Risk Management of Chemical Hazards Arising During Food Manufacturing

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Abstract The three main types of food contaminants are physical, chemical and microbiological. Since ancient times chemical hazards are known as potential food safety concerns. These hazards may be transmitted into food at all phases in the processing, packaging, transportation, supply chain, including production and trade. The chemical hazards can arise in distinct forms and as a result of various events. With the advancement in the technology, detection of such contaminants becomes easier. Risk management of chemical hazard requires a vigorous management of food safety system that has focus on operational prerequisite programs, such as trader quality assurance and inventory control as well as Hazard Analysis and Critical Control Point (HACCP). This chapter highlights various groups of food contaminants, their occurrence in the food chain. Other part of the chapter mainly focuses on food process toxicants, food additives and nutrients, and approaches to be employed to solve the risk they pose to the consumer and prevent them from health hazards.

Keywords Risk management · Chemical hazards · Food safety · Food processing

Introduction

Since ancient times chemical hazards are known as potential food safety problems in terms of guideline (Sumar and Ismail 1995) and procedures of analysis to detect them (Accum 1820). These hazards are major cause of contamination of food and in extreme situation lead to outbreaks of food-borne diseases (Faille et al. 2018). Accidental or intentional contamination of food is an unfortunate act having serious consequences on human health. Food contamination was recorded in history

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A. Malik et al. (eds.), *Health and Safety Aspects of Food Processing Technologies*, https://doi.org/10.1007/978-3-030-24903-8_13

8000 years ago, however, with the advent in the agri-food industry and globalization, this problem has been spread all over the world (Robertson et al. 2014). The contamination in food may be caused during various stages of procurement, handling, processing, packaging and transportation.

There are several reasons of food contamination (Ingelfinger 2008). Preparation of food is subjected to a series of processing, where each phase is a possible source of contamination by hazardous chemicals. For improving the shelf life of a food product, some chemicals are intentionally added during the food preparation. Chemical hazards in food generally consist of food processing contaminants, environmental contaminants, unapproved adulterants and food additives (Mastovska 2013). Environmental contaminants refer to impurities added by humans or naturally occurring in air, water or soil. Food processing contaminants are produced in food during cooking, heating, roasting, canning, hydrolysis or fermentation (Schrenk 2004). In this chapter various groups of food contaminants and the principles that underlie the effective management of risks related to the chemical hazards by agribusinesses has been discussed.

Risk Management of Chemical Hazards

All over the world regulatory agencies have recognized the risks that chemical contaminants pose to the food supply. As a result, they have established the limits for many of these compounds in different food categories in order to protect the people from exposures to contaminants level which may pose adverse health effects. The growing complexity of global food trade (Ercsey-Ravasz et al. 2012) combined with the patchwork of regulatory requirements, has created additional challenges in ensuring both the security of the food supply and its full compliance with regulatory requirements.

Food marketing and manufacturing in different parts of the world also requires companies for ensuring safety of food for human consumption and to meet regulatory requirements. In the European Union, regulations also require companies to take steps to ensure that the food ingredients they use also conform with all applicable regulations on chemical contamination (European Parliament 2006). However, the application of a food safety standard that ensures compliance with different national regulations on chemical contaminants presents many challenges. Because of the need to prioritize regulations for chemical contaminants and complexity of the number of different foods in the food supply, national regulations do not set limits for all relevant chemical contaminants for all possible categories of foods. The importance of setting limits for chemical contaminants in ingredients and products is particularly important in view of the fact that many chemical contaminants are inherent in the environment and therefore remain in trace amount in the food supply. The challenge for global agribusinesses is to create a chemical contaminants control program that ensures product safety and regulatory compliance. Establishing a science-based, risk-based approach to define target lists and limits for chemical contaminants in food categories, which would allow companies to reduce the risk of ingredients and products exceeding national regulations. In addition, such an approach would enhance public confidence in the food supply safety and inform regulators that the risks associated with contaminants are being addressed.

