Indian Institute of Technology, Guwahati

A Project

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Food Safety and Adulteration

Contents:

1. A brief introduction to the contents (food safety and adulteration) that are going to be present in the article
2. Background of food safety and adulteration article
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Introduction:

Food is the essential sustenance of life on earth. The global importance of food safety is not fully appreciated by many public health authorities despite a constant increase in the prevalence of foodborne illness. There are even many adulteration methods present and being developed as though there are insufficient unsafe methods of food processing or preserving that would detain the general quality of living. So in this article were going to deal with what food safety is and what food adulteration is and the reason for increasing demand of learning them so as to eradicate these mal practises for a better quality of safe living. We are even going to mention a few recent advances in this field of food safety and adulteration after which we are presenting a new proposal that which is eccentric of the complete article. A

concluding speech with references/bibliography are present in the end.

This will be an important task for the primary health care system aiming at “health for all”.

Background of the field:

What is food safety? It is a process of preparing and storing food, may be in raw form or cooked but taking the safety measures that are required for the later safe consumption. It is an assurance that food is acceptable of human consumption according to its intended use. Safe food means food prepared on clean and sanitized surface with utensils and dishes that also are cleaned and sanitized and stored at the optimum temperature that retains vitamins and minerals but do have any harmful pesticides. But, nowadays the importance is not fully considered by many health authorities and by general public despite emerging and propagation of new foodborne illness. Unsafe food consumption leads to commonly called illness *food poisoning*. This is due to the optimum conditions prevailing for the pathogens to develop colonies and host of our body for their nutrition supply.

What is Food adulteration? It is a term used to describe a food product that fails to meet the legal standards or adulteration is an addition of another substance to a food item in order to increase the quantity in of food item in raw

form or prepared form, which may result in the loss of actual of food item. The additives may be food items or non-food items.

So, **the scope or aim of this project is to create awareness among the readers/consumers about the Food Safety and Food Adulteration methodology.**

There are some common types of adulterated foods. They are milk and its derivatives, atta, edible oils, cereals, coffee, tea, confectionary, baking powder, non-alcoholic beverages, curry powder etc.

Types of Adulterants :-

Intentional Adulterants	Sand, marble chips, stones, mud, other filth, talc, chalk powder, water, mineral oil and harmful colour.
Incidental Adulterants	Pesticide residues, droppings of rodents, larvae in foods.
Metallic Contaminants	Arsenic from pesticides, lead from water, effluent from chemical industries, tin from cans.

Metal Contaminants in Food:

Various types of toxic heavy metals, including lead, arsenic, cadmium, mercury etc. occur naturally in the environment in the soil, in surface water, and in the atmosphere. These toxic elements can make their way into the food we eat through various routes. For example, heavy metal fumes released into the atmosphere can return by way of precipitation and contaminate the soil and surface water. The heavy metal residues can be directly taken-up by the cereals grown on the soil or washed into water bodies, where they are absorbed by fishes, thereby entering the human food chain. Therefore, **food is a major way of entry of toxic metals into the human body that causing serious health problems**.

According to the FSSR metal contaminants of food have been categorized as following:-

Lead

Lead can enter the human food chain as a result of human activity with the environment. For example, lead residues present in soil can contaminate vegetables. As for example, the recent Maggi incident, where the level of lead

contamination was found to be higher than permissible limits, most probably arose from lead-contaminated soil where the main raw material i.e. wheat, is grown. Lead can also contaminate aquatic life such as fishes that are consumed as food.

Health Hazards: Chronic exposure to lead through contaminated food affects the central nervous system (CNS) and the gastro intestinal (GI) system. Chronic exposure results in loss of concentration, confusion, depression, headaches etc. GI symptoms include stomach cramps, nausea and vomiting. It also causes toxicity to the developing fetus *in utero*, leading to premature and low birth weight babies.

Copper

Copper is an essential element, it can be toxic to humans at high levels i.e. above the recommended permissible limits. Copper contamination of food can occur if the cooking utensils, including pots and pans are made of uncoated copper, especially if acidic foods are cooked. Copper can also enter the human food chain through the use of copper-containing fungicides.

Health Hazards: Chronic exposure to copper can cause liver failure.

