



Food Chemicals Induces Toxic Effect on Health: Overview

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Abstract

Production of food and its preservation for long time may involve addition of chemicals. Hence, chemical substances can play an important role in food production and preservation. For.e.g. the additives in the food prolong the shelf life of foods; colours, make food more attractive. Flavouring agents like aldehydes make food tastier. Unlike any other industry, agriculture is also a part of industry. The agriculture industry relies heavily on large number of chemicals which may be toxic in nature. Some of these chemicals may get absorbed by our body. Accordingly the use of chemicals involved in production, harvesting (collection), processing, packing, transport, marketing and consumption creates deleterious effect on both human and ecology. Majority of the additives in the food may lead to headache, nausea, weakness and difficulty in breathing. The research on nerve cells has shown these chemicals to cause toxic effect on nerve cells. Although the toxicants cannot be avoided, but the level can be reduced by adopting or making use of organic, sustainable and less toxic options.

1 Introduction

In past decade there has been a spike in the demand for food. This is because the population is overgrowing and also incomes are rising. The demand to boost agriculture production to meet the daily demand of food has augmented the use of pesticides and plant hormones for agriculture purpose. The pesticides and plant hormones are chemical in nature. The rampant use of these toxic chemicals has caused long-term negative health effects on health. In majority of the population specifically in the children, the negative health effect ranges from disorders of immune system, musculoskeletal system, nervous system, and the formation of neoplasms. The hazardous substances are not only used by farmers for production, but also by retailers for storage purpose as they want to ensure that the fruits and vegetables retain their fresh look for a longer period, as desired by customers¹.

2 Food, chemicals and human exposure

Food contamination can occur if the food has come into contact with hazardous chemicals. It can also occur further down the food chain such as through eating contaminated fish. The

exposures of population at large by hazardous chemicals through the food they eat create adverse health effects. Adverse health effects are dependent on the factors of the exposure. The factors that mainly play an important role are:

- Type of chemical
- Amount or Dose of the chemical (the amount or level of a chemical a person was exposed to)
- Duration of exposure (how long did exposure occur)
- Frequency of exposure (how many times the person was exposed)

The occurrence of adverse effect on health also depends on the way the chemical enters and is excreted by human body. There are chemicals which rapidly absorb through skin. Health effects also depend on the toxicity of the chemical that has entered human body. Some chemicals are very toxic in small amounts and others are only toxic in large volumes.

The response of human being is different to chemical exposure in different ways. Some people may be exposed to a chemical

and not get sick. Other people may be more sensitive to chemicals and get sick more rapidly or have more severe reactions than others. The variables that mainly play a role in a person's susceptibility to exposure and adverse health effects include age, gender, genetics, pregnancy or other health conditions

In case of fetus, child, and adolescent, the adverse effects from exposure to chemicals is more as compared to adults. The fetus is the most susceptible because their developing organs may be permanently damaged. The factors that affect the susceptibility include developmental stage and level of environmental exposure. Similarly, children, especially from one to six years of age, are also in a stage of rapid development. During this period, children may take more chemical into their bodies due to body chemistry, level of activity, and relative small body size. As children develop, chemicals introduced into the body can alter many hormonal processes required for proper cell development. As a result, changes can, for example, cause organs within the body to be altered, impairing proper development to a mature organ. Adolescents may share in the risk due to their increased physical activity and curiosity of the world around them.

The tolerance of human body to certain amount of chemicals depends upon the rate and extent of absorption and rate and extends of excretion. Once a person is exposed to a chemical, it may enter the blood stream, and eventually reach the liver. The liver attempts to detoxify harmful chemicals in the body by converting them to less toxic ones or ones that could be used by the body. The body naturally attempts to eliminate substances that are harmful or are not used. The kidneys filter substances out of the blood and excrete them in urine. Also, chemicals are removed from the body in feces, sweat and exhalation. However, the body may not be able to remove all the chemicals. The amount, type, and length of time the human body gets exposed to harmful substances associated with food will determine adverse health effects².

Substances that are added to food to maintain or improve the safety, freshness, taste, texture, or appearance of food are known as food additives. Some food additives have been in use for centuries for preservation – such as salt (in meats such as bacon or dried fish), sugar (in marmalade), or sulfur dioxide (in wine).

