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Chemical Contaminants of food, Related Health Risks & Possible Remediation

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ABSTRACT

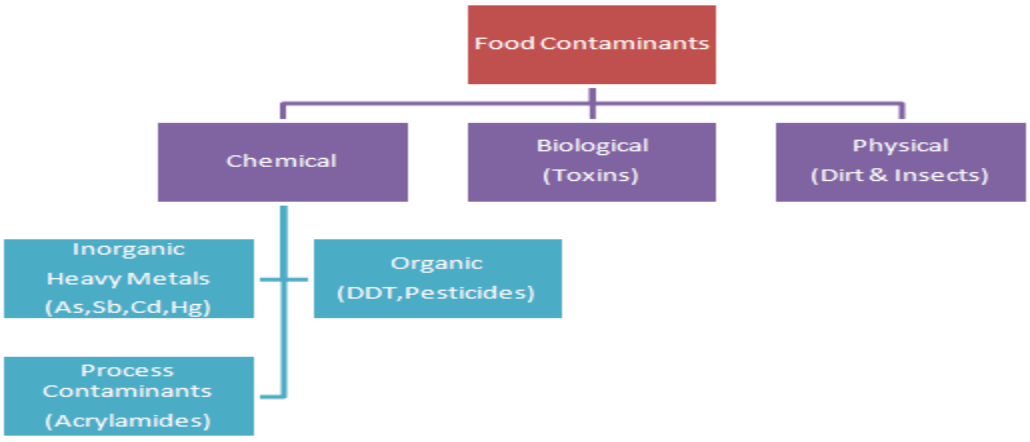
For healthy living, human beings need food, air & water. What if this food is contaminated? What we should eat then? To answer this question we have to understand the term contaminants, then its sources & then its effect on health of human beings. Recent researches have shown alarming level of chemicals present in food items whether they are produced naturally or artificially. Food contaminants means unwanted chemicals present in food affecting its quality & making it unfit to eat in long term. This review article discussed food contaminants & possible remediation or prevention method is also discussed.

Keywords: Contaminants, metals, Plasticizers, Pesticides, Organic pollutants, DDT

INTRODUCTION

As we are advancing towards a more modern world, pollution is increasing at very fast pace covering our food, water & air. Scientists around the world are much interested in finding solution to this problem. Recent researches are mainly focused on air & water pollution & it is appeared that we are slightly unaware of killing or disturbing effects of food contamination. These food contaminants after permissible levels in food can cause adverse health effects. So these are needed to be studied. Before discussing different food contaminants, we should know the meaning of term "Contaminants". Contaminants are any potentially undesirable substances (Physical, chemical, Biological) present in food, water, air & soil. This review will discuss chemical contaminants. These chemicals are normally present in our food but their excessive concentration creates health problems. WHO has defined some safety measures for food & it gives us idea about possible level of these chemicals in our food & body. According to WHO, our body can bear presence of some chemicals up to some level but after that level, it may cause some serious ill effects. So we should check our diet. Chemical contaminants include heavy metals (Hg, Cd), organic compounds (Chloropropanol), food preservative, additives & plasticizers etc. These chemicals enter food chain during handling & processing of food. Most food contains natural or synthetic chemicals. Some chemicals are introduced knowingly in food are known as additives comes under artificial contaminants. The exposure of human body to contaminants may cause several chronic diseases including metabolic & reproductive disorder & cancer.

Classification of food contaminants:



Food contaminants can be chemical or biological. Biological contaminants include bacteria fungi, toxins produced. Chemical contaminants include inorganic, organic & process contaminants.

Inorganic contaminants include DDT, pesticides etc. Process contaminants are the ones which are produced during heating or cooking of food & these may be harmful (Acrylamides).

1. Inorganic food contaminants

Food is contaminated by metals & these metals include Arsenic (As), Antimony (Sb), Cadmium (Cd), Mercury (Hg), Lead (Pb) [1]. According to food safety standards given by WHO, these metals are safe for us up to a certain limit.

A) Arsenic is a metalloid & exists normally in two forms organic & inorganic. Its inorganic form is more toxic than organic form [2]. Various chemicals are used in agricultural activities such as insecticides, herbicides, fungicides, pesticides but to a lesser extent. These agricultural chemicals accumulate in soil & plants resulting in trail amount of as in food stuff [3]. Arsenic compound has no specific taste, odor & color in water so it can't be detected easily. Arsenic compound are soluble in water so it can be present in high amount in seafood especially shellfish but it contains organic form which is less toxic [4].

