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Dreadful practices of adulteration in food items and their worrisome consequences for public health: a review

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ABSTRACT

Even though food has many health advantages, people nowadays struggle with several health problems as a result of food adulteration. The use of essence, industrialization, and the price of development all contribute to the prosperity of civilization and the adulteration of food. It is a result of corporate unbridled consumerism and selfishness, which does so intentionally to maximize gain. Food adulteration lowers food quality and has a variety of detrimental effects on human health. The table in this study highlights adulteration in about 50 food products and shows that there are nearly 55 adulterants present. Some of these, such as heavy metals, some synthetic colorants, brick dust, calcium carbide, melamine, DDT, formaldehyde, urea, etc., seriously affect human health. These adulterants have the potential to cause a slew of fatal diseases, wreaking havoc on public health. Food adulteration has a variety of acute and chronic effects on the human body, including inflammation, digestive issues, urinary issues, non-carcinogenic hazards, carcinogenic hazards, and so on. Among these are several diseases that can be fatal.

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1. Introduction

Adulteration of food is defined as consciously or unconsciously incorporating foreign substances into foods or attempting to remove some value from main food source production, both of which can affect food quality (1).

An adulterant is a toxic chemical that should never be present in predominant foodstuffs; however, when incorporated, it deteriorates the food ingredients and demolishes food quality (2).

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Adulteration makes eating unlivable and unpleasant, and it can be venomous. It also harms our health by dispossessing us of nutritional constituents. People can also experience trouble of food intolerances or neurotoxic effects caused by tainted food (3). Economic gain, negligence, and unsanitary manufacturing, preservation, transport, and transactional conditions are the main causes of food contamination or adulteration. Hence, the consumer is either misled or generally victimized by disease (4).

Adulteration of food can be classified into three types. These are - purposeful adulteration, in which silt, liquid, sand, coal, colored powder, etc. are incorporated for marketing gain; metallic adulteration, which encompasses lead, arsenic, tin, and other metals from chemical plants; and unintended adulteration, in which the most widely known adulterants, such as pests, insects, as well as many microbes from numerous sources (6). In today's world, food adulteration is quite widespread all around, and such adulterated products are distributed on the open market, where individual citizens, posing a range of health consequences, consume them. Numerous food products have indeed been revealed as tainted a significant proportion of which are bread, dairy, frozen yogurt, fruits and veggies, oil, seasonings, and so forth (7). In addition, an intervention of fruits and veggies causes them to develop relatively quickly. Steroids were inoculated into chickens in a quite short period to develop hens (8).

Numerous foodstuffs include adulterants, which pose a multitude of risks to human health including allergies, cancer, brain damage, hyperactivity, glaucoma, blindness, and cardiac arrest (10).

For instance, the adulterant mineral oil, which causes diarrhea, vomiting, cancer, etc., is contained in oils and black pepper. Lead chromate, a highly prevalent adulterant, can cause anemia, neurological damage, and other problems when it is added to spice powders like turmeric and blended spices (11). Milk is frequently adulterated with water, which reduces the nutritious content of the milk. Researchers discovered several contaminants in powdered milk, including melamine, urea, detergents, hydrogen peroxide, starch, and others that pose a hazard to public health. Melamine damages the kidneys, urea promotes cancer, ulceration, and other conditions, and surfactants are frequently used to emulsify, which harms human digestive health (12).

People who consume contaminated foods are susceptible to several food-borne illnesses, including diarrhea, stomach pain, diarrhea, and vomit (14). Every year, contaminated food affects thousands of people, making it one of the biggest issues with global health. People frequently get food-borne illnesses as a result of consuming foods that were manufactured in unclean circumstances and inappropriate warehousing facilities (15).

