ARTICOLO

Majedul Hoque
Department of Pharmacy, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh
Arafath Jubayer
Department of Pharmacy, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh
Iftear Kazim Rafi
Department of Pharmacy, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh

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Corresponding author:
Majedul Hoque
Email: majedulhoque1995@gmail.com

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FOOD ADULTERATION IN BANGLADESH BECOMING MOST COMMON HEALTH AND SOCIAL THREAT

ABSTRACT

Food adulteration describes the mixing, deceit, and substitution of different toxic, inedible substances for actual ingredients in food manufacturing.
When food lacks necessary ingredients or has inferior components that are bad for our health, it's usually considered as contaminated. In Bangladesh, food adulteration was done by the practice of introducing dangerous compounds, harmful colors, misbranding, false label and hazardous food additives.

At every stage of the food chain, from manufacturing to consumption, the majority of foods in Bangladesh are contaminated with hazardous chemicals, such as preservatives, toxic colors, used oil, dirty water etc, which lead to a variety of chronic and non-chronic illnesses in the body of consumers.
In order to further detect, combat, and prevent future adulterations, this review offers concise yet comprehensive information to comprehend the nature and scope of food adulteration.

The goal of this review is to present a thorough analysis of the reasons behind food adulteration, as well as the bad health impact, consumer perceptions, and food categories involved. It also sought to draw attention to the possible health hazards associated with eating adulterated food items and the significance of recognizing and preventing such malpractice.

The review included a comprehensive analysis of publications, studies, articles, and regulatory standards pertaining to food adulteration.
The purpose of this review is also to briefly discuss various potential solutions and the existing state of food adulteration in Bangladesh.
The evaluation also underlined how urgent it is to combat food adulteration by combining legal actions, technical developments, and consumer education.

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RIASSUNTO

Il termine "adulterazione alimentare" descrive la miscelazione, l'inganno e la sostituzione di diverse sostanze tossiche e non commestibili con ingredienti reali nella produzione alimentare.
Quando un alimento manca degli ingredienti necessari o contiene componenti di qualità inferiore dannosi per la salute, viene solitamente considerato contaminato. In Bangladesh, l'adulterazione alimentare si è verificata attraverso la pratica di introdurre composti pericolosi, coloranti nocivi, marchiature errate, etichette false e additivi alimentari offensivi.

In ogni fase della filiera alimentare, dalla produzione al consumo, la maggior parte degli alimenti in Bangladesh è contaminata da sostanze chimiche pericolose, come conservanti, coloranti tossici, olio usato, acqua sporca, ecc., che causano una varietà di malattie croniche e non croniche nell'organismo dei consumatori.
Al fine di individuare, combattere e prevenire ulteriormente le adulterazioni future, questa revisione offre informazioni concise ma complete per comprendere la natura e la portata dell'adulterazione alimentare. L'obiettivo di questa revisione è presentare un'analisi approfondita delle ragioni alla base dell'adulterazione alimentare, nonché del suo impatto negativo sulla salute, delle percezioni dei consumatori e delle categorie alimentari coinvolte. Ha inoltre cercato di richiamare l'attenzione sui possibili rischi per la salute associati al consumo di alimenti adulterati e sull'importanza di riconoscere e prevenire tali pratiche scorrette. La revisione ha incluso un'analisi completa di pubblicazioni, studi, articoli e standard normativi relativi all'adulterazione alimentare. Lo scopo di questa revisione è anche quello di discutere brevemente le diverse possibili soluzioni e l'attuale situazione dell'adulterazione alimentare in Bangladesh. La valutazione ha inoltre sottolineato l'urgenza di combattere l'adulterazione alimentare combinando azioni legali, sviluppi tecnici ed educazione dei consumatori.

INTRODUCTION

Among the necessities for all living things, food is consumed for daily activity. Animals and people can consume or drink food for survival or enjoyment because it contains a range of vital minerals and nutrients, including proteins, lipids, water, and carbohydrates [(1) (2)]. Population productivity and health are influenced by the type of food people consume and how nutritious it is in terms of nutrients. Although proper nutrition is crucial for good health, the positive impacts of modified food are limited [(3)]. A poor diet has been associated to an increased risk of several morbidities and deaths, including cancer, type II diabetes, and cardiovascular disease. For example, eating foods containing high glutamate raises a person's blood glucose levels [(4)]. Furthermore, contaminated food items cause both financial harm and mild to severe health effects. Symptoms of eating contaminated food include diarrhea, nausea, allergic reactions, diabetes, cancer, and more [(5)]. Food is considered adulterated when its quality is reduced due to the addition of substances that are bad for human health.
These foods can lead to a variety of health issues, including respiratory distress, edema, cardiac arrest, glaucoma, cancerous effects, paralysis, kidney failure, diarrhea, joint pain, dropsy, gastrointestinal issues, and liver problems [(6)]. Certain contaminated foods can also have a direct impact on our internal organs, resulting in liver, kidney, heart, and several other organ failures [(7)].