Arsenic

Arsenic can enter humans through consumption of shellfish, as well as through vegetables grown in fields where fertilizers had been applied. Arsenic poisoning arising from

contaminated ground water, used for drinking purposes, is a huge problem in West Bengal, where over 2 lakh people are suffering and has been referred to as the "**the biggest arsenic calamity in the world**"^[13].

Health Hazards: Chronic exposure to arsenic through contaminated drinking water can cause dermatitis and can lead to various types of cancer, including cancer of the skin, bladder and lungs. It can also affect memory, reproductive function, and cause cardiovascular diseases.

Tin

The use of tin cans for packaging foods and beverages can lead to contamination with tin. Therefore, avoiding canned food would be a good idea to reduce the risk of tin poisoning. Tin can also enter food through the use of tin-containing organo-pesticides.

Health Hazards: Studies in humans and animals have indicated that chronic exposure to tin and its compounds through food can cause GI effects, liver damage, reproductive effects, developmental effects, as well as cancer.

Cadmium

Cadmium can enter the body through food crops via contaminated soil and water. Kidney of food animals such as goats and sheep can contain high levels of cadmium. This metal can also be found in molluscs and crustaceans. Cadmium can also be present in chocolate-based sweets and candies.

Health Hazards: Chronic exposure to cadmium through food can cause hypertension, kidney damage, bone lesions (osteoporosis & osteomalacia), as well as birth defects.

Mercury

Mercury can enter the body through food in the form of *methyl mercury*, which can accumulate in large sea-fish such as swordfish. Reducing intake of sea-fishes in the diet is an effective way of reducing exposure to this mercury compound.

Health Hazards: Mercury has toxic effects on the GI system, CNS, immune system, respiratory system, renal system, as well as the eyes and skin.

Chromium

Chromium can be generated by industrial processes and manufacturing activities. It can contaminate groundwater by poor storage, leakage and improper disposal practices, as a result of which the drinking water can become contaminated.

Health Hazards: Chronic oral exposure to chromium can cause kidney damage, liver damage, GI effects, cardiovascular effects, as well as hematological changes. Animal studies have also indicated that *chromium can cause developmental defects* in utero***.***

Nickel

Nickel is a naturally occurring metal that can enter the human food chain from environmental contamination. While short-term exposure can cause allergic reactions, long-term

exposure can lead to reproductive failure and developmental problems, as evidenced from animal studies.

Health Hazards: Oral exposure to nickel can cause GI effects such as stomach aches, hematological effects (increased red blood cells), as well as renal effects (proteinuria).

The basic reasons for the deterioration in food standards is, "**low money wages translated against high costs in the distributive system and a failure of the distributive trades to advance as fast as urban populations**". ^[1] therefore Economic Factors came in idea. the application of chemical and micro-biological knowledge and analytical techniques to the practical problems of identification and measurement within an appropriate regulatory framework. Economic factors, which are held mainly responsible for the lowering of food quality in the first place, are held to have played little part in its subsequent improvement, the assumption being that, in economically, higher food quality could only be achieved at the expense of profits. It can be argued, though, that food standards would not have improved significantly in the absence of major changes in the structure and organization of the food industry, and without a very substantial fall in real food prices and growth in real incomes. The improvement in real incomes and fall in real food prices meant, firstly, a decline in food fraud as the profits from adulteration diminished and, secondly, once basic calorific needs were satisfied, greater interest in food choice and quality. ^[2]

In light of some recent incidents we would like to show some pictures of busting for selling adulterated food spices in Ghaziabad india.

And even famous china plastic rice incident where rice made out of plastic is sold to civilians mixed with natural rice in some ratios.