Toxic effects of Arsenic [5]

1. High concentration of As can cause As poisoning which results in vomiting, diarrhea, cardiac dysfunction, muscular cramps etc.
2. Chronic exposure to inorganic arsenic via drinking water can cause Blackfoot disease.
3. The International Agency of Research on Cancer (IARC) considered arsenic as a carcinogenic agent.
4. Arsenic can also affect gastrointestinal, cardiovascular & nervous system.

Prevention – To avoid arsenic toxicity, one should follow balanced diet.

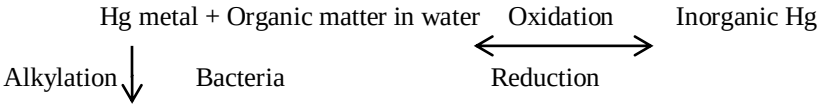
B) Cadmium is a metallic element found in some fertilizers [6]. It enters into soil. Staple food like wheat, rice may accumulate cadmium naturally by absorption from soil. Cadmium reaches to food through contaminated soil or water containing increased concentration of cadmium [7].

According to global environment monitoring system - food contamination monitoring and assessment program (GEMS) [2] of WHO, the lowest level of Cd are found in egg, fruit, milk & medium level in cereals & potatoes & highest in Kidney (shows accumulation) [8].

Toxic effects –

1. Chronic exposure of cadmium through food affect kidney.
2. IARC (1993) classified cadmium as Group 1 element which means carcinogenic.

C) Mercury exists naturally in abundance in environment by both natural & human means. Mercury exists in 3 forms – metallic, inorganic & organic (more toxic). These forms can be interconverted under some conditions [9].



Methyl Hg (widely exist, most toxic)

Use of Hg compounds in fungicides & seed treatments, disposal of Hg containing batteries increases Hg level in soil. Fish & seafood products contribute to increased level of methyl mercury. It bio accumulates in chain increasing its concentration at each step.

Toxic effects –

1. Methyl Hg poisoning includes paraesthesia, malaise & blurred vision with long latent period [10].
2. In severe cases patient may fall into coma & ultimately dies.
3. Hg affects localized positioning in Central Nervous System (CNS) affecting sensation, vision & hearing.

4. Metallic, inorganic & organic form of Hg is neurotoxic. It is found to have a very retarding effect on the fetus, if pregnant mother is exposed to low level of Hg at any stage of pregnancy.

D) Lead is metal, when present in soil may be taken up by plants (e.g. Cereals, vegetables) and aquatic food animals especially shellfish may accumulate lead from contaminated water & sediments and again can reach to our diet [11]. Lead is also added as an additive to our food & lead containing utensils such as food cans, can transfer metal to food present in can.

Toxic effects –

1. It may cause abdominal pain, vomiting & anemia on short term exposure.
2. It can cause retarded cognitive & intellectual development in children.
3. It can damage CNS of fetus & young children.

Prevention –

1. To minimize Pb level in food, we should soak & wash vegetables particularly leafy vegetables thoroughly in water before cooking.
2. Avoid food items containing high Pb content (for e.g. lime, preserved egg).
3. Food container free from Pb should be used while packaging.

E) Antimony – the presence of metals in food including Sb, As, Cd, Cr, Pb, Hg & Sn is regulated under the adulteration (metallic contamination) regulations. Antimony is a metal & metalloid silvery white solid present mostly in trivalent stable state. Its compounds have been used for treating diseases like parasitic infection in humans.

Antimony is known to be present in vegetables, meat, fresh water, fish & poultry. Toxicity of antimony & its compound depend on its water solubility & oxidation state. Trivalent oxidation state is more toxic than +5 oxidation state.

Toxic effects –

1. Large amount of antimony salt in body can cause irritation of gastrointestinal tract resulting in symptoms including vomiting, abdominal cramps, diarrhea & cardiac toxicity.
2. It is known to have genotoxic effect.

2. Organic food contaminants –

It includes chemicals like DDT & pesticides.
DDT (Di-chloro Di-phenyl Tri-chloro-ethane) – It is once a broad spectrum pesticide, now has been banned since 1970 in most countries & is regarded as persistence organic pollutant (POP's) [12]. The POPs are of particular concern due to their persistence and bio accumulation in environment. It is a organochlorine insecticide used to control insects in forest and on agriculture crops such as Colorado potato beetle [13]. DDT was first discovered in 1874 but insecticidal property came to known after 1939 [14]. It was also used to control household pests such as moth and lice.DDT has been used to control insects transmitted diseases like malaria, sleeping sickness and yellow fever [15].

Toxic Effects

1. DDT affects nervous system, It can cause convulsion.
2. The poisoning symptoms are confusion, tremor, malaise, headache, fatigue and delayed vomiting.