Risk management is defined as "coordinated activities to direct and control an organization with regard to risk" (British Standards 2002). Chemical hazard's risk management starts with the recognition of the Paracelsus statement (1493-1541) "the dose makes the poison" (Borzelleca 2000). Paracelsus dictum indicates that toxic effect of a substance depends both on the amount and frequency of intake. In general, therefore, toxicity may be acute when a response is induced after a single or small number of (relatively) high doses (e.g., paralytic shellfish poisoning), or chronic, when an adverse event occurs after long-term exposure at (relatively) low doses (e.g., dietary arsenic-induced skin cancer). In terms of risk management, the Paracelsus dictum delivers a limit value, which distinguishes among safe and dangerous consumption. These values are established using risk assessment procedures (Benford 2012). Then the values can be used to update regulatory limits.

International best practice believes that this is best achieved through risk-based management approach. In addition, where this is unavoidable, as a general principle and even in the absence of appreciable risk to the consumer, the limits for chemical contaminants must be consistent with the ALARA (as low as reasonably achievable) principle (Food and Agriculture Organization 1997). The principle generally employed to the setting of regulatory limits for certain chemicals and is frequently included in the Regulation for contaminants for which limit does not exists (Council of the European Communities 1993).

The reviews of BS ISO 31000:2009 (British Standards 2009) indicates that, in a commercial (food) context, risk management considers not only aspects of the hazard and its probability; but also all the business operations and mechanisms necessary to ensure that the risk can be maintained at an acceptable level. For this a farm-to-table approach is required. Alldrick (2012) suggested that such an approach needs know-how of the way and where the contaminants happen within the food chain; the effects of industrial transformation; handling of foods after the purchase and ultimately; who ends up consuming it. Therefore, risk management of chemical hazards needs a robust food safety management system and also operational prerequisite applications, like trader quality assurance and record control as well as the implementation of Hazard Analysis and Critical Control Point system.

Chemical Hazards in Food

Essentially, potential chemical contaminants in foods (Fig. 1) can be classified into the following categories:

1. natural toxins, for example plant toxins, phycotoxins and mycotoxins.
2. environmental contaminants, for example heavy metals.

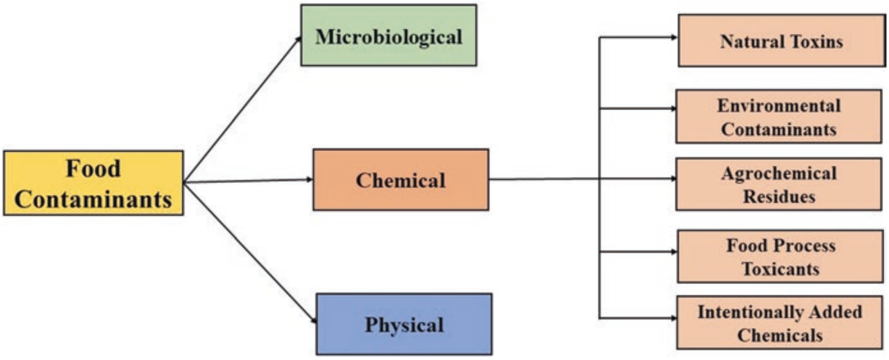

Fig. 1 Chemical hazards associated with food

3. agrochemical residues, for example pesticides and veterinary drugs.
4. processing toxicants, for example heterocyclic aromatic amines, acrylamide.
5. internationally added chemicals, for example food additive and nutrients.