Scientific and technological progress :-

There is a prospect of intensive husbandry being used to grow transgenic plants and animals that are resistant to pests and diseases, thus reducing the need for chemical control. The increasing use of aquaculture for the production of fish should make it possible to apply safety measures more effectively now that reliable food safety advice is available for this area of production. ^[10] The expansion of international and interregional trade in human and animal foodstuffs can be expected to increase the risk 6 that contaminants will be carried for long distances. Simple and rapid screening methods should be developed for the detection of pathogens in such products, together with innovative approaches to their application in the interest of food safety. It will also be necessary to develop simplified methods for the diagnosis of foodborne diseases in humans and to use them in worldwide surveillance. ^[3] During the 20th century the tried and tested methods of preventing food contamination and rendering contaminated foods safe, among them cooking, pasteurization, sterilization and fermentation, have been improved. Newer methods, such as irradiation, microwave cooking and high-pressure treatment, have been developed. Further progress in this area will undoubtedly be made in the future. Information technology offers the prospect of revolutionizing health education, the exchange of epidemiological data, and the training of health professionals. ^[4] Finally, the large-scale use of solar power as a non-polluting, low-cost

renewable energy source should help to increase food safety in some parts of the world by making cheap energy for refrigeration more widely available.

Surface-Enhanced Raman Spectroscopy Techniques Applied to Food Safety :-

Surface-Enhanced Raman Spectroscopy (SERS) is an advanced Raman technique that enhances the vibrational spectrum of 7 molecules adsorbed on or in the vicinity of metal particles and/or surfaces. Because of its readiness, sensitivity, and minimum sample preparation requirements, ***Surface-Enhanced Raman Spectroscopy is being considered as a powerful technique for food inspection.***^[8] Recent advances have led to many novel applications of SERS in biological analysis, resulting in new insights in biochemistry and molecular biology, in the detection of biological warfare agents, and in medical diagnostics for cancer, diabetes, and other diseases.^[11] SERS can also be applied to material sciences as well as food safety, drugs, explosives, and environmental pollutants.

Technique or Methods	Drawbacks	Advantage
Impedance or potentiometric	Homogeneous sample necessary	Accurate and Simple
Enzyme-linked immunosorbent assay	Narrow detection span	Highly sensitive kit

Polymerase chain reaction (PCR)	Error due to non-target DNA amplification	High sensitivity and linearity
Fluorescence	Photo bleaching	High sensitivity
Colorimetry	Complicated usage	High sensitivity
Surface plasmon resonance	Sophisticated device necessary	High sensitivity without label
Micro cantilever	Low repeatability in liquid samples	Low detection limit
Quartz crystal microbalance	Low sensitivity	Miniaturization
Surface acoustic Wave	Low sensitivity and repeatability	Miniaturization

Table 1 :- Emerging technologies for the detection of biological and chemical risk factors.

The following are potential and <u>recent advances</u> in Surface-Enhanced Raman Spectroscopy :-

(a) detection of foodborne pathogenic micro-organisms :-The World Health Organization (WHO) defines foodborne illnesses as diseases in 2007 ^[12] , usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food. Conventional methods for detection and identification of microbial pathogenic agents mainly rely on specific microbiological and biochemical identification.

These methods can be classified in following three types :-

- **culture- and colony-counting methods that involve the counting of bacteria** :- It is reliable and accurate, the major drawbacks of culture- and colony-counting methods, which are recommended by the US Department of Agriculture, are their labor-intensive and time consuming operations. It usually requires three general steps: enrichment, colony isolation, and confirmation, and it takes two to three days for initial results and up to seven to ten days for confirmation.
- **immunology-based methods that involve antigen body interactions** :- The major strengths of the immunology-based method is highly sensitivity kit and its weakness arries due to its narrow detection span.
- **the polymerase chain reaction (PCR) method that involves DNA analysis** :- The major strengths of the PCR method is highly sensitivity in nature and its weakness is error takes place due to non- target DNA amplification.

(b) the detection of food contaminants and adulteration, concentrated specifically on antibiotics, drugs, hormones, melamine, and pesticides :- The presence of antibiotic residues in food products is a major concern because of the development of antibacterial resistance to these drugs in humans. The 10 traditional methods for detection of antibiotics are based on chromatography^[13], which is time consuming and labour intensive. Thus, the study by He et al. (2009) was aimed at the application of SERS coupled with dendritic AgNPs to detect three restricted antibiotics: enrofloxacin (ENRO), ciprofloxacin (CIP),

and chloramphenicol (CHL). AgNPs, prepared via a simple replacement reaction involving both zinc (Zn) and silver nitrate ($AgNO_3$), were deposited on a clean gold-coated glass slide to produce the nano substrate. Solutions of ENRO, CHL, and CIP were deposited on this substrate and analyzed by micro-Raman.

