Food Adulteration: Injurious Adulterants and Contaminants in Foods and their Health Effects and its safety measures in India

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***Abstract*: The present work contains the matters regarding food adulteration types, causes of adulteration and its health problems with specific reference to intentional, accidental and natural food adulteration and adulteration control approaches. Adulteration in food has been a concern since the beginning of civilization, as it not only decreases the quality of food products but also results in a number of ill effects on health. The adulterated food bears or contains any "poisonous or deleterious substance" which may render it injurious to health. Food can be adulterated intentionally and accidentally. Legal enforcement is also taken by government to prevent food adulteration. Authentic testing of food and adulterant detection of various food products is required for value assessment and to assure consumer protection against fraudulent activities. Through this paper, intend to compile different types of adulterations made in different food items, the health risks imposed by these adulterants have even been classified as toxic, carcinogens or cancer causing substances. Usage of new technologies like Genetically Managed, Nano-tech foods, functional foods are very much profitable and helpful for our food processing and food production. FSSAI about food safety and regulation have ensured the development of various techniques like physical, biochemical/ immunological and molecular techniques, for adulterant detection in food.**

***Keywords*: Food Adulteration, adulterant, Health hazards and Adulteration control approaches.**

1. Introduction

Food adulteration is a social evil and major problem of the every society **[1,7]**. Adulteration in food products in India has been rampant especially in the products that are sold in Urban- Slum areas, semi-urban as well rural areas where the innocent consumers are cheated due to sub-standards/poor quality of food products even after paying the reasonable prevailing retail prices **[13]**.India is the country of farming. Food and water are not only the elixir of life but these valuable products are worshipped as god in India **[1]**.Food laws play an important role in the quality control strategy. A number of laws have been enacted in the country control for the purpose of laying down quality standards. There are various other supportive acts made for healthy business in food line and consumer welfare and stability of law and order regarding supply of food, quality, and quantity. There are two kinds of food laws and orders in our country .first one is for monitoring safety standards mandatory, compulsory in nature and second quality standards mostly voluntary. Anyway overall aim of food laws is to maintain food quality and quantity keeping all pros and cons of welfare and harm to consumer first and which may not be interfering in fair trade or food procedure business .it is constituted duty of every Government to care about health and living status of the public and at the same time to allow food business to grow and develop according to increasing demands **[17]**.

Food safety is of primary concern to food agricultural organization (FAO) and world health organization (WHO). Food safety providing assurance that food will not cause harm to the consumer when it is prepared and /or eaten according to its intended use (FAO, 1996). Food safety is as an area requiring priority attention to safeguard the economic interests of small holder farmers and the poor .there is a glaring lack of relevance of private sector, agricultural research in developing countries to the genuine needs of the poor. Food safety is a function of the nature of technology used to produce and process food .it can be manipulated through genetic improvement, agronomic practices and postproduction storage and processing **[6,15,18].**

The aim of study is to know/awareness of the type of adulteration, health hazards of adulterant and control approaches among the people in India.

1.1Food Adulteration

Food adulteration is a growing menace that unscrupulous traders and manufacture all over the world indulge in to exploit gullible consumers to make quick and easy money. It is very difficult for the consumer to select one food item because of misleading advertisements, improper media emphasis and food adulteration. As a result of these malpractices, the ultimate victim is a consumer, who innocently takes adulterated foods and suffers. In all free market societies where legal control is poor or nonexistent with respect to monitoring of food quality by authorities, usage of adulterants is common and rampant. Every nation on earth has suffered cases of adulteration at one time or other. Government authorities with great efforts have succeeded in reducing the recurrent occurrences; but have not been able to eliminate it. Only an aware and an informed consumer will be able to eliminate it conclusively by continuous routine monitoring. The dictionary defines food adulteration as an act of intentionally debasing the quality of food offered for sale by either the admixture or substitution of inferior substances or by the removal of some valuable ingredient **[6,9,18]**.