Natural Toxins

Phytotoxins

Several plant foods have pharmacologically active elements that sometimes can be precisely eaten for the properties they bring (example, caffeine in coffee). In other cases, herbal foods may comprise pharmacologically active substances that at even comparatively low concentration can result in disease or death. These compounds are termed as phytotoxins and are frequently secondary metabolites (for example, alkaloids, phenolics and terpenes); but it can also be proteins such as lectins of certain legumes (D'Mello et al. 1992). Pyrrolizidine alkaloids are an example of how consumers may be exposed to phytotoxins as a result of consuming foods in which the producing plant is accidentally mixed or bioaccumulated. The 1, 2-unsaturated alkaloids of pyrrolizidine are known for causing hepatic veno-occlusive disease which, in its acute form led to high mortality incidence and in its chronic form results in liver cirrhosis (WHO 1988). The poisoning of these compounds is related with the cereal crops contamination with *Heliotropium* species seeds in different portions of the world. Research work in Germany have shown the presence of common groundsel (*Senecio vulgaris*) leaves and flowers, that may also have pyrrolizidine alkaloids as a contaminant of mixed salad preparations, and Bundesinstitut fur Risikoberwertung (BfR) has suggested the limits of these compounds from *S. vulgaris* must be maintained as low as possible (Dussemund et al. 2010). Food Safety and Standards (Contaminants, toxins and Residues) Regulations, 2011 has given permitted limits of some natural toxins (Table 1).

Table 1 Permissible limits of some natural toxins in foods

Name of the chemical contaminant	Description of food	Limit µg/kg
Aflatoxin	Cereals and cereal products	15
	Pulses	15
	Ready to eat nuts	10
	Spices	30
Aflatoxin M1	Milk	0.5
Ochratoxin A	Barley, wheat, rye	20
Patulin	Apple juice and apple juice ingredients in other beverages	50

The European Food Safety Authority (EFSA) assessed the risks associated with the occurrence of phytotoxins in honey (European Food Safety Authority 2011) and suggested that although, in general, there is no harm to the majority of the population but young children and babies who consume a lot of honey are likely to worry about their health. Therefore, agri-food companies must follow their food safety management systems considering the raw material and the target market product. Hence based on the situation, various risk management strategies will be taken into account. When phytotoxins are directly linked with the plant being used, risk management may involve following methods: vertical selection of cultivars having lesser levels of chemical contaminants; post-harvest culture and handling of the plant to minimize the production of phytotoxins or removing contaminated plant; also the treatment for denaturing or removing contaminants from the food. For example, the maintenance of low levels of glycoalkaloid (solanine and chaconine) in potatoes by minimizing the light exposure during tubers developing and post-harvest storage (Potato Council 2015); thermal denaturation of lectins (phytohemagglutinins) in some legumes (Almeida et al. 1991). In general, for many phytotoxins-plant combinations, no limit is set neither in the Codex Alimentarius nor at a regulatory level. Therefore, food businesses should be conscious of the potential of plant foods to include these compounds and ensure, through the approaches described above, that their concentrations are as low as reasonably achievable (ALARA principle) to avoid any risk of contamination.

Phycotoxins

Phycotoxins are produced by cyanobacteria. They have various chemical structure and pathologies. Bioaccumulation of phycotoxins in both aquatic animals that consume algae and in their predators, which ultimately enter the food chain thus posing a risk to the consumer (Etheridge 2010). Some examples of phycotoxins are paralytic toxins in molluscs (PSPs) (saxitoxins), diarrheal toxins (DSPs) (okadaic acid) and neurotoxic toxins (NSPs) (Brevetoxins). Phycotoxins can also be a problem in sea fish, such as ciguatoxins. Phycotoxin contamination in drinking water led to toxicosis in farmed animals (Fitzgerald and Poppenga 1993), in humans (Pouria et al. 1998) and in their pets (Lürling and Faassen 2013).

For protecting the consumer from harmful properties of phycotoxins and other health threats, risk management has defined laws. Regulatory authority regularly monitors the fishery. Such as the Food Standards Agency in England and Wales conducts weekly investigation of fisheries for determining phycotoxins levels in shellfish and algae (Food Standards Agency 2015). These monitoring systems allow control authorities to inform producers of the risk of unacceptable contamination and the possibility of closing the fishery if the limits are exceeded. Among other risk management measures, it is recommended that consumers avoid or limit fish consumption and avoid fish body parts like liver, eggs and head, intestines, known to have a particularly high rate of ciguatoxins (Ansdel 2014). For microcystins in drinking water, WHO has proposed an indicative limit of 1 μg/L (World Health Organization 2011). Guidance on the management and elimination of toxin in drinking water sources is also available (US Environmental Protection Agency 2014).