Numerous factors determine food safety and security, as evidenced by a study conducted by the government and other regulatory authorities, and all these variables contribute to food products at every step of the food chain (17). Potential dangers result in contamination throughout the supply chain, which would include handling, stockpiling, mass transit, and dissemination, and are controlled by food risk control (18). About 57 percent of people worldwide are affected by various health hazards because of consuming infected and

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adulterated foods, with 32 percent being youngsters. and 25 percent being adults (19). The primary objective of this research article is to expose the terrible practices of food adulteration and the detrimental consequences that these practices have on public health.

2. Methods of cited literature

2.1. Criteria for considering studies for review

During the search and selection of the appropriate documents for the study the following parameters were considered: articles on the basic aspect of food adulteration, articles containing the scenario or practices of adulteration from the viewpoint of different countries in the world, articles on patterns and practices of adulteration in a variety of important food products, effects or implications on the public in the world.

2.2. Search methods for identification of studies

Given writing the research paper, search articles and reviews through PubMed, Google Scholar, and Google.

2.3. Selection of studies

Only papers that were linked to the study selection criteria were added to the papers from the articles that were searched. On the other hand, papers that we're unable to follow the study selection criteria were excluded from the study paper. After reviewing more than 40 research articles, information from 60 relevant reference sources was included in the search paper.

3. Most common adulterated foods

Food products that we purchase and consume are already at risk of being tainted at various phases of the supply chain.

As per the FSSAI study conducted, the much more popular dishes discovered to be tainted included dairy, fish, fruits and veggies, liquids, syrup, oil, wheat bread, tea, chilies, and many other seasonings, among others, and the foods were tainted by incorporating toxic substances with companions (21). Lead chromate has been discovered in pulses; painted barn in seasonings; acetaldehyde and gelatin in cream; urea, washing powder, starch, etc. in dairy; iron additives in tea; sand, dry erase powder, etc. in wheat flour; calcium carbide, copper salt, formalin, etc. in fruits and veggies; salt is often adulterated by light-skinned powdered stone; honey is found with molasses and cane sugar as an adulterant, etc. (22). To make foods more appealing to customers, varieties of colorants are being used. Sulfuric acid is used to consider making evaporated milk. (23). Data provided by the Institute of Public Health (IPH) and licensed by the Ministry of Health and Family Welfare (MOHFW) of Bangladesh shows that between 2001 and 2009, approximately half of all food samples were determined to be contaminated (24).

Table 1. The adverse consequences on public health caused by the adulteration of food

References	Study Location	Food Involved	Adulterants Used	Reasons for using adulterants	Health Consequences of Adulterants
(25)	Italy	Wine	Methanol	- Conspicuous trends of particularly 2-isopropyl-thioxanthone	- Caused the deaths of 23 individuals
(26)	Bangladesh	Spices, pulps, juices, lentils, and oils	Chromium, tartrazine, and erythrosine	- Increase the bulk and reduce cost, quality and make more profit	- Kidney, skin, liver, prostate, and lung cancer
(27)	Spain	Vegetable Oils	Car oil	- Using denatured oil for industrial use and subsequently refined for minimizing cost	- More than 20000 cases of illness - 663 fatalities
(26)	Bangladesh	Bread and wheat flour	Rye flour	- To attract consumers, rise the shelf life of food, increase the revenue	- Spontaneous abortion and traumatic event
(30)	Tanzania	Milk and dairy products	Bacterial infection of *Staphylococcus aureus*	- Commercial rather than subsistence reasons	- Pimples, skin infections - Pneumonia - Even blood poisoning
(28)	Bangladesh	Blanched and puffed rice	Urea	- For maximizing profit	- Renal and nervous system damage - Respiratory problems
(32)	Ethiopia	Dairy milk	*Staphylococcus aureus* bacterial infection	- Inadequate hygiene maintenance practices, lack of idea about the quantity of milk at the point exposure	- Nausea, vomiting, sweating, diarrhea, stomach cramps
(3)	India	Edible oils and fats	Mineral oil	- Increasing acceptability to consumers and profit	- Can cause cancer
(33)	China	Honey	Large fructose syrup with corn	- Using cheap sweeteners for getting profit as a pure product	- Weight gain, diabetes, obesity, and liver disease
(26)	Bangladesh	Turmeric powder	Brick dust, artificial powder, and pigment	- To attract consumers, increase the shelf life of food, increase the profit margin	- Carcinogenic
(34)	Nepal	Food grains (i.e., corn, groundnuts, wheat, etc.) or other food products are typically stored during the storage	Aflatoxin	- Its availability and increased shelf life of products	- Causes toxicity - Associated with cancer, kwashiorkor, and delay in childhood development
(3)	India	Smoked fish, meat, water contaminated with mineral oil, oils, fats, and fish, especially shellfish	Refrigerated together with fried and raw fish	- Increasing acceptability to consumers and profit	- Can cause cancer