Many different food additives have been developed over time to meet the needs of food production, as making food on a large scale is very different from making them on a small scale at home. Additives are needed to ensure processed food remains safe and in good condition throughout its journey from factories or industrial kitchens, during transportation to warehouses and shops, and finally to consumers.

The use of food additives is only justified when their use has a technological need, does not mislead consumers, and serves a

well-defined technological function, such as to preserve the nutritional quality of the food or enhance the stability of the food³.

The source of food additives includes plants, animals, minerals, or synthetic. They are added purposefully in the food to perform processes for consumers. There are several thousand food additives which make food safer or more appealing.

3 Category of food additives

WHO and FAO (Food and Agriculture Organization of United Nations), groups divide food additives into 3 broad categories based on their function.

Flavouring agents

Flavouring agents are the agents added to food to improve aroma or taste. These make up the greatest number of additives used in foods. A wide variety of food items ranging from confectionery and soft drinks to cereal, cake, and yoghurt include hundreds of varieties of flavoring agents. Nut, fruit and spice blends, as well as those derived from vegetables and wine come into the category of natural flavouring agents. In addition, there are flavourings that imitate natural flavours.

Enzyme preparations

Enzymes are naturally-occurring proteins that boost biochemical reactions by breaking down larger molecules into their smaller building blocks. They can be obtained by extraction from plants or animal products or from micro-organisms such as bacteria and are used as alternatives to chemical-based technology. The various uses of enzyme include: in baking (to improve the dough), manufacturing fruit juices (to increase yields), wine making and brewing (to improve fermentation), cheese manufacturing (to improve curd formation).

Other additives

The processes like preservation, colouring, and sweetening can be done using other food additives. They are usually added when food is prepared, packaged, transported, or stored, and they eventually become a component of the food.

Decomposition of food is caused by mould, air, bacteria, or yeast. Preservatives slow this decomposition. In addition to maintaining the quality of the food, preservatives also help control contamination that can cause foodborne illness, e.g. botulism.

Coloring is added in foods to replace colours lost during preparation, or to make food look more attractive.

Non-sugar sweeteners are often used as an alternative to sugar because they contribute fewer or no calories when added to food.

4 Health risk of food additives and its evaluation

The evaluation of risk to human health with food additives is conducted by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). This is an independent, international expert scientific group responsible for assessing the risks to human health from food additives.

Risk Assessment of Food Additives

As per WHO, only the food additives that undergo a JECFA safety assessment can be used. The above applies whether food additives are derived from a natural source or synthetic. National authorities, either based on the JECFA assessment or based on an independent national assessment, can then authorize the use of food additives at specified levels for specific foods.

The evaluation by JECFA is based on scientific reviews of all available biochemical, toxicological, and other relevant data on a given additive.

Acceptable Daily Intake (ADI) is the starting point for determining whether a food additive can be used without having harmful effects. The ADI is an estimate of the amount of an additive in food or drinking water that can be safely consumed daily over a lifetime without adverse health effects.

5 International standards for the safe use of food additives

The safety levels determined on the basis of assessments completed by JECFA are used by the joint intergovernmental food standard-setting body of FAO and WHO, the Codex Alimentarius Commission. These bodies establish levels for maximum use of additives in food and drinks.

National food regulations need to be implemented permitting the actual use of a food additive. Once a food additive has been found to be safe for use by JECFA and maximum use levels have been established in the Codex General Standard for Food Additives.

6 Standards and guidelines on food labeling

The Codex Alimentarius Commission establishes standards and guidelines on food labeling. People who have allergies or sensitivities to certain food additives should check labels carefully.

The national authorities are encouraged by WHO to monitor and ensure that food additives in food and drinks produced in their countries comply with permitted uses, conditions and legislation. National authorities are primarily responsible for ensuring that the use of a food additive is safe and complies with legislation in their respective countries.

7 Adverse effects of Food Chemicals

Aluminium and Alzheimers Disease

Aluminium is used as a direct food additive as a firming agent, carrier, coloring agent, anticaking agent, dough strengthener, curing agent and texturizer. Direct food additives are those that have been intentionally added to food for a functional purpose, up to few percent. These additives are used in milk, processed cheese, yogurt, cheese, jams and preserves.