Food adulteration for economic gain occurs in various ways, such as blending, replacing ingredients, concealing inferior quality through packaging, selling spoiled food, mislabeling, or providing inaccurate labels, and adding harmful substances [(8) (9)].
The disparity between consumer income and food prices is a significant contributor to food adulteration. For example, when the expenses of food production surpass what consumers are willing to spend, sellers are compelled to offer inferior quality food products. Adulteration represents one of the most substantial and difficult issues encountered today.

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This is mainly due to the ineffective enforcement of laws and the difficulty in apprehending offenders, as many works in collaboration with officials [10].

Moreover, food adulteration is a significant issue for consumers, governmental bodies, food manufacturers, regulatory organizations, and various industries [11] [12]. The problem of food adulteration is being tackled by various food safety regulations, but the frequency of occurrences is increasing daily, making it crucial to manage the problem with the help of enforcement of laws [13]. Most food manufacturers, processors, restaurant proprietors, and various business owners are involved to some extent in this unethical act of adulteration.

In Bangladesh, common food items that are often subject to adulteration include fruits, meats, milk, vegetables, fish, wheat, butter, ghee, spices, rice, bacon, sweets, drinks, and baby foods [14][15][16][17][18].

The fruits were combined with calcium carbide, thiophene, formaldehyde, color additives, and sweetening agents. Formaldehyde and toxic dyes are frequently used in vegetables, whereas formaldehyde is utilized in fish [17] [19].

A lot of everyday food items like cabbage, potato, banana, tomato, mango, and others were found to be contaminated with harmful pesticides, according to a report from the (NFSL) National Food Safety Laboratory [17]. DDT (Dichloro diphenyl trichloroethane) continuously exploited by business owner in dried fish. Milk was discovered to be tainted by formalin or water or fat extraction or wheat flour or powdered milk or thickening agents. Powdered milk is mixed with melamine or aldrin [20] [21].

Vegetable oils are mixed with non-consumable oils, which are less expensive [22]. Fragments of urea, small stones, sand and coloring agents are generally mixed with rice to increase weight [23]. Mixing chili powder with brick dust and Sudan red dye is very common, while metanil yellow and colored chalk powder is used to adulterate the turmeric powder [21] [24].

Mixing dried papaya seeds with black pepper is prevalent, and colored sugar syrup was added to honey [14]. Artificial ripening of papayas and bananas exploits carcinogenic substances [25] [26] [27].

Preservatives in various foods are being used exceeding the permissible limits. Rye flour is used in barley, as well as in bread and wheat flour to increase profit [28].

Vibrant colors used in food products can be enticing, visually appealing, and mouth-watering.

These colors are also found in various sweets and cultural dishes such as beguni and peaju, which may lead to issues like indigestion, vomiting, diarrhea, allergic reactions, asthma, various neurological disorders, and even cancer [29]. Bottled beverages and fruit drinks are produced using harmful chemicals.

Goods like cakes, biscuits, and confections are produced in unsanitary conditions with mixing spoiled flour, rotten eggs, burned oil, contaminated water, and powdered milk without expiry date, even textile dyes, chemicals, and flavoring agents [30].

Previous studies about food adulteration in Bangladesh are mostly specific to a single topic, like the detection of food adulteration, legislation, particular types of food and market size etc.

This review offers a succinct and comprehensive overview of food adulteration that will enhance understanding about bad health impact of food adulteration, prevention, and public awareness about adulteration in Bangladeshi context. The purpose of this article is to inform readers about the current landscape of food adulteration in Bangladesh and to encourage administrative authorities to implement necessary reforms and laws for strong penalty as soon as possible.

Basic food and supply water contamination in Bangladesh

Water and food contamination in different major cities is the primary source of heavy metals that are exposed to crops, vegetables and other food items obtained from soils, posing major health risks to humans. This is due to the massive amount of solid waste that is produced daily from industrial discharge, fossil fuels, fertilizers, sewage sludge, and municipality wastes [31] [32]. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, molybdenum, and vanadium were among the heavy metals that were significantly deported from soils and water to locally grown vegetables (spinach, tomato, creeper and cauliflower) that were grown in industry polluted Konabari area in Gazipur and Keraniganj in Dhaka [33]. Because there are very less effluent treatment plants (ETP), the factory waste is dumped onto agricultural lands, ponds and river ultimately polluting the crops.

