort, body aches, anemia, paralysis, abnormalities of the skin, increased cancer spread, pathological lesions in vital organs and eye [2, 8]. As a result, food spoilage should be taken very seriously because of its impact on public health. People suffer from kidney failure, heart disease, asthma, other chronic diseases and skin problems. Individuals are unfortunate victims of the rampant and uncontrollable adultery trade [33].

4. Detection of Adulteration

Physical, chemical, biological, and other methods are used to determine the presence of predators in food. All of these mechanisms, which have largely replaced the original organoleptic and other symbolic experiments, are constantly being revised as food addiction intensifies and new problems arise [34]. In many cases of adultery, a variety of analytical techniques are used, which gives the analyst the best choice. Red wine that is contaminated by bilberry or elderberry juice produces a light blue liquid containing lead acetate [19, 35].

4.1 Chemical and Biochemical Methods

Obscure objects can be easily located through various biological and chemical methods such as immunology-based, spectroscopy, electrophoresis-based and chromatography-based [8, 36]. HPLC (High-performance liquid chromatography) can be used as a quality control tool as it can differentiate many chemical ingredients and blends; it is also used to identify food items and to identify adultery [37]. That is, its ability to distinguish chemical compounds makes it useful in the detection of adultery. For example, HPLC is a widely accepted analytical technology for adulterous diagnostics, and chemical determination of the device. There are other methods used in diagnosis of adulterous compounds like gas chromatography, mass spectroscopy and Fourier transform infrared spectroscopy (FTIR) [38]. These methods distinguish different types of the same product for

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ISSN: 2309-6152 (Online)
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detection of adulterous compounds and they can even prove the authenticity of different chemical compounds. Near-infrared spectroscopy (NIRS) is one of the spectroscopic methods that can detect predators in immature objects but can detect contamination [39].

4.2 Physical Method

Various physiological mechanisms for detecting adultery have been developed, including the analysis of microscopic and macroscopic physical structure and dietary analysis that examine body variables such as texture, morphology, bulk density, melting, etc., yet quantitative adultery is not guaranteed in these methods [40]. For instance, a small study of various spices, such as cumin, coriander, peppers, and cloves, revealed the presence of starch outside these powdered spices (FSSAI, 2010). Adultery and various contaminants (insects, debris grain, weed seeds, spoiled grain, stones, dust, grass, rats' fur and feces, etc.) grains can be detected by taking a small sample from a glass plate and inspecting it by sight dirt because pure grain will not have such filth [41].

4.3 Sensory Method

Neurological techniques have been used to identify specific adultery. Neurological processes, on the other hand, should not be included in the rules for detecting food addiction, despite the fact that routine sample analysis usually involves the study of its organoleptic properties. International organizations including the International Standards Organization (ISO), the American Society for Testing Materials (ASTM), Food Safety and Standards Authority of India (FSSAI) and others have developed and approved generalized food sensory systems and products [42].

Such strategies are useful for trade (e.g., asset valuation) and resource management. In addition, the findings of the product performance is accepted by US Food and Drug Administration (FDA) as evidence. In certain cases, adjudication settlement in the United States rely solely on sensory testing data. The limitations of using sensory methods to identify adultery are subjugation and, although there are few drawbacks, the use of multivariate mathematical methods [43].

Sensory data is best analyzed using these processes, and strong conclusions can be drawn. The Generalized Procrustes method, for example, may be used to evaluate the results of Free-choice Profile profiles. The latter recounts many types of heterogeneity in the way each panel list defines samples before combining words that appear to measure similar characteristics. The same method has been used to organize alcoholic beverages, tea and coffee into categories [44].

5. Limiting Adulteration

Mixing can be avoided when buying food, using simple methods at home, and by conveying to the respective supervisors. The quality of food products should be checked prior to purchasing and only food which contain detail of parameters should be preferred. Colored grains, beans, sweets, spices, junk food, dirty milk, or oil should be avoided. Less ripe but less ripe fruit should be purchased to stimulate ripeness [45]. Spices, sauces and whole grains (pulses and cereals) could be separated by hand and blended at home. Otherwise, the grain may be filtered and external impurities such as sand, gravel, or particles of impurities can be easily removed. In fact, this is an ancient home culture practiced by rural Indians. In the fruit,

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ISSN: 2309-6152 (Online)
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peeling can remove a layer of wax, which is a house of several harmful microbes. Fumonisin-B1 toxin produced by *Fusarium moniliforme* or *Fusarium verticilliodes* in moldy grains can adversely affect human health. Boiling grass peel seeds and washing them with clean water results in removing 90% toxins (BOAA, Beta-noxalyl amino alanine) [46].

Nuts and food grains must be stored in a dry, cool and clean place after drying them post harvesting to prevent the growth of mold. The characters that are blocked during storage can also be dried. Without this precaution, if mold is detected, never scrub and eat leftover grains. Grain washing four times with gentle rubbing and dehydration after each bath, followed by warming, will remove more than 95 percent of the remnants of malathion, methyl parathion, fenvalerate, cypermethrin, or chlorpyriphos [47].

Consumers should buy canned food only after checking the expiration date, and should never buy expired food, ice, or juice in the open, often contaminated market. Before pouring juice or stirring food, hot water and soap should be used to clean the containers. In the event of uncertainty, extracts from plants can effectively reduce coliform bacterial infection in fruits and vegetables [48].

Chemical impurities in excess can be removed from vegetables and fruits by thoroughly washing and peeling. Fruits and vegetables with more fat should be less preferred as pesticide residues can be placed or absorbed in their fragrant layers [49]. Fruits and vegetables should be washed for 10 minutes in 2 percent salt solution after which they should be rinsed with cold water at least 2-3 times to remove toxins. Cooked foods are safer than raw foods because due to cooking methods, the amount of pollutants decreases and also helps in breaking and eliminating toxins from the body [50].

6. Conclusion

Eating adultery can have a huge impact on our health beyond our control. It can be avoided if our community takes a number of safety measures. The government must monitor food price increases. Consumers should avoid buying food in areas that do not meet adequate hygiene standards. Government agencies should inspect local and reputable grocery stores. These reforms and measures can only ensure the health of future generations if we engage ourselves in making these measures a success.

7. Authors' Contributions

All authors were contributed in preparing initial concept and designing, gathering of data, analysis and interpretation of gathered data. After critically reviewing, all authors agreed to submit the manuscript to this journal.

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CODEN: JCLMC4
Journal of Coastal Life Medicine

TABLE: 1 Various food products and adulterants used to alter the food quality

Food & drink products	Objectives	Adulterants	References
Black pepper	Adding bulk	Papaya seed	[3]
Chillie powder	Increasing weight	Stones	[5]
Coffee	Adding bulk and color	Chicory, roasted barley powder, tamarind seed	[24]
Common salt	Increasing weight	White powdered stone, chalk	[17]
Ghee	Making it more yellow	Vanaspati, oleomargarine	[24]
Green chillies and peas	Bringing green color	Malachite green	[5]
Honey	Increasing taste and amount	Molasses, cane sugar	[24]
Milk	Increasing volume	Water, skim milk	[3]
Condensed milk	Giving rich texture	Paneer, khoya	[5]
Red wine	Adding texture	Biberry juice	[24]
Sugar	Increasing amount	Chalk powder	[17]
Tea leaves	Adding color	Black/Bengal gram dal husk	[5]