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(35)	**Malaysia**	**Herbal and food products**	**Inhibitors of Phosphodiesterase -5 and its analogs**	- **Its availability and lack of laws enforcements by regulatory authorities**	- **Headaches, flushing, nasal inflammation, nasopharyngitis, and dyspepsia**
(28)	Bangladesh	Chili powder	Sudan red, red brick powder, sand, gravel, unauthorized colors, sawdust, or dry papaya seeds	- For maximizing profit	- Tumors in liver and bladder - Eventually for cancer, respiratory complaint, stomach disorder
(3)	India	Saffron, cashew, clove, chilies	Petals, husks or stalks, and fruits	- Increasing acceptability to consumers and profit	- Affected by low-quality standards
(28)	Bangladesh	Fruit ripening	Calcium Carbide	- For maximizing profit	- Kidney, skin, liver, prostate, and lung cancer
(36)	Brazil	Honey	Fed extra sucrose or sucrose solution or syrup	- Low public awareness and the absence of comprehensive research are the primary causes.	- Can cause obesity - cause toxicity and elevated blood sugar levels
(3)	India	Drinking water, seafood, tea, etc.	Fluoride	- Increasing acceptability to consumers and profit	- Fluorosis induces excess fluoride.
(37)	China	Meat products	Unauthorized Sudan powder	- Availability of adulterants, maximizing profit, lack of authorized steps	- Cancer-causing teratogenicity, genotoxicity, and carcinogenicity, and their degradation products are considered hazardous
(26)	Bangladesh	Butter	Dalda mixed with pigment, powder, soap, oleomargarine or lard, cow's intestine	- To attract consumers, increase the shelf life of food, increase the profit margin	- Asthma and deteriorated kidney function
(3)	India	Oils	Rancid oil	- Increasing acceptability to consumers and profit	- Abolishes vitamin A and E
(28)	Bangladesh	Sweet, sauce, pastry, powder, spices	Coal tar and manufacturing dyes	- For maximizing profit	- Carcinogenic
(3)	India	Fruits like water	Arsenic	- Increasing acceptability to consumers and profit	- Vertigo, anxieties, cramps, paralysis - And, even can causes death
(28)	Bangladesh	Condensed milk	Sulfuric acid and palm oil	- For maximizing profit	- Cardiac function delinquent

(38)	**China**	**Milk foodstuffs**	**Melamine**	- **Minimizing cost, maximizing profit, lack of awareness**	- **Kidney failure**
(3)	India	Fish	Mercury	- Increasing acceptability to consumers and profit	- Brain damage, paralysis, death
(28)	Banglad esh	Dry fish	*DDT*	- For maximizing profit	- DDT is linked to an increased risk of developing different types of cancer. - Risk to Fertility
(39)	Banglad esh	Raw fish	Formaldehyde (formalin)	- Multidimensional use of adulterants (formalin), availability, lack of scientific studies, inappropriate regulation, and activeness of laws and regulations	- Irritated eyes, nose, and throat - Asthma can be provoked by exposures of 5-30 ppm or higher - Long-term ingestion can increase cancer risk, as well as respiratory, gastrointestinal, cardiovascular, nephrological, and cognitive troubles
(3)	India	Fruit drinks, food, and beverages	Cadmium	- Increasing acceptability to consumers and profit	- Disease of Itai-itai - Increased salivation - Liver and kidney impairment - Cancer of the prostate
(26)	Banglad esh	Soft and hard beverages	Dyes based on copper, zinc, or indigo	- For marketing purposes, longer food shelf life, and more profits	- Toxic to health
(3)	India	Food grains, pulses, etc.	Sand, stone, chips of marble, filth	- Increasing acceptability to consumers and profit	- Impairment of gastrointestinal tract
(28)	Banglad esh	Milk	Adulterate cow or buffalo milk with starch, milk powder, and urea	- For maximizing profit	- Cancer or acute renal distortion
(3)	India	Water, liquors	Cobalt	- Increasing acceptability to consumers and profit	- Insufficiency of the heart and myocardial failure