An adulterant is a chemical substance which should not be contained within other substance. The addition, replacement and removal of adulterant/other ingredient is called adulteration the usage of adulterants has been common in societies with few legal controls on food quality and poor /nonexistent monitoring by authorities, dangerous chemicals and poisons. Food additives are not adulterants, if present within the specific limits. And exceeded limits they become significant adulterants and can cause serious health hazards to the consumer's .food adulteration are chemical substance added to processed foods (i) to enhance /retain quality attributes such as texture, physical properties, taste, flavour etc. (ii) to control the spoilage and enhance shelf life of the processed foods. First category of food additives include Antioxidants, emulsifiers/stabilizers, preservatives, anti caking agents, artificial sweeteners, bulking agents, acid regulators, leavening agents, flavouring agents, glazing agents**[9]**.

1.2. Existing and Emerging Food Safety Problems

Adulterated food is dangerous as it may be toxic and effect health, it could deprive nutrients required to maintain proper health and it may cause intoxication or problems such as allergy in sensitized individuals. A variety of chemical, biological and physical hazards are the major causes of food safety problems. Among these the bacterial contaminants, environmental contaminants including pesticide residues, mycotoxins and adulterants have been reported to be responsible for causing large-scale outbreaks of food poisoning and smaller incidents. These include various "food poisonings" reported in newspapers in India from time to time, outbreaks of Lathyrism, epidemic dropsy, venoocclusive disease, various mycotoxicoses and food borne disease due to chemical toxins(2). Although not all food incidents are injurious to health, nevertheless they undermine consumer confidence in food safety and are costly to individual companies and national economies. Novel foods, such of unapproved varieties of genetically modified foods (e.g. star link variety of maize) have in the past posed problems of food allergenicity **[3,4]**.

1.3 **Reasons of food adulterations**

A food article (product) would be considered adulterate due to any one from the following reasons-
(a) If the product sold by a vendor is not of the nature, substance or quality demanded by the purchaser or which it purports to be.
(b) If the product offered contains any substance or if it is so processed as to injuriously affect its nature, substance, or quality.
(c) If any inferior or cheaper substance has been substituted wholly or partly in the product, or any natural constituent has been wholly or partly abstracted from it, to affect its quality.
(d) If the product had been prepared, packed, or kept under unsanitary conditions, has become contaminated, injurious to health or is unfit for human consumption.
(e) If the container of the product is composed of any poisonous or deleterious substance which renders its contents injurious to health.
(f) If the product contains any prohibited colouring matter, preservatives, or contains any permitted colouring matter or preservative in excess of the prescribed limits.
(g) If the quality or purity of the product falls below the prescribed standard, or its constituents are present in proportions other than those prescribed, whether or not rendering it injurious to health.
Thus to put it in perspective we can say that adulteration is "The act of intentionally debasing the quality of food offered for sale either by the admixture or substitution by inferior substances or by the removal of some valuable ingredient"**[5,6,10]**.

1.3.1**Another reason for food adulteration**

The causes of adulteration may be, In general, following are the reasons for adulteration
i) Increase the value of commercial attributes/characteristics of the products.
ii) Sometimes adulteration, even though not hazardous, may lead to severe contamination issues, e.g. spraying of water on dry chilies to cope with excess weight loss may lead to Aflatoxins.
iii) Blending is not adulteration, unless origin of the product is significant
iv) When supply is less than demand, to earn more profits.
v) Shortage of authentic ingredients at affordable prices
vi. Inadequate knowledge on the consequences and associated food safety risks.
vii) Lack of awareness and updating of the information on the adulteration related food safety outbreaks.
viii) Availability of too many products in the market
xi) Poor buying practices of consumers.
x) Consumer mentality of bargaining,
xi) Consumer psyche.
xii) Availability of adulterants.
Now a day, "Adulteration is health menace". Thus, food adulteration takes many forms: mixing, substitution, abstraction, concealing the quality sale of decomposed foods and using false labels. The pity is that the so-called modernization has brought with it, the evils of adulteration. Somehow, the Indian consumer has become accustomed to live with adulteration. Even educated consumers do not pay attention to the menace of adulteration. Many of the spices, ready to eat ground masalas and commonly used products are found contaminated/adulterated. The adulteration problem in India has attained massive dimensions **[12]**.

