
Role of chemistry to prevent food adulteration

¹Dr. Tamanna Begam

¹D.B.S. P.G. College, Govind Nagar, Kanpur

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Abstract

Food adulteration refers to the intentional or unintentional addition of harmful substances to food products. main causes of food adulterated products include cost-cutting measures, lack of proper regulation and enforcement, and a lack of awareness among consumers. chemistry plays a vital role in detecting and preventing food adulteration. Food adulteration is a serious public health concern that can have severe consequences for consumers, the food industry, and society as a whole. Chemistry plays a crucial role in preventing food adulteration by providing methods for detecting and analysing contaminants and impurities in food products. Various chemical techniques such as chromatography, spectroscopy, and microscopy can be used to identify and quantify adulterants in food. Additionally, food chemists can use chemistry to develop methods for preserving and protecting food from spoilage and contamination. Overall, the application of chemistry in food science is essential for ensuring the safety and quality of food for consumption.

Keywords:- food adulteration, analytical techniques, microorganisms, GC-MS, FDA, ionizing radiation, FSSAI.

Introduction

Food adulteration is the intentional or unintentional addition of harmful substances or the removal of essential ingredients from food products. It is a significant public health concern that can lead to serious health consequences for consumers. The main causes of food adulteration include cost-cutting measures, lack of proper regulation and enforcement, and a lack of awareness among consumers. The impact of food adulteration can be severe, including illness, injury, and even death. One of the main causes of food adulteration is cost-cutting measures. Food producers and manufacturers are often under pressure to reduce costs and increase profits. This pressure can lead to the use of cheap, lower-quality ingredients, or the addition of harmful chemicals to food products. For example, melamine was added to milk powder in China in 2008 to increase the protein content and reduce costs. This resulted in the death of six infants and the hospitalization of thousands of others. Some common examples of food adulteration in India include the addition of chemicals such as urea and formalin to meat products and the use of artificial colours and flavours in food products. Another cause of food adulteration is a lack of proper regulation and enforcement. Food regulatory agencies are often underfunded and understaffed, which can make it difficult for them to properly monitor and enforce food safety regulations. This can lead to a lack of oversight and accountability in the food industry, allowing unscrupulous actors to engage in food adulteration with little fear of being caught. A lack of awareness among consumers is also a significant cause of food adulteration. Many consumers are not aware of the risks associated with food adulteration and may not know how to identify and avoid adulterated food products. This can make it easy for food producers and manufacturers to engage in food adulteration without being detected.

Role of Chemistry: - Chemistry plays a vital role in detecting and preventing food adulteration. Food adulteration refers to the intentional or unintentional addition of harmful substances or the removal of essential ingredients from food products. This can lead to serious health consequences for consumers and can also damage the reputation of the food industry. One of the main ways in which chemistry is used to detect and prevent food adulteration is through the use of analytical techniques. Chemists use various analytical techniques such as chromatography and spectroscopy to identify and quantify the presence of harmful substances in food products. These techniques allow them to detect even small amounts of contaminants, such as pesticides, heavy metals, and bacteria. By analysing food samples, chemists can ensure that food products meet the standards for purity and composition set by regulatory agencies, such as the FDA and the USDA.

One example of a specific analytical technique that is used to detect food adulteration is gas chromatography-mass spectrometry (GC-MS)¹. This technique is used to detect and identify small molecules in food samples, such as pesticides and other contaminants. GC-MS can detect these molecules at very low concentrations, making it an extremely sensitive and accurate method for detecting food adulteration. Another example of a technique that is used to detect food adulteration is infrared spectroscopy². This technique uses infrared light to identify specific chemical compounds in a food sample. Infrared spectroscopy can be used to identify a wide range of compounds, including vitamins, minerals, and other beneficial compounds. By identifying these compounds, chemists can ensure that food products meet the standards for purity and composition set by regulatory agencies. In addition to these analytical techniques, food chemists also use their knowledge of chemistry to develop methods for preserving and processing food that can help prevent spoilage and contamination. For example, they can use techniques such as pasteurization and canning³ to kill harmful bacteria and extend the shelf life of food products. They also use chemistry to develop food additives such as emulsifiers and preservatives that can help maintain the quality and safety of food products. One example of a preservation method that is used in the food industry is the use of high-pressure processing (HPP). This method uses high pressure to kill bacteria and extend the shelf life of food products. This method is particularly effective in preserving fresh fruits and vegetables, and can also be used to preserve other types of food products, such as meats and dairy products. Another example of a preservation method that is used in the food industry is the use of irradiation. This method uses ionizing radiation to kill bacteria and other microorganisms that can cause food spoilage. Irradiation is a very effective method for preserving food products and can be used to preserve a wide range of foods, including meats, fruits, and vegetables. Chemists also use chemistry to develop food additives such as emulsifiers and preservatives that can help maintain the quality and safety of food products. Emulsifiers are substances that are added to food products to help keep ingredients from separating. They are used in products such as salad dressings, ice cream, and other food products that contain oil and water. Preservatives are substances that are added to food products to help prevent spoilage. They are used in products such as bread, cheese, and other food products that are exposed to air.