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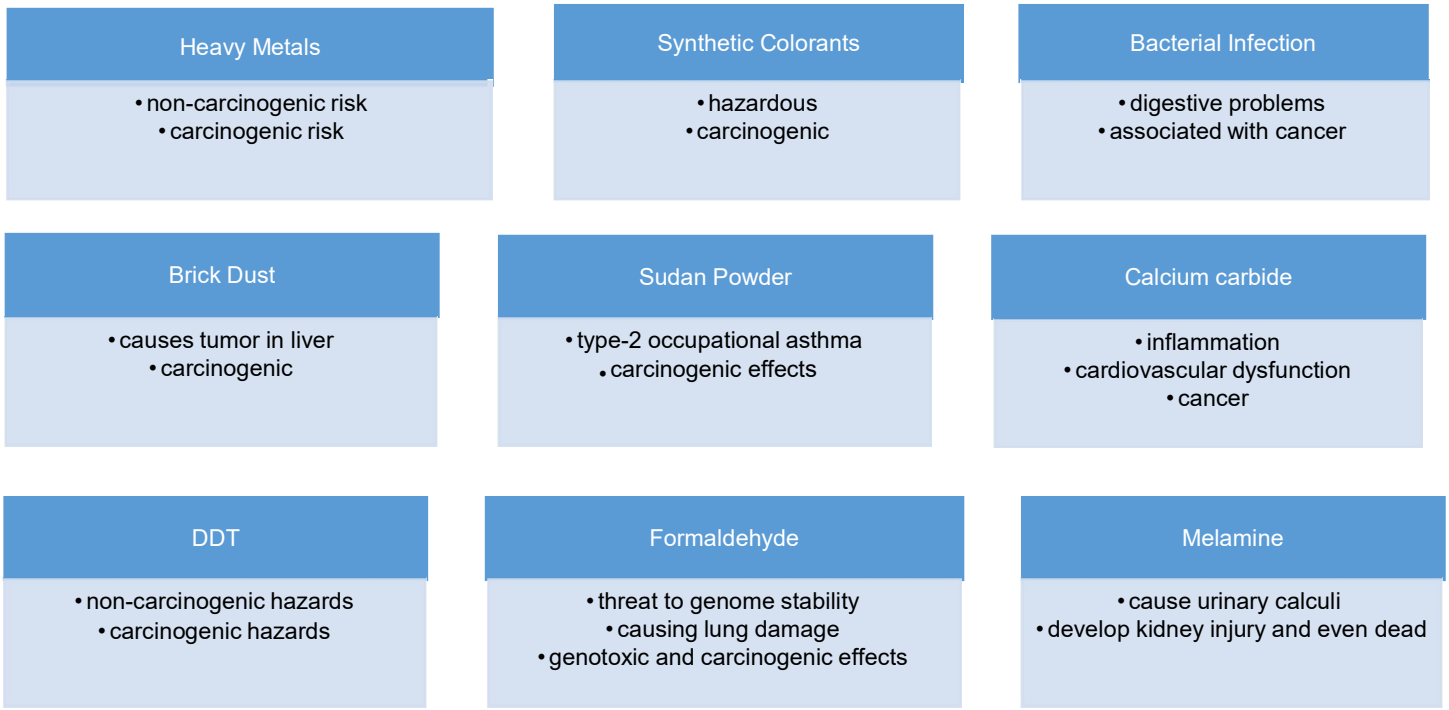