1.4. Types of adulteration:

There are three types of adulteration namely:
1. Intentional adulterants:
Intentional adulterants are sand, marble chips, stone, mud, chalk powder, water, mineral oil and coal tar dyes. This adulteration cause harmful effects on the body.
2. Metallic contamination:
Metallic contaminations include arsenic from pesticides, lead from water, and mercury from effluents of chemical industries, tin from cans etc.
1. Incidental adulterants:
Incidental adulterants are pesticide residues, tin from can droppings of rodents, larvae in foods. Metallic contamination with arsenic lead, mercury can also occur incidentally. Pests such as rodents and insects intrude into the food at high degree and produce filth in the form of excreta, bodily secretions and spoilage through micro organisms. The most common incidental adulterants are pesticides, D.D.T and marathon residues present on the plant product.The toxins usually pile up in the fatty tissues of such vital organs as the thyroid, heart, kidney, liver, mammary gland and damage these organs. They can be transferred from the umbilical cord/ blood to the growing foetus and through breast milk in children, the disease apart from crippling them inhibits their growth [9,12,19].

1.4.1 Examples of common Food Adulteration in different food commodities

Now a day several reports were accounted in various food items such as milk spices, ghee, and oil and fats. Adulteration in food is normally present in its most crude form; prohibited substances are either added or partly or wholly substituted. In India normally the contamination/adulteration in food is done either for financial gain or due to carelessness and lack in proper hygienic condition of processing, storing, transportation and marketing. This ultimately results that the consumer is either cheated or often become victim of diseases. Such types of adulteration are quite common in developing countries or backward countries. However, adequate precautions taken by the consumer at the time of purchase of such produce can make him alert to avoid procurement of such food .it is equally important for the consumer to know the common adulterants and their effect on health. Adulteration most often includes artificial colours, sand, marble chips, stones, mud, other filthy material talc, chalk powder, water, mineral oil, vegetable oil argemone seeds etc. There are various techniques to detect the adulterants such as chemical method or with help of sensitive instruments [9,10,11].

Generally food security for the urban people is closely related to many factors like their age, religion, marital status, economical status, scarcity of clean water for cooking, drinking, washing lack hygienic aspects, due to lack of awareness and improper sanitation in food preparation has great impact on health. Beside this, bad practices, poor hygiene environments and lack of awareness lead to spread of various communicable diseases via the food system. Table 1 shows the common food adulteration found in different food commodities [11,12,13].

Table 1 Common Food Adulteration in different food commodities [10,17]

Sr. No.	Food stuff	Adulterants	Health Hazard
1	Milk	Water, skim milk, neutralizers, calcium hydroxide, sodium bicarbonate/carbonate, sodium pyrophosphate, urea, Vanaspati, Starch, Detergent, invert sugar/glucose, synthetic milk, ammonium sulphate, hydrogen peroxide, boric acid, removal of fat, sodium chloride, melamine (resin).	Indigestion kidney stone and renal failure in children(melamine in milk), Cancer or acute renal failure
2	Khoa, Chhana, ice-cream	Starch, substandard fat, non permitted colour ,blotting paper, vanaspati/margarine,	Toxic
3	Butter	Mashed potatoes, other starches, vanaspati /oleomargarine/lard	Economic loss
4	Ghee	Vegetable oil, cheaper animal fat	Economic loss, Cancer or acute renal failure
5	Edible oil (vegetable oil)	Cheaper oil, linseed in mustard oil, coconut oil with ghee, argemone Mexicana oil, white mineral oil, prohibited colour, castor oil, mineral oil, Karanja oil, Neem oil.	Erythema, epidemic dropsy, hepatitis odema (skin and liver disease, Loss of Vision and Heart diseases
6	Vanaspati	Cheaper fat ,groundnut, cottonseed and linseed oil	Economic loss, Loss of Vision and Heart diseases
7	Coffee powder	Mug dad coffee (senna occidentalis) ,roasted powder of wheat, gram, date seed, chicory and tamarind husk, corched persimmon stone powder	Diarrhea, stomach disorders, giddiness and