Mycotoxins

The toxic metabolite produced by some fungi like molds, that infect and multiply in agricultural products (eg. corn and wheat, fruits, peanuts and nuts) in the field and during storage are defined as mycotoxins. Mycotoxins include aflatoxin, fumonisin, deoxynivalenol (vomitoxin), ochratoxin and patulin. They can produce several toxicological effects. Some mycotoxins are mutagenic, carcinogenic or teratogenic, in susceptible animal species and are known for causing different diseases in livestock and humans. Their occurrence in human and animal foods is inevitable. Environmental factors like temperature, humidity and rainfall during the pre-harvest, harvest and post-harvest periods play an important role in their occurrence in food products. Mycotoxins are contaminating about 25% of world's agricultural production (Charmley et al. 1995) and these are the widely produced and controlled food contaminants in the world (Van Egmond and Jonker 2004). With regard to their toxic and other biological effects, the aflatoxins are very interesting compounds. Acute or subacute poisoning resulted in animals by feeding aflatoxin-contaminated diets or by treating with purified preparations of toxins. Levels of Aflatoxin in the feed to 10–100 ppm or less resulted in poisoning in most domestic animals. Although cattle tolerate relatively high levels of the toxin, they secrete in milk aflatoxin M_1, a derivative that is also toxic. Aflatoxin B_1 is among the most potent chemical carcinogens known, and it is this property that has provided an important stimulus for research on these mycotoxins. The presence of these toxigenic molds in human foods presents an obvious potential risk to public health, which provides strong motivation for implementation of all available techniques for minimizing contamination of foods by mycotoxins.

Based on the strategy of prevention concept the codes of practice were developed (Battaglia et al. 1996). Both internationally and nationally the codes of practice include: patulin in apple juice and related products (Codex Alimentarius Commission

2003a); mycotoxins in cereals (Codex Alimentarius Commission 2003b), aflatoxins in peanuts (Codex Alimentarius Commission 2004) and nuts (Codex Alimentarius Commission 2005a) and ochratoxin A in wine (Codex Alimentarius Commission 2005b) and coffee (Codex Alimentarius Commission 2009).

Environmental Contaminants

Heavy Metals

Heavy metals including lead, cadmium, arsenic and mercury, may be of concern in some foods due to agricultural practices (use of pesticides containing heavy metals etc.), industrial waste or the leaching of the heavy metals contained in equipment, containers or utensils in contact with food. Their toxicity depends on their molecular form such as inorganic arsenic is more toxic than the organic form (European Food Safety Authority 2009); while organo-mercury compounds are known for more toxicity (European Food Safety Authority 2012). The consumption of foods contaminated with heavy metals have adverse health consequences. Exposure to lead can hinder cognitive development in children (FDA 2006). Inorganic arsenic consumption resulted in skin lesions, cancer, cardiovascular disease, developmental effects, neurotoxicity and diabetes in humans (JEFCA 2010). Bandara et al. (2010) suggested that rice contaminated with cadmium is due to the use of fertilizers. The dietary exposure to arsenic is related with contamination of groundwater with high levels of arsenic. Sources of human exposure are thus drinking contaminated water or consuming contaminated crops irrigated with groundwater (World Health Organization 2012). Permissible limits of some heavy metals in food and food products according to Food Safety and Standards (Contaminants, toxins and Residues) Regulations, 2011 are given in Table 2.

The adoption of stricter environmental protection regulations will result in reduction in levels of heavy metals in the environment which also resulted in simultaneous decline in the concentrations of heavy metals in plant based foods (Kabata-Pendias and Mukherjee 2007). When a heavy metal that requires preventive control is identified by hazard analysis, the type of control depends on entrance of heavy metal in the food product. If the food product contains a food crop contaminated with heavy metal through contaminated soil, a preventive control such as a supply chain control with a verification program to ensure that the grower performs an evaluation of the growing area before the use of it for agriculture may be appropriate.