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In Bangladesh, we have permitted issues like food contamination and pollution to escalate unchecked. To date, neither the health ministry, the ministry of science and technology, nor the ministry of industries has performed any strong assessment of pesticide residue levels or harmful chemicals in the food products being sold [(34)]. Approximately twenty million individuals in Bangladesh continue to consume water containing arsenic, a harmful toxin identified in the water supply few decades ago [(35)]. The health system in Bangladesh mostly overlooked the impact of arsenic exposure on public health. A study estimates that around 43,000 individuals die annually due to arsenic-related illnesses in Bangladesh [(36)].

Common street foods sold in Bangladesh

To gain clear insight of food adulteration in Bangladesh, it is essential to know that what are the different types of street food usually sold in Bangladesh? Street food is increasingly favored by city dwellers due to its affordability, convenience, and visual appeal. According to the World Health Organization (WHO), street food refers to "foods and beverages prepared and/or sold by vendors in streets and other public areas for immediate consumption or for later consumption without any additional processing or preparation" [(37)].

In Bangladesh, there is a variety of street foods available in urban areas. One of the most popular street foods is Chotpoti. The main ingredients in chotpoti include white peas, chickpeas, potatoes, eggs, onions, green chilies, tomatoes, cucumbers, coriander, bay leaves, and lemon juice.

The spices used are salt, tamarind, black pepper, red chili powder, and dried cumin. Achar, or pickles, is a popular recipe among schoolchildren in Bangladesh. These are pickled vegetables and green fruits that offer a sweet, sour, and spicy flavor. They are prepared using green fruits, vegetables, chili, mustard oil, sugar, and various spices. A popular street food in Bangladesh is Jhalmuri, which is basically a mixture of puffed rice and various spices. Street foods like vajavuji (including Piaju, beguni, bora, etc) are often served by people in Bangladesh. Snacks like beguni (fried slices of eggplant/brinjal) and piaju (onion lentil fritters) are favorites among individuals of all ages in the country.

The main components of these street foods are wheat or rice flour, red lentil (for piaju), eggplant or chili, soybean oil, onion, chili, salt, and other spices. Also widely favored by the public in Bangladesh are sharbat, which consists of a variety of sweet beverages usually served cold. This refreshing drink is made from water, sugar, ice, lemon juice, sugarcane juice, and various fruit juices [(38)].

The microbiological safety of food sold on the streets raises significant concerns, as these foods are considered a worldwide vector for the spread of foodborne pathogens. A study carried out in Dhaka, the capital city of Bangladesh, from November 2015 to March 2017, analyzed a total of ninety samples of street food, which included fried, spicy, boiled, sweet, sugary solids, fruits, juice, and rice cookies. The samples were collected in triplicate from various vendors across ten distinct locations in the city, namely Banani, Mohakhali, Agargaon, Baridhara, Nilkhet, Uttara, Rampur, Farmgate, Dhanmondi, and Newmarket. Among the ninety street food samples, various types of bacterial contaminants were identified. There were 28 samples that tested positive for E. Coli, 40 samples that contained Salmonella spp., 5 samples positive for Campylobacter spp., 18 samples with Vibrio spp., and 66 samples showing the presence of S. aureus [(39)].

A different research conducted in Dhaka found the existence of Pseudomonas sp., Bacillus sp., E. Coli, Proteus, Yersinia, along with several other bacterial species in Fuchka, a widely enjoyed street food in Bangladesh [(40)]. The presence of these bacterial species in food poses a significant threat to human health since they are known to cause foodborne illnesses [(41)].

Reasons for food adulteration

Food adulteration is primarily driven by economic factors. In many instances, the adulteration of food is done to boost business profits. Manufacturers may employ inexpensive ingredients (prohibited as a food item) that can be easily disguised as a spice to enhance sales volume, leading to a reduction in the cost of pure spice and an increase in overall profit margins [(42)]. If a producer cannot satisfy a customer's quality standards, they might tamper with the product either to conform to the specifications or to lower the price by providing a lower-quality item.

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For instance, in certain instances, the altered product may appear more attractive than authentic spice. Cistus, which has a deep green color, can be mixed with oregano to create a fraudulent flavor that looks more appealing than genuine oregano.

In numerous instances, blending various color categories to meet color specifications may involve substances that are not permitted for human consumption, rendering the product adulterated. Consumers who are unaware of this adulteration often think they are getting a great deal.