			severe joint pains,economic loss,
8	Tea dust leaves	Artificial colour, tea wastes, gram husk, coffee husk, cashew nut endosperm, by product of leather industry, tamarind seed powder, sawdust, exhausted tea, chicory powder, iron filling	Cancerous,tetanus, Appendicitis and Small Intestine problems.
9	Soft drink alcoholic and other beverages, fruit products	Non permitted colour, Artificial sweeteners as saccharin, dulcin	Toxic /carcinogenic
10	Chilies powder	Sawdust, brick powder, non permitted colour (sudan dye), salt, talc powder	Toxic Stomach disorder, Carsinogenic, Loss of Vision and Respiratory diseases
11	Turmeric powder	lead chromate, foreign starch, common salt, husks, earthy matter, Metanil Yellow, Other aniline dyes (Non permitted colour)	Carcinogenic, anemia abortion , paralysis, brain damage
12	Dal whole and spilt pulses (Food grains)	Dust, pebble, stone, straw, weed seeds, damaged grain, weevil led grain, hidden insects, rodent hair &excreta, kernel bunt, ergot (bajra), khesari dal, clay ,gravels, webs, non -permitted colour	Toxic, Incurable paralysis, tumor and cancer, Anaemia, Epilepsy, neurotoxity
13	Maida, suji (rawa)	Resultant Atta, cheaper flour, boric acid, sand, soil, insects, webs, lumps, iron fillings ,rodent hair and excreta, excess bran, chalk powder,	Abdominal pain
14	Asafoetida	Soap stoner, or other earthy material, starch, foreign resin,Other resin Colophon residue obtained after the distillation of turpentine oil.	Abdominal pain
15	Jaggery	Chalk powder, sugar solution, sodium carbonate, washing soda, non permitted colour.	Economic loss
16	Cinnamon	Cassia bark of chichi dalchini	Economic loss
17	Cumin seeds	Grass seeds colored with charcoal dust	Economic loss
18	Saffron	Dried tendrils of maize cob	Economic loss
19	Iodized salt	Common salt, white powdered	Abdominal pain, Stomach disorder, Appendicitis
20	Whole spices	Dirt, dust, straw ,insect, damaged seeds ,other seeds, rodent hair and excreta	Economic loss
21	Black pepper	Papaya seeds, light black pepper, coated with mineral oil, black pinheads	liver problems and stomach disorders ,Economic loss
22	Cloves	Volatile oil extracted Exhausted or De-oiled Cloves.	Economic loss
23	Dhania powder	Starch, cow dust or horse dung, powder, sawdust	Micrological toxication
24	Pithi sugar	Washing soda, chalk powder, yellow colour(non permitted)	Economic loss
25	Wine	Diethelyne glycol	Toxic
26	Honey	High Fructose corn syrup, sucrose, invert sugar, cane sugar solution, gur, starch, glucose, wax, water.	Economic loss , Obesity, Diabetes , Eyes and nerve damages
27	Sweets	Metanil yellow	tumor and cancer

Source-Fssai

It is found that there are various chemicals and colours used in fruits and vegetables can prove disastrous for digestive system, eyes and liver which are also results in vomiting and diarrhea in children, kidney failure. Chemicals such as Calcium carbide used in mangoes, bananas, copper sulphate used to ripen fruits faster and oxytocin can leads to brain damage, a harmone used for faster growth of Pumpkin, watermelon, brinjal, gourds, cucumber. Wax adds shine on apples and pears. Cheap green colours containing chemicals such as metallic lead applied to bitter gourd and leafy vegetables to give fresh colour. Pesticides and herbicides used excessively for growing fruits and vegetables **[13].**