Figure 1. Worrisome consequences of some adulterants on human health at a glance (40-42)

4. Impact of food adulteration on population health as a whole

A descriptive summary of contaminated food products with responsible adulterants, reasons for adding adulterants, and potential health hazards are provided in Table 1.

In addition, Fig. 1 summarizes the most dangerous adulterants and their concerning health effects.

The extensive usage of adulterants, which causes heightened awareness, discomfort, and susceptibility contributes to the rising prevalence of food adulteration and its negative effects on public health (44).

Adulterants can cause a wide variety of acute signs and symptoms, including nausea, abdominal discomfort, autoimmune disease, asthma, headache, sinus infection, laryngeal blockage, pneumonia, dermatitis, adverse reactions, indigestion, and blood in the urine, nerve damage, and lightheadedness. Some of these signs and symptoms are more severe than others. Acute adulteration for a long period can lead to circulatory failure, cardiogenic shock, renal failure, hepatocellular carcinoma, liver cancer, epilepsy, and a variety of other diseases, in addition to the effects listed earlier in this section (45).

Among the adulterants listed in the table and preceding paragraph are lead, mercury, cobalt, chromium, cadmium, arsenic, Sudan red, metanil yellow, melamine, urea, aflatoxin, DDT (Dichloro Diphenyl Trichloroethane), calcium carbide, formalin, and some others.

Acute long-term exposure of heavy metals can easily hinder the human normal physiological cellular functions (47). When heavy metals like lead, chromium, and arsenic build up in the body, it may result in damage to the kidneys and liver, as well as defects in children who are exposed to the metals during pregnancy (48). Moreover, the International Agency for Research on Cancer (IARC) has labeled As, Cd, and Pb as carcinogens (49).

Sudan dyes, which are often used in foods like chili powder and curry, amongst other things, may pose a significant threat to the health of humans (51). Lawful uses of Sudan II, III, and IV are fully accountable for the wide occurrence of these intoxicants and must result in permanent exposure of people to such substances. Sudan III continues to remain admissible for ingredients that do not interact with mucosal surfaces (51). Individuals being subjected to addictive substances on a routine basis for extended periods at a significant level may also have detrimental ramifications (52). Sudan I, II, and III reaction products, along with Sudan Red 7B as well as Sudan Black B reaction products, have now been proclaimed accused carcinogens and categorized as group 3 substances by the International Agency for Research on Cancer (53).

Because of its cheap price, the brilliant orange cationic dye known as metanil yellow is used to a great extent in the food industry as a colorant in a broad variety of food items (54). Metanil yellow can cause harm to the human heart, abdomen, liver, kidneys, peripheral nerves, gastrointestinal tract, gastric tissue, and other important organs and homeostatic mechanisms (55). According to some research, access to metanil yellow wreaked havoc in both the fine-grained and Purkinje intercellular spaces of the nervous system rates (56). The intestinal epithelium was also discovered to be irreversibly altered as a result of metanil yellow disclosure, leading to a loss of nutrient uptake capacity (57). A study on goat cardiac tissue found that metanil yellow provokes hepatotoxicity, increases oxidative stress, and distorts the stages of the intracellular antioxidative enzymes and superoxide dismutase in goat heart in utero (55). A study on Swiss albino mice discovered that metanil yellow provokes scrotal cellular injury, as well as demyelination in the Sertoli cells and sperm cells. It was also connected to scrotal damage in studies that have pointed components in lab rats, mice, and rats (58).