Table 2 Acceptable limits of some heavy metals in foods

Name of the chemical contaminant	Description of food	Maximum permitted concentration in parts per million
Lead	Edible oils and fats	0.5
	Infant milk substitute and infant food	0.2
	Fruit and vegetable juices	1
	Corned beef, cooked ham, luncheon meat, chopped meat, canned chicken, canned mutton and goat meat	2.5
	Berries and other small fruits	0.2
	Citrus fruits/pome fruits/stone fruits	0.1
	Fruiting vegetables	0.1
	Legume vegetables	0.2
	Pulses	0.2
	Poultry meat	0.1
	Fish	0.3
Copper	Infant milk substitute and infant food	15
	Juice of grape, orange, tomato, apple, lemon and pineapple	5
	Tea	150
	Pulp and pulp products of any fruit	5
	Foods not specified	30
Arsenic	Milk	0.1
	Infant milk substitute and infant food	0.05
	Juice of grape, orange, tomato, apple, lemon and pineapple	0.2
	Pulp and pulp products of any fruit	0.2
	Fish and crustaceans	76
	Foods not specified	1.1
Cadmium	Infant milk substitute and infant food	0.1
	Fruiting vegetables	0.05
	Leafy vegetables	0.2
	Legume vegetables	0.1
	Pulses	0.1
	Rice, polished	0.4
	Wheat	0.2
	Fish	0.3
Mercury	Fish	0.5
	Other foods	1
	Non-predatory fish, crustaceans, cephalopods, molluscs	0.5
	Predatory fish (tuna, marlin, sword fish, elasmobranch)	1
Methyl mercury	All foods	0.25
Chromium	Cereals and vegetables	1
	Meat of animal and poultry	1
	All fishery products	1

Agrochemical Residues

Pesticide Residues

Presence of pesticide residues is of concern in food crops and in foods of animal origin (due to pesticide residues in animal feed). "The term pesticide is used for products such as insecticides, fungicides, rodenticides, insect repellents, herbicides or weed killers, and some antimicrobials intended to prevent, destroy, repel or reduce all types of pests" (EPA 2015). Bioaccumulation of some pesticides can also occur via food chain, such as in eggs (Holmes et al., 1969) and milk (Salas et al. 2003). Food products adulteration with pesticide residues happens through improper handling of raw materials containing registered pesticides and raw materials exposed to banned pesticides.

For regulation of pesticides three federal agencies have share the responsibilities. Those pesticides that have been approved by the US Environmental Protection Agency (EPA) can be applied directly to crops according to the labelling instructions. The EPA sets a tolerance, i.e. the maximum amount of pesticide residues allowed in or on a food for registered pesticide. The responsibility of FDA is to implement pesticide tolerances for foods other than meat, poultry and certain egg products, which is the responsibility of the US Department of Agriculture Food Safety and Inspection Service (USDA FSIS) (FDA 2012). Regulations such as EU Regulation 396/2005 (European Parliament and Council 2005) postulate that which pesticides may be applied to which crops and what residual quantities are authorized in food stuffs anticipated for human consumption. Given the variety of possible combinations of pesticide crops and pesticides, these are supported by a database to facilitate regulatory agreement (European Commission 2015). The risk of pesticide use is reduced partly by advising the accountable makers of pesticides to the end-users. It specifies the plants for which the pesticide may be used, and suggested rates of application.

Animal Drug Residues

Drug residues in animals may be a problem for foods of animal origin (muscle meat, organ meat, fat/skin, eggs, honey and milk). These occur after the giving medicines to livestock. Medications are commonly administered for any of these reasons: therapeutic (for curing animal from a particular disease), prophylactic (to prevent the contraction of a certain disease) or directly for growth promotion. The first danger to the consumer is the inadvertent use of pharmacologically active residues with possible harm. Depending on the chemical properties of the drug, residues of certain drugs may concentrate during food preparation and processing. For example, if a fat soluble, heat stable drug residue is present in raw milk, the drug may concentrate when the milk is converted to full fat cheese (Cerkvenik et al. 2004; Imperiale et al. 2004). An example of unauthorized drug residue that adulterated foods is fluoroquinolone, an antibiotic that is not approved for use in honeybees in the US and has been detected in honey products from certain non-US regions (FDA 2015).