2.1 **Food Safety Standards and Acts 2006 (34 of 2006), Rules 2008, Regulations 2011.**

Parliament of India has enacted the comprehensive legislation which considerable the laws relating to food. The new act namely food safety and standards act 2006 (Act no. 34 of 2006) is based international legislative instrumenatalistics and codex Alimentaries commission which are related to find norms with the aims to establish Food Safety and Standards Authority of India(section 4). The new act has been introduced with the intention of providing safe, hygienic and wholesome food for the citizen's of the country. It also bestows responsibility on the manufacture and supply safe, hygienic food and wholesome food. It provides provision regarding food recall problems and improvement notice, compensation to the victim or the legal represented to be paid by vender or manufacturer. The main features of the Act are to establish an integrated line of control and response, decentralization of licensing, single reference point, self-compliance, making the business food operators to ensure the quality at all the stages and the act claims to be contemporary, comprehensive, and having standards based on science and transparency **[5,6,7]**.

3. **Control approaches and safety measures for food Adulteration and food safety** **(9,10,13.17,18)**

Establishment of food safety policy provides guidance as to the appropriate level of protection and the scope of the food safety. While establishing food safety policy, it should be carried through an open and transparent process. Increased transparency also protects the interests of consumers, as well as of trading partners. The local regulatory bodies/authorities have limitations and been in-effective even though the regulations have been tightened recently after the enactment of FSSAI (Food Safety and Standards Authority of India).and also to drawing experts on food safety from Government (local government, state and central regulatory agencies) industry, consumer organization, academia, professional societies, representatives of farmers including dairy, fishery, animal husbandry and other food producers, food processors, manufacturers, distributors, consumer groups, public health community, health care providers, trade associations, media(4). It is possible to control the food adulteration and food safety through proper approaches by statutory and regulatory authorities; industry, scientific community and consumers i.e. end users **[9,10,12]**.

Table 1 shows that **Control approaches and safety measures for food Adulteration in India**
Source-Fssai

4. Recommendations:

The government on its part can make the consumer aware of their rights and responsibilities by campaign make the complaint procedure consumer friendly, availability of quality fair price shop for poorest quintiles. Only when the people are aware of their rights to demand pure and nutritive food instead of becoming brunt and suffering quietly and take to task the unscrupulous traders and manufacturer by way of filing public interest litigation in court, then only such serious social evil of food adulteration can be aborted to certain extent. Honest implementation of law is a key approach.

5. Conclusions.

Adulterant is rampant in poor strata of society due to consumer's illiteracy and ignorance of their rights responsibilities towards food adulteration. Food adulteration is a socio–economic crime, a mode of adulteration is harmful for human beings and source of profits is for businessmen who are involved in adulteration activities .Government of India enacted an integrated comprehensive control legislation Act called food safety and standards act 2006, rules 2011, regulations 2011. Better auditing, Food safety management system (FSMS), traceability, recall and other systems in place under the new act which will help in curbing food adulteration. The use of biotechnology can lead to improved food safety by reducing pesticides use and enhancing the post harvest keeping quality of products, however may pose health risks duo to possible transfer of toxins and allergens between species. For adulteration controls, integrated approach through statutory and regulatory authorities, industry, scientific community, consumer guidance, voluntary agencies, proper counseling and IECT (Information, Education, Communication and Training) materials can play a vital role.