In recent years the risk of Alzheimer's disease has been linked with the use of Aluminium. The proportion of elderly people is showing rapid increase and is suffering with the disease. In recent times reports have indicated the intake of aluminum as a risk factor.

The intestinal absorption of aluminum differs according to its chemical structures, coexistent substances such as maltose, citric acid, silicon and hydrogen ion concentration exponent. There is likelihood that Aluminum absorbed from the intestine possibly gets accumulated in the brain tissue. There are some reports which indicate that the aluminum in the brain are toxic to nerve cells and produce Alzheimer's disease-like pathological or biochemical changes in animal brain. While there are a number of epidemiological reports which show that the presence of aluminum in the water supply relates to the disease incidence⁴⁻⁵.

Aluminum-induced bone disease

Osteomalacia is the manifestation of Aluminum-induced low-turnover bone disease. In a dialysis patient Aluminum-induced bone disease is seen when serum Al is greater than thirty microgram per litre⁶⁻⁸.

Aluminum-Induced microcytic anemia

A microcytic, hypochromic anemia is associated with elevated plasma Al in chronic renal failure patients⁹.

Aluminum toxicity in the premature infant

Premature infants are fed intravenously, because they do not tolerate oral feeding. The calcium gluconate and phosphates which are used as components of the feeding solution given intravenously contain significant amount of aluminum. In premature infants kidneys are not fully matured and therefore their ability to excrete the aluminum is very less. Consequently premature infants are at risk of sufficient aluminum accumulation as these may develop metabolic bone disease, cholestatic hepatitis, and reduction of mental development.

Fish Consumption and its effect on health

Epidemiological studies have indicated that fish intake is associated with neurocognitive development and visual outcomes in children are attributed to long-chain polyunsaturated fatty acids (PUFA). Methyl mercury (MeHg) represents the most toxic and abundant form of environmental mercury (Hg) exposure to humans and exposure occurs primarily through fish consumption. In a study¹⁰ conducted on fish consumption during childhood in Portugal, the intake of Hg

from fish was estimated and the indices of risk was calculated. The study demonstrated the presence of risk in subsets of the population. As per the study risk communication and population education need to be established to prevent consumption of predatory fish species that contribute to the increase in risk toxicity and to encourage ingestion of prey fish, which represent significant levels of high-value nutrients such as PUFA.

Another study¹¹ indicated that the numerous health benefits provided by fish consumption were compromised by the presence of toxic metals and metalloids such as lead, cadmium, arsenic and mercury. These metals and metalloids indicated harmful effects on the human body if consumed in toxic quantities.

Toxic Trace Elements and Gastrointestinal Toxicity

Depending on their concentration and chemical form, many trace elements have been considered essential [iron (Fe), zinc (Zn), copper (Cu)], whereas others have been considered harmful [lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As)]. As per the study¹², the main route of exposure is oral. The excretion or passage through the gastrointestinal tract has a role in their entry into the organism to elicit the toxic effect.

Bakery Products and Metabolic Stress

During modern thermal cooking or processing, the ingredients commonly present in processed foods act as excellent substrate for chemical reactions¹³. Carbon nanostructures (CNs) get formed due to complexation or polymerization of partially combusted lipids, proteins, and other food macromolecules with synthetic food additives during high temperature food processing or baking (at high temperature of 200-250°C). These unknown nanostructures produce adverse physiological effects or potential health risks.

8 Summary and conclusion

The continuous exposure of toxic chemicals present in food contribute to a plethora of diseases and other toxic effects in human beings. Food additives have been implicated as a contributing factor to dementia, bone disease, microcytic anaemia. Preservatives are added to many processed foods including breads, cereals, and meat. Studies have found additives as a source of nausea, weakness, headaches, and difficulty in breathing.

New research has shown that they may damage human nerve cells. The toxicants in our food can not be avoided entirely, but several things can be done to reduce exposure. This includes choice of organic, less-toxic and sustainable options and demand of local and farm food.

9 Conflict of interests

There is no conflict of interest

10 Authors contributions

MS and AP carried out literature review and draft the manuscript. CR and SS participated in collection of data. Both authors read and approved the final manuscript.

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