Impact of food adulteration:- The impact of food adulteration can be severe. It can lead to illness, injury, and even death. In addition to the physical health consequences, food adulteration can also have a significant impact on the economy. Adulterated food products can damage the reputation of the food industry and lead to decreased consumer trust and confidence in food products. Food adulteration can also have a significant impact on public health. Adulterated food products can contain harmful chemicals

and bacteria, which can lead to serious illnesses such as food poisoning, cancer, and even death. This can place a significant burden on healthcare systems and can lead to increased healthcare costs. The impact of food adulteration can also be felt by farmers and food producers. Adulterated food products can lead to decreased demand for their products, which can lead to decreased profits and even bankruptcy. This can have a significant impact on rural communities and can lead to increased poverty and unemployment. Lack of awareness among consumers is also a significant cause of food adulteration. Many consumers are not aware of the risks associated with food adulteration and may not know how to identify and avoid adulterated food products. This can make it easy for food producers and manufacturers to engage in food adulteration without being detected. Food adulteration can have serious health consequences for children, as their bodies are still developing and may be more vulnerable to the harmful effects of contaminated food. Consuming adulterated food can lead to malnutrition, food poisoning, and long-term health problems such as organ damage and developmental delays⁴. It can also weaken the immune system and make children more susceptible to illnesses. It is important for parents to be aware of the potential risks of food adulteration and to make sure that the food they give to their children is safe and free from contaminants. Elderly people also have weak immune system. Consuming adulterated food can lead to food poisoning, which can be more severe in older adults due to a weakened immune system and other age-related health issues. In addition, elderly people are at a higher risk of nutrient deficiencies, and consuming adulterated food can further contribute to this problem⁵. Adulterated food can also increase the risk of chronic diseases such as heart disease, stroke and diabetes. On a broader economic level, food adulteration can lead to decreased consumer confidence and trust in the food supply, which can negatively impact the food industry and related businesses. Additionally, recalls and other efforts to address food adulteration can be costly for food manufacturers and distributors, and can lead to decreased profits and revenue. Food adulteration can also lead to trade losses and sanctions for countries that export food products. Countries importing food products can also impose penalties or even ban the importation of those products, leading to a decrease in the country's revenue. Overall, food adulteration can have serious economic consequences, both for individuals and for the broader economy. It's important for government and other organizations to implement and enforce regulations to prevent food adulteration in order to protect public health and prevent economic losses.

Food adulteration can have significant negative social impacts. Firstly, it can lead to health problems for those who consume the adulterated food. This can result in increased healthcare costs and lost productivity due to illness. Secondly, it undermines consumer trust in the food supply and can damage the reputation of food producers and suppliers. This can lead to decreased sales and income for these businesses. Thirdly, it can also contribute to income inequality, as those with lower income may be more likely to purchase and consume lower-quality, adulterated food. Lastly, it also undermines the global food security and can result in large scale food recalls which can cause a major financial loss to the producers.

Eye opener Data by Govt of INDIA (FSSAI data 2018-19)⁶

According to the data released, during the year 2018-19, a total of 1,06,459 samples were analysed. While 3.7 % of these samples were found to be unsafe, 15.8% were found to be substandard and 9% samples had labelling defects. This shows how serious the problem is.