SERS is being considered a promising technique for food-safety assessment because it is rapid, sensitive, and requires minimal sample preparation.

Significance of Chemical , Micro-biological and Analytical techniques :-

Importance of biogenic amines to food safety :- Biogenic amines are natural anti nutrition factors and are important from a hygienic point of view as they have been implicated as the causative agents in a number of food poisoning episodes, and they are able to initiate various pharmacological reactions. examples :- P-phenylethylamine, putrescine, spermine, tyramine, cadaverine, tryptamine, Histamine, spermidine etc. Histamine has been implicated as the causative agent in several outbreaks of food poisoning, while tyramine and P-phenylethylamine have been proposed as the initiators of hypertensive crisis. Histamine, tryptamine, B-phenylethylamine, and tyramine are biologically active amines which have important physiological effects in humans, generally either psychoactive or vasoactive. Psychoactive amines affect the nervous system by acting on neural transmitters, while vasoactive amines act on the vascular system. Histamine is a powerful biologically active chemical and

can exert many responses within the body. the effect of histamine does not appear unless an allergic reaction occurs. ^[5] The biogenic amine content of various foods and feed have been widely studied and found in cheese, fish and meat products, eggs and mushrooms. Usually amine production results from the presence of bacteria that are capable of de-carboxylating amino acid.

Food manufacturing techniques :- In the same way as in iron and textiles in the early Industrial Revolution, the second half of the 19th century saw the emergence of the large food firm, organized on factory lines, and the gradual forcing out of the smaller, less reputable and less efficient makers. Higher levels of business concentration led to higher standards all round because business success in the large companies, especially those incorporated under the new limited liability acts, was based on the conversion of high-quality inputs into high-quality outputs, and on the generation of steady profits. As a rule, the higher the technology and the greater the scale, the more standardized were the products and the narrower the scope, technically and financially, for fraudulent practice. More important even than the changes in manufacturing were those in the retail trades, which were responsible for the majority of adulteration.

Adulterated food by the Food Code :- A food whose appearance, taste, composition, or other attributes has been changed and its quality decreased but it is offered to the consumer as the usual food under common name or by other

false name. Another definition often used, deliberately placing on the market for financial gain foods that are falsely described or otherwise intended to deceive the consumer.

Analytical Testing of Metal Contaminants in Food:-

Lead, Copper, Arsenic, Tin, Zinc, Cadmium, Mercury, Chromium and Nickel in foods can be tested by **Atomic Absorption Spectrometry (AAS)**. AAS is an analytical technique that measures the concentration of various elements. The technique is so sensitive that it can measure down to parts per billion (ppb) i.e; 1 part in 10^9 in a sample. The technique uses wavelengths of light that are specifically absorbed by an element. AAS has many applications in different areas of chemistry, one of which is for the testing of metal contaminants in food. A variation of AAS, called vapour generation AAS can detect even miniscule levels of mercury, including methyl mercury in fish. Another variation is the flameless-AAS.

An even more sensitive analytical method is the **Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)**, which measures down to parts per quadrillion (ppq) i.e; 1 part in 10^{15}, and therefore, a million times more sensitive than AAS. ICP-MS can estimate elements having an atomic mass of 7 – 250 i.e; Lithium to Uranium, and sometimes even higher. Therefore, it is possible to measure all the above metals by ICP-MS also. Another method that can be used is Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). Besides these highly sensitive methods, conventional

colorimetric methods that measure single elements are also available at the disposal of the analytical chemist. Therefore, it is evident that since both standards and highly sensitive analytical methods are available, regular testing of raw food materials could prevent entry of toxic metals through food, thereby averting untoward health problems and helping us to lead more healthy and productive lives.

Well, all above mentioned methods, techniques and penal code are large scale safety checks that could diminish unsafe food production. But owing to its drawback that these checks cannot be done by every individual before having food we got some small scale security checks on the safe food consumption in our next module.

A New Proposal

Objective :-

To Provide the simplest idea about how to we detecting Adulterants such as artificial and toxic colours, extraneous matters deliberately for otherwise added with food etc. to the citizens. Hence a step towards food safety.

eg. :- (i). Detection of difference in between common salt and iodised salt.