In certain situations, counterfeiting can promote the emergence of imitation products, while other manufacturers in the market may also engage in similar practices to compete with the adulterating producer [(17)].

Additionally, to maintain the freshness of food, some dishonest practices are often employed to avoid financial losses caused by food spoilage during transportation and sale. For example, adulterants may be added to boost volume, thickening agents to counteract dilution and strengthen the solids content, substitute for fat, carbohydrate, or protein content, prolong shelf life, improve appearance, and create an authentic look [(43)].

Some food manufacturers and sellers often promote their products with exaggerated advertisement.

This makes it challenging for consumers to choose safe food items due to misleading or fake advertisements. The ultimate victim of these practices is the consumer, who unknowingly consumes contaminated foods and suffers the consequences. Consequently, effective media coverage on food adulteration plays a significant role in reducing these offenses and informing consumers about the dangers of contaminated food to human health; however, in certain countries, the media has not given attention to that issue.

Media attention raises awareness among consumers regarding food adulteration and helps protect their health from associated diseases [(44) (45)].

To enhance the smoothness and visual appeal of rice, auto-rice mills often polish it to varying extents, although this can diminish its nutritional value.

In many facilities and factories that produce chips, chanachur, semai, and noodles, as well as for frying fish and meat, the used oils are commonly used again and again.

This practice can result in the presence of potentially harmful free fatty acids in the burnt oil [(46)].

The availability of adulterants facilitates the adulteration process for traders. Factors contributing to food adulteration include intense competition within markets, an abundance of products, inadequate purchasing habits by consumers, the absence of penalties, and the lack of consistent market oversight. Additionally, global occurrences can lead to adulteration; for instance, natural disasters like severe weather events and earthquakes, along with crop damage, can influence both the availability and cost of products.

Perceptions of customers regarding food adulteration

In 2015, a research study was conducted in Dhaka city to explore consumer perceptions about food adulteration. The research sites included two different shopping areas: a supermarket located in Mirpur-2 and a wet market (kacha bazaar) in Mirpur-6. Both venues offered similar products such as fish, meat, vegetables, fruits, grains, groceries, and cosmetics. The qualitative research methods used in this formative study involved in-depth interviews with 12 customers and 4 employees from the supermarket, as well as 12 customers and 9 vendors from the wet market, along with a group discussion with market committee members from the wet market, with a total of 38 participants engaged from both markets [(11)].

According to the research, 58% of consumers and approximately 45% of vendors believed that this problem was present throughout the entire food supply chain, from preparation to consumption. Many customers voiced their worries about food adulteration and mentioned that they struggled to find sources of pure food. Additionally, due to the lack of available information, they remain unaware of the current level of contamination.

In contrast, around 50% of the total customers from the wet market recognized that food was being adulterated. A large portion (91%) agreed that consuming contaminated food is harmful to health. A significant number of participants, along with half of the consumers (50%), felt that eating contaminated food could reduce life expectancy and lead to long-term health issues.

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Furthermore, participants noted experiencing diarrhea, dysentery, and vomiting as immediate effects of eating contaminated food. Only 25% of wet market shoppers recognized the harmful implications of contaminated food on health. Numerous elements that affect consumers' food-buying decisions were found depicted in (**Figure 1**).

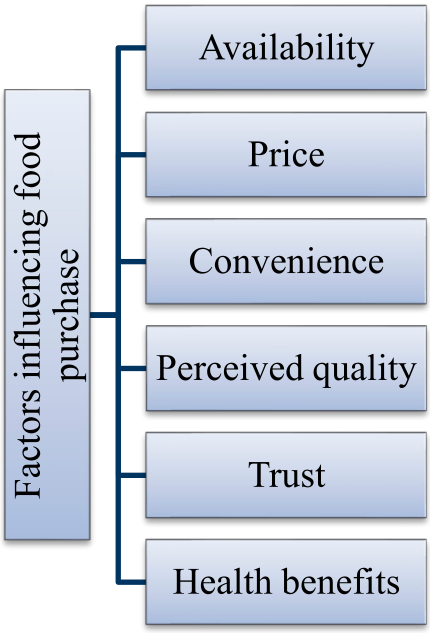

Figure 1
Different factors that influence food purchase behavior among customer.

Various types of food adulteration practiced in Bangladesh

A large portion of the food products in Bangladesh are considered unsafe for consumption due to the involvement of food manufacturers, processors, restaurants, fast food establishments, and others in this cycle of adulteration (**Table 1**). Food adulteration takes place through the use of dangerous chemicals and toxic artificial colors or additives. Additionally, the improper and unsanitary handling of food contributes to its contamination [(47)].