ENFORCEMENT REPORT: 2018-19⁶

S. No.	Name of State/UT	No. of Samples Analysed	Non-Conforming Samples					No. of Cases Launched		No. of Convictions / Penalties			Target (2019-20)
			Unsafe	% age Unsafe	Sub Standard	Labelling defects/ Misleading/ others	Total	Criminal	Civil	Convictions	Penalties	Penalties Amount (Rs.)	
1	Andaman & Nicobar Islands	268	0	0.0	11	0	11	1	90	1	89	12,74,000	500
2	Andhra Pradesh	4715	149	3.2	244	299	692	104	456	29	344	1,06,91,300	5000
3	Arunachal Pradesh	291	1	0.3	3	7	11	1	7	0	6	21,000	400
4	Assam	515	46	8.9	48	17	111	7	14	0	5	77,000	1000
5	Bihar	4135	110	2.7	151	111	372	25	146	0	30	10,65,000	5500
6	Chandigarh	315	3	1.0	16	11	30	37	21	30	15	3,35,000	400
7	Chhattisgarh	988	16	1.6	141	51	208	23	27	17	8	9,95,000	2000
8	Dadara & Nagar Haveli	58	0	0.0	2	4	6	0	6	0	6	63,000	100
9	Daman & Diu	145	0	0.0	1	3	4	0	4	0	0	0	200
10	Delhi	2461	96	3.9	148	241	485	29	110	38	31	47,16,001	3000
11	Goa	1550	6	0.4	45	37	88	1	9	0	17	8,66,000	2500
12	Gujarat	9884	47	0.5	432	343	822	22	353	22	237	1,95,89,004	10000
13	Haryana	2929	95	3.2	459	183	737	47	488	5	242	51,16,860	3000
14	Himachal Pradesh	229	6	2.6	20	17	43	4	10	4	35	9,65,500	750
15	Jammu & Kashmir	3600	44	1.2	732	640	1416	10	698	1	466	57,18,800	5000
16	Jharkhand	499	44	8.8	101	63	208	10	71	0	22	4,85,000	2000
17	Karnataka	3945	100	2.5	120	236	456	71	249	0	146	9,50,800	5000
18	Kerala	4378	201	4.6	321	259	781	102	565	2	339	1,11,17,000	6000
20	Madhya Pradesh	7063	44	0.6	651	674	1369	114	1095	8	557	1,82,28,200	10000
21	Maharashtra	4742	278	5.9	633	125	1036	957	910	18	529	1,19,96,269	7000
22	Manipur	388	0	0.0	28	28	56	0	16	0	12	6,89,000	1000
23	Meghalaya	81	3	3.7	0	0	3	1	0	0	3	1,93,700	200
24	Mizoram	124	2	1.6	7	18	27	0	0	0	0	0	300
25	Nagaland	202	0	0.0	175	0	175	0	63	0	63	37,500	300
26	Odisha	327	22	6.7	44	25	91	38	123	0	3	2,20,000	1000
27	Puducherry	2037	0	0.0	39	0	39	0	0	0	0	0	2500
28	Punjab	11920	92	0.8	2015	1854	3961	45	1840	3	1762	1,57,03,200	10000
29	Rajasthan	5760	208	3.6	1272	667	2147		657	141	686	20,17,000	7000
30	Sikkim	182	0	0.0	17	0	17	0	0	0	0	0	300
31	Tamil Nadu	5730	728	12.7	813	1060	2601	666	1718	306	1485	5,01,11,950	7000
32	Telangana	1760	23	1.3	86	59	168	33	191	3	15	2,48,000	2000
33	Tripura	192	2	1.0	6	0	8	0	3	0	0	0	400
34	Uttar Pradesh	22583	1404	6.2	7907	2506	11817	451	8524	73	5526	15,89,81,003	22000
35	Uttarakhand	755	0	0.0	25	10	35	8	28	0	28	28,53,000	2500

Processes that can help in stopping food adulteration:-

Food testing: Food testing laboratories use chemistry to analyse food samples to detect any contaminants, harmful additives, and to ensure that the food products meet the standards set by regulatory agencies.

Traceability: Food traceability systems use chemistry to track the origin and movement of food products through the food supply chain, which can help to identify the source of adulterated food products and prevent them from entering the food supply.

Preservation and processing: Food chemists use their knowledge of chemistry to develop methods for preserving and processing food that can help prevent spoilage and contamination. For example, they can use techniques such as pasteurization and canning to kill harmful bacteria and extend the shelf life of food products.

Food authenticity: Food authenticity tests use chemistry to verify the identity, origin, and quality of food products. For example, DNA analysis can be used to detect the presence of adulterants or substitutions in food products, such as using cheaper and lower-quality fish species in fish products.

Food packaging: Food packaging can be designed to use chemistry to improve the safety and quality of food products. For example, using modified atmosphere packaging or active packaging that can extend the shelf-life of food products and prevent food adulteration.

Conclusion:- In conclusion, chemistry plays a critical role in ensuring the safety and quality of the food we consume. By using analytical techniques and developing preservation and processing methods, chemists can detect and prevent food adulteration, which can protect the health of consumers and the reputation of the food industry. Additionally, food chemistry can also be used to improve the taste, texture, colour, and nutritional value of food products, making them more appealing to consumers. Food adulteration is a serious public health concern that can have severe consequences for consumers, the food industry, and society as a whole. The main causes of food adulteration include cost-cutting measures, lack of proper regulation and enforcement, and a lack of awareness among consumers. To combat food adulteration, it is essential to increase funding for food regulatory agencies, improve enforcement of food safety regulations, and increase consumer awareness of the risks associated with food adulteration. By taking these steps, we can help to ensure that the food we eat is safe and of high quality. The role of chemistry in food adulteration is crucial to ensure the safety and quality of food products for the public's health and well-being

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