Methods and Plan :- a. Cut a piece of potato , add salt and wait for a minute. b. Add two drops of lemon juice. If it it iodised salt , blue colour will developed. In the case of common salt , there will be no blue colour.

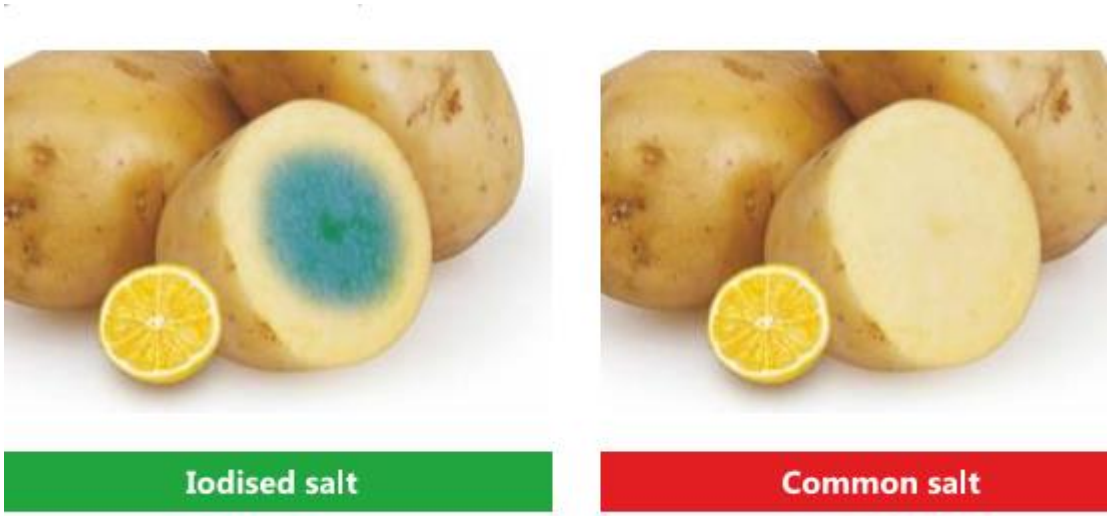

fig (i)

eg. :- (2). Detection of coloured dried tendrils of maize cob in saffron.

Methods and Plan :-

a. Genuine saffron will not break easily like artificial. Artificial saffron is prepared by soaking maize cob in sugar and colouring it with coal tar.
b. Take a transparent glass of water and add small quantity of saffron.
c. If saffron is adulterated , the artificial colour dissolves in water rapidly. A bit of pure saffron when allowed to dissolve in water will continue to give its saffron colour so long as it lasts.

fig.(ii)

eg. :- (3) Detection of water in milk.

Methods and Plan :-

a. Put a drop of milk on a Polished Slanting Surface.
b. Pure milk either stays or flows slowly leaving a white trail behind.
c. Milk adulterated with water will flow immediately without leaving a mark.

Fig.(iii)

eg :- (4) detection of other oils in coconut oil.

Method and Plan :-

a. Take coconut oil in a transparent glass.
b. Refrigerate it but not freeze it.
c. After refrigeration coconut solidifies oil
d. Remaining oils float on top of it

fig (iv)

Conclusion :-

Food quality and food safety have been slippery concepts, difficult to quantify and in large measure subjective. The weight of public concern shifted at each successive stage of economic development, from simple adulteration in the early Industrial Revolution, to 'legalized adulteration' in the mature industrial economy, to concern about the methods of food production on farms and the safety of the 'cool chain' in the present day.

We make to ensure safe food to the citizens. Hence ***we can test or check the food for differents types of adulterants, Chemical and Micro-biological contaminants and other safety parameters for food*** at household , or we detects adulterants with rapid testing and covers common adulterants such as artificial and toxic colours , extraneous matters deliberately for otherwise added with food etc.

Ultimatey , at the end of the day we require every civilian participation towards food safety so that this practises could be fast removed from the thoughts of food manufacturers for large profits and even from the consumers looking for high benefits under low prices. Know your rights and laws that can be taken against unsafe food manufacturers and adulterant

adders so that they could be penalized under law codes. Take food authorized by fssai (indians) which assures safe food.

“It is health that is real wealth and not pieces of gold and silver”.

--Mahatma Gandhi

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