Deliberate adulterants are substances that an adulterer purposely incorporates to increase their profit margin. Examples of adulterants such as sand, marble pieces, stones, dirt, chalk powder, water, and dyes can harm the body.

Metallic contamination encompasses tin from containers, lead from water sources, mercury from wastewater, and arsenic from agricultural pesticides and chemical manufacturing [(48)].

During Ramadan, the occurrence of adulterations reaches its highest level as individuals seek to gain quick and substantial profits. Reports indicate that there are serious issues regarding the excessive presence of adulterated and chemically tainted items of foods, vegetables, fish, meat, fruits, grains and packaged foods, even expired life-saving medications in local markets. Burnt oil is utilized to prepare Iftar foods such as peaju, alur chop, kabab, and other foods during Ramadan, which negatively impacts the human digestive system.

The drinking water found in bottles and jars is often contaminated by unclean or contaminated pond water, as well as water supplied by the water supply authority in Dhaka, Bangladesh [(49) (50)]. (**Figure 2**) represents a simple example of food contamination in Bangladesh.

Figure 2
A glimpse of food contamination in Bangladesh, applying chemicals to fruits (Up) and adding water in milk (Down).

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TABLE 1
ADULTERANTS USED IN DIFFERENT FOOD ITEMS IN BANGLADESH (17) (24) (25) (51)

FOOD CATEGORY	FOOD ITEMS	ADULTERANTS
Grains	Rice	Urea added to make it whiter
	Puffed rice	Urea fertilizer used to make it whiter and puffier
	Lentils	Toxic coloring agents, imported low-quality inedible lentils mixed with textile dye
	Wheat and corn	Low quality and damaged corn mixed with good one
	Course flour	Red toxic color mixed with rice and flour to sell as husked rice, red ata
Vegetables	Tomato	Calcium carbide for artificial ripening
	Pointed gourd and peas	Textile green dye
	Eggplant	Excessive amount of pesticides and heavy metal
	Potato	Harmful color, substandard fertilizers
	Spinach and creeper	Pesticides
	Cucumber, melon	Pesticides
Spices	Turmeric powder	Brick dust, buter dal, kheshari dal (lentils), artificial powder, color
	Chili powder	Wood powder with color
	Coriander powder	Dust from outer layer of rice
	Cumin powder	Brick dust, toxic color, powder
	Salt	Absence of iodine
Fruits	Mango, banana, pineapple, papayas orange and lychee	Calcium carbide for artificial ripening
	Dates	Low quality and expired dates, mixing oil to make clear shiny appearance
	Apple and grapes	High amount of preservatives and damaged fruits mixing
	Different local branded juice items	Water, flavor, saccharin, sweet pumpkin, and textile color
Bakery items	Cake	Textile dye, chemicals, inedible date expired flour, fertilizer urea, substandard inedible dalda, rotten egg
	Biscuit	Ammonium bicarbonate, sodium cyclamate, fertilizer urea, palm oil, burnt oil, outdated inedible flour
	Bread	Substandard inedible dalda, rotten egg
Confection	Chocolate	Artificial color, expired sugar and chemicals
	Honey	Sugar syrup
	Sugar	Soda used instead of sugar in food
	Sweets	Selling date expired and mixing hazardous chemical to make crunchy
	Jam and jelly	Barley, flour, saccharin and toxic color
Edible oil	Soybean oil	Palm oil, color, burnt mobil from rail locomotives, burnt oil from electric transformer
	Mustard oil	Palm oil and mustard flavor
Fish	Hilsa fish	Jatka (immature hilsa) and sardine
	Pangasius, few carp fish and other cultivated fish	Heavy metal contamination from feed, formalin used for long time preservation
	Canned fish	Formalin, antibiotics, heavy metals and aromatic compounds
Meat	Cow meat	Mixed with buffalo meat
	Poultry	Excessive heavy metal contamination from feed, antibiotics
	Mutton	Some restaurants used dog meat instead of mutton to make kacchi and biriyani

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TABLE 1 ADULTERANTS USED IN DIFFERENT FOOD ITEMS IN BANGLADESH (17) (24) (25) (51)		
Dairy items	Liquid milk	Mixing water and removing fat content, fake milk, preservatives
	Powder milk	Melamine, porcine, starch
	Cheese, butter, condensed milk	Starch, palm stearin, formalin, expired milk powder, acids etc
Random	Pickle	Rotten raw materials
	Bottled water	Tap water, inadequate labeling
	Traditional items	Excessive price

Impacts of contaminated food on public health

Contaminated foods represent a significant danger to public health. In a developing nation like Bangladesh, where there are low income levels, widespread illiteracy, and limited health awareness, this danger becomes more pronounced. The consequences of consuming adulterated foods can be either short-term or long-term, or both.