Issues related to the risk management of veterinary medicines generally indicate one or more of the following: failure in best practice; imports of meat inclosing drug residues authorized in the exporting country but not in the importing country; or the use of unauthorized medicines to gain an unfair economical profit.

Legal regulations have been made in many countries that require veterinary medicines to be allowed only by the European Union, the European Medicines Agency (such as the European Parliament and Council 2009) and that their residues in food should not surpass the levels of special regulation. In some jurisdictions, usage of some drugs in all or in some animal groups is strictly prohibited. The EU has prepared a list of banned drugs that do not have a maximum residual limit (MRL) (European Commission 2010).

Food Process Toxicants

Food process toxicants are chemical hazards that arise directly during food processing (Lineback and Stadler 2009). Generally, these arise in consequence of chemical reactions that occur due to thermal processing or activities of microbes occurring in processing and/or storage (e.g. histamine in fish and ethyl carbamate in fermented products). Some of them also occur as environmental pollutants like polycyclic aromatic hydrocarbons (PAHs) and if occur either in feed or drinking water, they can be bioaccumulated in substantial amounts in meat, fish, and other animal products (eggs, milk).

The heat usage in the making process is additional cause of contamination. Usage of high temperatures during cooking in households and in industry is the commonly used process for the processing of food. The practice of a high cooking temperature coupled with external factors may result in the toxic compounds formation which affect food safety and quality. Harmful compounds like acrylamide, nitrosamines, chlorophenols, PAHs, furans are formed during processing food operations such as roasting, heating, grilling, baking, preserving, fermenting or hydrolysing (Nerín et al. 2016). Deep frying is a major basis for the production of number of toxic compounds in food manufacturing processes (Roccato et al. 2015). These thermally-made compounds occur due to two general mechanisms. Firstly, the partial burning of cooking fuel (PAHs), during smoking (Gomaa et al. 1993), or in domestic cooking, for example, the burning of fuel during grilling (Lijinsky and Ross 1967). Second mechanism is the result of chemical reactions that occur during cooking process. Examples include chloropropanols, acrylamide and heterocyclic aromatic amines.

The risk management of food process toxicants is partly based on their chemistry of formation and the impact of processing on these reactions. Some combinations of chemicals and food have legal limits. For example, limits have been set in the European Union for the occurrence of chloropropanol-3-monochloropropane-1,2-

diol (3-MCPD) in hydrolysed vegetable protein and soya sauce; and dioxins in animal origin products (eggs and milk, meat) and fish origin (European Commission 2006). Similarly, there are legal limits on the existence of histamine in fish products (European Commission 2013) and certain heterocyclic aromatic amines in meat flavors (European Parliament and Council 2008),

Another example of food process toxicants is of acrylamide. Important sources of acrylamide in the diet are high carbohydrate contented foods (coffee, baked pastries and fried potato products) produced at high temperatures (Svensson et al. 2003). For various foods of potential high-risk, extensive research helped in the identification of mitigation measures. One such measure is the "Acrylamide Toolbox" (Food Drink Europe 2014). The toolbox works on the ALARP principle. It addresses issues of how precursors can be formed or removed earlier for processing, also processing alternatives to lessen formation of acrylamide.

Intentionally Added Chemicals

Food Additives

Food additives and nutrients have been added to foods since prehistoric times. Although staple foods do not contain additives as food are processed to be converted into a variety of products, more and more additives usually are used. With the technical advancement in food processing many different additives are used. For achieving the desired effect more than 3000 diverse additives are deliberately added to foods. A food additive is a substance whose anticipated usage causes it to be incorporated into the food or affect the food properties. The additives usually offer some profit to the food manufacturers, processors or consumers. For consumers, additives can enhance the organoleptic properties of foods, increase their nutritional value otherwise facilitate the preparation of ingredients and meals. For the food manufacturer or processor these additives improve product quality, variety safety and shelf life.