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Sr.no	**Government**	**Consumer**	**Industry/Trade**	Scientific community/Academia
1	Information gathering and research, Regular interactions with the industry to understand their concerns	Community participation	Train managers and food handlers	Conduct useful research
2	Provision of health related services	Active consumer groups	Information labeling and consumer education	Identify gaps by community need assessment
4	Food legislation and enforcement	Educated and knowledgeable public	Good practices by primary producers and distributors	If possible do intervention studies eg. RTE/RUTF
5	Advice for industry/trade	Discriminative and selective consumers	Quality assurance and control of processed foods	Capacity building
6	Consumer Education	Safe food practice in the home	Appropriate process and technology	Method development, validation
8	Information gathering and research	Community participation	Train managers and food handlers	Meta analysis, risk assessment
9	Provision of health related services	Active consumer groups	Information labeling and consumer education	Dietary intakes/ consumption
10	Regulators to examine the research data, methods used, tests of analysis and international data/status available	Proper understanding of the adulteration issues.	Strengthen R&D	Aligning with NRV
11	Modify codex/other guidelines to suit our population needs/reference values	To know difference between the natural and aesthetic attributes [texture, appearance and taste] of foods and accepting the natural ones to the extent possible.	Invest in establishing in accredited labs	Investigate new food borne diseases, innovate methods of detection of adulterants, contaminants, and carry out risk assessments of existing and emerging problems e.g. genetically modified foods.
12	Introduction of food legislation and enforcement in consultation with other stake holders, Stringent monitoring of the implementation, Integrated approach throughout the food chain involving all the stake holders, statutory and regulatory authorities, industry, scientific community	To know the common adulterants their effect on health	Submit proof of concept	Hazard analysis critical control point (HACCP) measures relevant to each sector are identified after a carefully study and implemented rather than purely relying only on obtaining certificates
13	Advise industry and educate consumer, Successful implementation of policy programme throughout the country uniformly would ensure safe, hygienic and quality food both for domestic consumption and for export	To educate and alert them on safe consumption of food articles as well as for their good health	Evidence based product development	Food safety prevention programmes are introduced at the food production, processing and distribution chain.
14	Network with other departments of Government, Central agency is facilitating and coordinating work across all stakeholders as well as providing support and encouraging the sharing of best practices.	The codex and the committees have suggested confidence building measures among the consumers.	Testing methods based on codex /national guidelines	Guidance to stakeholders for implementation of preventive food safety measures needs to be provided.
15	From reaction and response to anticipation and prevention, Stipulating the practically feasible rules, requirements and regulations on the adulterants and updating them at regular intervals.	To know the provision for compensating the consumer who gets any injury or incur any health hazard, along with the penalty or punishment given to the perpetrator.	Methods of validation	Preparation of specific guidelines for Good agricultural practices (GAP), Good manufacturing practices (GMP), Good hygienic practices (GHP), (GVP), and (GTP) relevant to local scenario is essential.

16	Shifting the primary responsibility for food safety to industry ,	--	Quality assurance, global practices, process technology	Provide technical support to the key personnel in the use of non-regulatory options such as guidelines, advice and education.
17	By adopting a "production-to-consumption" approach to food control, Adopting risk analysis as an essential discipline to improve food safety. Adopting a more "integrated" approach to working with related sectors (such as animal and plant health)	--	Corporate responsibility	Potential food hazards can be minimized along the food chain through the application of good practices.
18	By giving industry more flexibility in implementation of controls	--	To feel more ethical and moral responsibility as food business operator to supply and serve wholesome food to the society.	Identification of key personnel at the grass root level for implementing the food safety preventive measures is essential .
19	By ensuring the cost-effectiveness and efficiency of government control functions	--	Regular update on the process and allergen related outbreaks in the world.	--
20	Increasing the role of consumers in decision making	--	Risk assessment (probability, severity) for all the ingredients, additives and processing aids and processing techniques with respective to adulteration.	--
21	Recognizing the need for expanded food monitoring	--	Frequent testing of vulnerable ingredients, additives and processing aids for positive clearance with respective to allergens.	--
22	Epidemiologically based food source attribution, Through regular updates of information regarding reported outbreaks of food safety issues pertaining to adulteration.	--	Third party auditing of the process to identify existing and probable lacunae of the system	--

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