Short-term effects may include food poisoning (resulting in diarrhea), which can lead to dehydration. Long-term consequences may involve organ damage, such as to the liver and kidneys, potentially resulting in conditions like cancer (52) (53) (54).

The impact of food adulteration on health can be either immediate or long-lasting, or it may affect the body in both short-term and long-term ways. Headaches, asthma, nasal congestion, hives, and various other common symptoms may be the direct result. Problems related to the stomach and intestines can include infections, diarrhea, and abdominal pain. In addition to hyperactivity, contact dermatitis, and other skin diseases, bleeding have also been reported. The combined consumption of mustard oil and argemone oil leads to epidemic dropsy.

Long-term effects refer to damage or consequences that persist over an extended period in the human body; these may include organ impairment, congenital disabilities, cancer, and liver deterioration. They also encompass harm to the teeth and adverse impacts on the digestive system, as well as anemia, heart failure, gastrointestinal issues, and various injuries affecting the skin, lungs, and eyes, among other parts of the body (55).

The (**Table 2**) below will provide insight into the adulterating substances and their detrimental effects on health.

Economic impact of food adulteration:

The main impact of food adulteration and inadequate food hygiene on human health is the occurrence of food-borne illnesses (69) (70).

While the precise economic impact of foodborne illnesses in developing countries is seldom assessed, it is likely considerably greater than in developed nations when evaluating the repercussions on local, family, and national economies, rather than only the total monetary amount. The societal cost assessment must include the elevated infant mortality rate, persistent diarrhea, malnutrition, joblessness, and expenses related to childcare. By including the value of deaths in the calculation of \$50 per case, the overall expense of treating the 1,000 million children affected by diarrhea would amount to \$50 billion.

In 2015, a study was conducted in Bangladesh to assess the economic impact of diarrheal diseases. The research presented the expected expenses for both residences and healthcare facilities. The average cost of illness for households was considerable across different age categories, according to that survey. The average illness cost for elderly individuals was higher compared to other age groups (BDT 8407.58 or US\$ 107.1). In contrast, the cost of treating children younger than five was significantly lower (BDT 3440.66 or US\$ 43.83) than that for children older than five (BDT 5173.09 or US\$ 65.90).

Male patients incurred higher average illness expenses (BDT 4441.82, or US\$ 56.58) than their female counterparts (BDT 3909.9, or US\$ 49.81). From the viewpoint of hospitals, the mean expense for inpatient care per patient was BDT 2104.09, or US \$26.70, with just 4.18% of the expenses attributed directly to medical care (71). The financial strain from these costs significantly impacts lower-income families and nations such as Bangladesh.

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TABLE 2 NEGATIVE IMPACT ON HEALTH BY FOOD ADULTERATION				
ADULTERATING AGENT	**APPLICATION ON FOOD**	**EXTENT OF USAGE (BANGLADESH)**	**BAD IMPACT ON HEALTH**	**REFERENCES**
Colouring agents chrome, tartzine and erythrosine	Spices, sauces, juices, lentils and oils	High (illegal use common in confection and child foods)	May cause cancer in kidney, liver, skin, prostate and lungs.	(56, 57)
Rye flour	Barley, bread and wheat flour	Moderate	Convulsion	(58)
Formalin	Preservation of fish, meat, fruit and milk	High (illegal use common in fish markets)	Throat cancer, blood cancer, childhood asthma and skin-diseases.	(21, 59)
DDT	Dried fish	Low (officially banned, but trace usage remains)	Cancer, particularly breast, liver, and pancreatic cancers, as well as reproductive damage (such as reduced semen quality, premature menopause, exposure to teratogens, and congenital disabilities), and certain neurological impairments have been documented.	(21)
Melamine	Milk powder	Moderate	Kidney malfunction	(60, 61)
Calcium Carbide/Ethylene dioxide	Ripening of fruits	Very High (widely used despite ban)	Cancer in kidney, liver, skin prostate and lung.	(62, 63)
Hormone	Cauliflower	High	Infertility in women	(64)
Urea	Puffed rice	High (especially in dairy adulteration)	Nervous system damage, cancer and respiratory problem.	(64, 65)
Oleomargarine or lard	Butter	Moderate	Asthma and weakened kidney function.	(49)
Burnt oil	Crispy snack	Low (illegal)	Food poisoning, reflux, heartburn.	(66)
Brick dust	Chili and turmeric powder	High	GI and respiratory problems.	(67)
Sulfuric acid and palm oil	Condensed milk	High	Cardiac function problem.	(68)
Boric acid	Used in noodles, sweets, and processed foods	Moderate (illegal)	Kidney damage, reproductive harm, carcinogenic potential	(21)
Endosulfan	Used in vegetables and fruits	Moderate (restricted but persists in environment)	Carcinogenic, reproductive toxicity, endocrine disruption	(62)
Carbofuran (Furadan)	Used in paddy fields and vegetable cultivation	High (in use illegally)	Highly toxic; causes seizures, cancer, respiratory failure, death	-
Malathion	Used on rice, wheat, and vegetables to control insects	High	Neurological damage, respiratory distress, endocrine disruption	-