Melamine-contaminated food exacerbated kidney problems and nephrolithiasis in Asia and North America throughout 2004 as well as 2007 (38). In 2008, a melamine-contaminated powdered milk imbroglio in China drew worldwide interest. Because of this imbroglio, 294,000 patients were reported with melamine-related urolithiasis, 51,900 of which were hospitalized, and at least six starved to death (59). Pure melamine seems to be non-toxic in tiny quantities (60); each day's limit is 0.5milligrams per kg of body mass (61). Melamine-cyanurate multifaceted hydrolyzing

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item is much more threatening than melamine and cyanuric acid solely (62).

Aflatoxin can contaminate foods such as grains, walnut, maize, cotton, groundnuts, and tree nuts (63). when they are going to grow, cultivated, and preserved (64). Aflatoxins can pose significant threats to humans and animals by exacerbating hepatic damage, carcinogenic effects, mutagenicity, teratogenic effects, and hypersensitivity (65). The most widespread aflatoxins seem to form B1, B2, G1, and G2 (66); among which, type B1 is noticed most often in food products and it has been observed it is the most efficient organic carcinogen and unwanted substances (67).

It has been demonstrated that the unbounded use of poisonous DDT powder in dry fish is a potential carcinogen (68). Several observational studies failed to detect higher risk of death (69), whereas others explored significant relation with pancreatic cancer (70), hepatic and bile ducts cancer (71), myeloma (72), cardiac disease, and presumably diabetes (73). DDT was classified as a "probable human carcinogen (Group 2B)" by the International Agency for Research on Cancer (IARC) in 1991 (74).

The pervasive use of formaldehyde solution in fruits, vegetables, fish, meats, and dairy foods for lengthy restoration causes harm to population health (75). Access to formaldehyde solution gaseous fuel can induce ocular, nose, and respiratory system itchiness (76). Formaldehyde solution exposure ranging from 5 to 30 ppm and greater can cause or exasperate bronchial asthma. Paraformaldehyde often can impair the retina and lead to blindness. Prolonged exposure to formalin can cause respiratory, gastrointestinal, hepatic, cardiovascular, nephrological, and cognitive difficulties, as well as cancer (77). Formaldehyde was recently time designated as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) (78).

Calcium carbide (CaC_2) is a chemical substance used in the manufacturing of acetylene and calcium cyanimide (79), the first of which affects the central nervous system by minimizing oxygen circulation to the brain (80). The conduct of food with calcium carbide is predominantly destructive because it encompasses drops of arsenic and phosphorous. The carbide produces acetylene vapor when liquefied in water. By inducing elongated hypoxia, acetylene vapor can distress the nervous system. Nuisances, vertigo, mood disorders, lassitude, mental shakiness, lack of memory, cerebral edema, and confiscations are the consequences. Carbides may also cause renal and liver problems, especially in children (81). Calcium carbide induces neurological disorders (82) and can cause cancer in the lungs, kidney, liver, skin, and prostate (68). Babies born to pregnant ladies who ingest carbide-ripened fruit may have birth defects (82).

The rising number of cancers, metabolic syndrome, and kidney failure recurrences across the country could be attributed primarily to tainted food consumption. Toxic residues in food have the most negative impact on a child's cognitive growth, as well as women's reproduction (83).

5. Conclusions

Lastly, from the above analysis and conversations, we can summarize that without our understanding, adulteration added to food products can cause enormous health effects. Since many traders use

various adulterants in different ways to make the maximum profit from food rather than enough investment. Adulteration can be avoided through our society's few attentive measures. Consumers should avoid purchasing food from locations where adequate hygiene conditions are not maintained. The government also should take more initiative by conducting various camps to promote its rights and detect food adulteration at home. Therefore, consumers' rights to obtain good food should be recognized and correctly and efficiently enforced to create a stronger country and health education should be made mandatory. To construct positive change in this situation, all responsible stakeholders in society must come forward to protect our health and prevent future generations from contracting food-borne diseases.

Conflict of interest

The authors state that there is no potential for a conflict of interest.

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