Pesticides are chemical substance used for killing pests in buildings and in agriculture production to improve yield and quality [16]. The adverse health effect of pesticides depends upon the toxic nature of pesticides, amount and duration of exposure of pesticides. There are four group of pesticides which are used as insecticides, herbicide, Carbonates, pyrethrins and pyrethroids and di-thio-carbonates.

Toxic Effects

1. Ortho-Phosphorus intoxication can result in respiratory failure.

2. Pesticides may accumulates in birds, animals, leading to death.

Prevention:

1. Leafy vegetable should be thoroughly washed to remove chemicals.
2. Toxic pesticides should be replaced by some other alternatives which have lesser toxic effects on human health.
3. Process Contaminants are the chemical contaminants that are produced in food industry during food manufacturing. packaging and some other processing.

Acryl-amide is a chemical produced during high temperature treatment of starch containing food. Toxic effect of these are:
1. Acryl-amide is a potential carcinogen and genotoxicant.
2. It can cause neuro-toxicity.
Prevention:
1. To minimize the risk of acryl amide in food, food should not be over cooked.
2. Meet and meet products should be cooked thoroughly to destroy pathogens.

Chloro-propanols are the chemical produced during heat processing. The two variant of Chloro-propanols are 3-mono-chloro-propan 1,2 di-ol (3-MCPD) and 1,3-dichloro-2-popanol (1,3DCP) [17]. (3-MCPD) is formed during normal heat processing steps such as baking, grilling and roasting [18]. These are some factors affecting formation of 3-MCPD in bread making include moisture content, Temperature, pH and food additives present in food. 1,3DCP is found in soya sauce, meet etc.

Toxic Effects

1. It is known to be genotoxic.
2. 3-MCPD affects kidney and CNS.

Ethyl carbonate is also known as urethane, is a chemical formed in fermented food naturally.
It use as a medicine for human beings, has been banned because of toxi-logical concern and lack of efficiency. Varying level of EC has been found in different fermented foods such as bread and soya sauce.
Toxic Effects:

It is a multi Site Carcinogen with short latency period in mice.

POLYCYCLIC AROMATIC HYDROCARBON

It is formed during dry heating of some food.PAH is a large group of organic chemicals that may be present in environment as a pollutant.These chemicals are lepophilic and chemically stable. Some PAH aresed in production of pesticides. It is studied that pyrolysis of fat at temperature above 200^{o} C result in formation of PAH. Some factor identified for formation of PAH during roasting of meet are

1. Fat content of food.
2. Duration of cooking.
3. Temperature.
4. Type of fuel.
5. Distance of food from heat source.

Some PAHs are probably carcinogenic as identified by IARC of WHO. Other contaminants are plasticizers, monomer plasticizers are a group of additives used in plastic material to improve their properties in polymer [19]. for example alkyl sebactes, butyl stearte and adipates are common plasticizers with low toxicity but they are known to cause carcinogenic and estrogenic effects. it has been reported in several survey that plasticizers migrated in to food on increasing temperature . Ham marling et. al. investigated ESBO (Epoxidised Soya Bean Oil) which is widely used in plastics such as PVC. It contains average level of 2 mg/kg in baby food packing in glass jars where as SFC has proposed use of TDI 1 mg/kg body weight. To ensure safety of consumers, the SFC has recommended use of PVC film with DEHA plasticizers whose TDI should below 0.3 mg/kg body weight [20]. Monomer are reactive substance and potentially toxic, is a ingredient of packing material. Styrene is a monomer used at industrial level. The daily styrene exposure can be up to 18.2 - 55.2 leg/person. Styrene adversely affect health of a person by causing irritation of eye, nose and skin. It also act as a depressant on CNS causing neurological impairment.

CONCLUSION AND FUTURE PERSPECTIVE

This review article has discussed number of different chemical that affect food quality. These chemical are categorized as inorganic, organic and process contaminants. These chemicals have toxic effect on health on long exposure. Researchers are being done to study the toxic effect of chemicals on food, this can help to remediate the ill effects. Mostly food contaminants discussed here are carcinogenic. So they are potentially very dangerous to human health. The toxic effect due to exposure can be minimized by taking balanced diet. The remediation process of the contaminants is only prevention and precaution. Other method may include abatement of soil and water pollution with some effective process. food contaminants directly affects our body so should be treated first or before consuming food. pesticides, used in agriculture should be replaced by some bio degradable chemicals. Chemicals contaminants is current topic of research which need help from all related areas such as environmental, chemical and biological. To control food contaminants by chemicals firstly water and soil pollutants have to be controlled then chemicals contaminants will be reduced.

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