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Food safety:

Nowadays, food safety is a significant concern, leading many consumers to be mindful of their dietary choices. Furthermore, an individual's choice of food can be a showcase their lifestyle preferences, religious practices, dietary restrictions, and health issues. Hence, accurate labeling is crucial to help consumers to make informed decisions.

The elemental makeup of food serves as a key indicator for assessing its quality, nutritional benefits, and authenticity. Additionally, evaluating the presence of specific nutrients is essential. Therefore, analyzing the elemental composition of food products is important, particularly for specific groups of consumers such as children, pregnant individuals, and those with allergies to certain food elements [(72)].

Although food security is equally important to both importing and exporting nations, numerous countries have lower food safety standards and have not developed sufficient monitoring or reporting systems to detect food adulteration [(73) (74)].

In today's world, food safety has become a significant issue for both the food sector and food safety agencies, primarily because of a rise in food adulteration incidents over the last ten years. Food items that are most vulnerable to fraud tend to be those with high market value, which are often produced on a large scale across the globe. Thus, it is becoming increasingly crucial for the industry, governments, and standard-setting bodies to verify, manage food components, and monitor for food fraud [(75)].

Food products prone to adulteration:

According to accounts from many writers worldwide, there are a variety of foods and beverages that are susceptible to adulteration. This implies that it could be challenging to find food items devoid of adulterants, such as flour, pulses, oil, fruit, vegetables, milk, sweets, spices, tea, coffee, honey, baked goods, chocolate, fruit juice, and the like.

About 90% of unbranded loose forms, as reported in the literature, are contaminated, including animal feed like cake used as a protein supplement for nursing animals [(76)] Most fruits and vegetable that contain rich amount of water and electrolytes are easily spoiled and don't exist longer time fresh are expected to adulterated [(77)].

Challenges to combat against food adulteration in Bangladesh:

Through an examination of the adulterated food scene, public opinion, mobile court, practical context, current news and ongoing market syndicate in Bangladesh, numerous challenges have been recognized including:

- Bad-mentality of making enormous profits at any expense and the authorities' inadequate planning and intension.
- Customers compromising behavior and not defending malpractice.
- Disorganized food regulation efforts and insufficient information regarding food contamination.
- Insufficient collaboration between activities such as plant quarantine, food regulation, standards, enforcement, and laboratories.
- Limited awareness of standards, laws, and regulations among both producers and consumers.
- Absence of consistent and suitable execution by law enforcement authorities.
- Ineffective food inspection and enforcement services.
- The BSTI (Bangladesh Standard and Testing Institute) authority asserts that they lack sufficient personnel to ensure food safety regulation in the industry.
- Lack of a system that involves consumer participation.
- The strong impact of politics and the corrupt practices of government officials.
- Insufficient advancement in technology and laboratory research.
- Lack of transparency and accountability.
- The enforcement system in Bangladesh lacks organization and has not developed effective inspection strategies, resulting in an absence of a clear approach to identify non-compliance with regulations.
- The absence of coordination and the overlapping responsibilities among various agencies involved in food safety.
- Illiteracy of general people and lack of hygiene.
- Limitations in financial resources.
- Compliance with high cost of food products.
- Lack of administrative manpower to actively combat against producer syndicate in Bangladesh.
- There are always a prevalent trend of malpractice and making enormous profits. All the responsible individuals maintain strong syndicate and symbiotic relationship among the producer, distributor, dealer, shopping mall, auditor, law maker, local administration and even local seller.

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Ways to prevent food adulteration:

The key issues that need to be addressed to combat adulteration are related to human rights, effective detection of offenses, and the seriousness of penalties. Food safety policies and strategies need to be implemented to incorporate the creation of a coordinated, risk-oriented food control program that spans the entire food supply chain from farm to table. This should be supported by a clear legal framework that supports the establishment of regulations and standards based on risk. Additionally, a further step would be to create a documentation center that provides easy access to information and data regarding current food safety challenges facing Bangladesh [78].

The national food inspection and enforcement services need to be bolstered in order to create and execute inspection programs that are based on risk, supported by well-trained, equipped, and supervised food inspectors, with an increased number of personnel [64]. It needs to develop extensive public awareness about the impacts of food adulteration on health. Exemplary and severe penalty should be imposed for the food adulterer.

Depending on the severity of the charges and the intended result, life in prison or the death penalty may be an option [49].

Proactive strategies and simple techniques of adulterants detection in food (**Table 3**), for managing food safety need to be implemented, necessitating the creation and provision of improved education on enhancing food safety and quality.

Additionally, there should be increased support for consumer organizations. Effective governance is essential to guarantee that consumers have access to safe and hygienic food [79]. Adopting and implementing appropriate laws is important, as is removing any barriers to them as much as possible.

The zonal agriculture department may offers training to farmers on the use of safe, alternative chemicals. Consumer rights organizations must to speak up more and take an active part in creating a nationwide campaign or movement [80].

All types of food research and studies conducted on a district-by-district basis throughout the country require well-equipped laboratories for testing formalin, DDT, color, preservatives, and carbide by trained and experienced officials [81] [82].

Enough resources should be allocated to the institutions established as part of a national strategy for the achievement of the right for food, utilizing educational programs to teach elementary and high school learners about the deadly consequences of food adulteration and encouraging moral behavior in the corporate community with the active involvement of industry executives.

To prevent food adulteration, it needs to ensure that all raw ingredients can be traced back to the finished product. This facilitates the detection and remediation of any supply chain adulteration hotspots.

A safe and unchangeable database for tracking each movement and transaction in the supply chain of foods is provided by blockchain technology.

By utilizing this, the integrity of traceability data is guaranteed and manipulation is avoided.

Advanced quality control systems driven by AI are more accurate than conventional techniques should be implemented at identifying pollutants and irregularities in food products [79] [83].

Advanced chemical testing laboratory with modern equipment needs to be established with the aid and supervision of government officials.

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TABLE 3 A STRAIGHTFORWARD TECHNIQUE FOR IDENTIFYING ADULTERANTS IN TYPICAL FOOD SAMPLES		
FOOD TYPES	ADULTERANTS	SIMPLE DETECTION METHOD
Wheat/corn flour	Chalk powder	If contaminated, upon addition of HCL or vinegar, effervescence will produce.
Milk	Water	Put some drops of pure milk on a glass sheet, white trail will left behind, while adulterated milk (having water) leaves no trail.
Chili powder	Brick and wood powder	Original chili powder will not dissolve easily and does not give dark red color in water.
Tomato ketchup	Color and harmful chemicals	Drop some ketchup in a glass having water, it will sink down and doesn't give red color easily. Whereas adulterated ketchup disperse easily and form red color.
Cumin powder	Saw dust	Add some powder in a bowl of water then powder sinks and dust will floats.
Mango and other ripen fruits	Excessive amount of preservatives	After eating, feeling of headache and dizziness will occur.
Coconut oil	Other mineral oil	Coconut oil solidifies in refrigerator but other oil does not.
Rice and grain	Damaged rice and sand	After putting some rice in a bowl of water, sand and damaged rice will floats.
Honey	Sugar syrup	Original honey will easily sink in water and duplicate honey will disperse easily and mix up with water. Duplicate honey has strong pungent taste.
Mustard oil	Palm oil, color and mustard flavor	Take a spoon of oil and heat the spoon for few minutes if the oil adulterated then it will change into colorless while pure mustard oil does not change color.

CONCLUSION

Healthy food is a fundamental human requirement and is essential for leading a healthy lifestyle. Dishonest traders in Bangladesh are increasingly mixing, replacing, and concealing quality checks from packaging materials, selling spoiled food, using fake labels, and combining inferior, even hazardous chemicals with actual food.

The trader who tainting food is breaching human right to safe food and putting public health at risk. Food adulteration needs to stop or come to a minimal level right away, although it is not possible to eliminate food adulteration in Bangladesh as a whole.

Food adulteration must be lessen by the government of the People's Republic of Bangladesh in order to save the life of its citizens and improves the quality of life. Many laws exist, yet none of them are being applied effectively. Ensuring food security and safe food for everyone can be achieved by appropriate actions taken by the relevant authorities, civic society, print and electronic media, social groups, and even consumers.

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