Additives can occur in different amounts in foods, play various tasks in foods and work synergistically with other additives. Important functions of these additives are (a) conserving or improving nutritional quality, (b) maintaining or improving product safety or quality, (c) assisting in preparation and processing (d) improving sensory properties (FDA 1979, 1992). Additives affecting nutrient value are mainly minerals and vitamins. Sometimes they are added for enriching foods or replacing the nutritional loss occurred during processing. For some foods, minerals and vitamins are added to fortify them for supplementing nutrients which are missing in the diet. To prevent growth of bacteria and fungi in food, antimicrobials or preservatives are used. The additives may delay spoilage or prolong the shelf life of foods by suspending lipid oxidation or rancidity. Additives used as processing or cooking aids generally affect the texture of ingredients and ready meals. Some of them are categorized as stabilizers, emulsifiers, thickeners, blowing agents, and anti-caking agents. The fourth main role of these is improving color or taste of foods in order to make them attractive. Natural and artificial colors are used to enhance the optical food appeal, to differentiate the taste of foods, to increase natural color intensity, or to restore color loss.

Direct toxicological effects of additives are of great concern. Short-term acute effects from additives are unlikely. A small number of additives are used at levels that result in direct toxicological impact. Some additives even used at acceptable limits may have severe effect on sensitive individuals. The reactions to sulfites and other additives, are examples of such a problem. With proper labeling, however, sensitive individuals should be able to avoid potential allergens. Cancer and reproductive problems are not reported in humans. However, some animal studies showed potential problems of some additives.

For ensuring the safety and efficiency of food additives many federal agencies, laws and regulations working together. The Food, Drug and Cosmetic Act of 1938 gives the US Food and Drug administration the power to regulate food, ingredients and their labelling. The amendment to the FD & C Act of 1958 on food additives requires FDA consent for the usage of new additives before their addition in food. This amendment also involves the additives manufacturer to demonstrate the safety of an additive for the recommended use until 1958 (e.g. Sodium nitrite for meat preservation).

Amount of food and color additives may be limited by Current Good Manufacturing Practice (CGMP) regulations. The Codex Alimentarius Commission Committee on Food Additives and Contaminants has established an international numbering system (INS) for food additives based on the E system (Codex Alimentarius Commission 2001). The INS system is planned as an identification system for food additives permitted for use in one or more countries.

Nutrient Additives

Recently there is increase in the use of nutrient additives. Grains and cereal products are often supplemented with vitamins for restoring the nutritional loss during processing or to increase the overall nutritional value. Minerals like iodine and iron are extremely important to prevent malnutrition. Like vitamins, minerals are mainly used in cereal products. In foods, amino acids and proteinaceous materials are not usually used, but to improve protein quality lysine sometimes added to grain.

Several processed foods have additives and/or nutritional additives (vitamins and minerals). Their usage is commonly governed by laws that vary according to jurisdiction. Restriction on the use of food additives may exist to avoid deception or for safety reasons. Sometimes food additives may be pharmacologically active when consumed in enough amounts. Such as the laxative effect of polyols and the adverse effect of aspartame (a source of phenylalanine) on persons suffering from phenylketoneurea. Therefore, foods containing them may need to contain cautions for consumers (European Parliament and Council 2008); minerals and vitamins also pose safety concerns, as the Paracelsus principle also applies. Vitamin-associated diseases are usually related with deficiency (e.g. scurvy); excessive intake of minerals or vitamins may also result in health problems. Therefore, there are indications as to which tolerable upper limits could apply to intake (European Food Safety Authority 2006).

Conclusions

Food contamination by chemicals is a serious issue. Generally, food contamination happens through environmental pollutants and naturally occurring toxins or during food processing and preparation. With the advancement in technology, these contaminants are easily detectable. But still there are many unknown contaminants hence research is required. For minimizing the individual exposure to food contaminants, the governments have taken suitable steps and measures are still needed to decrease the health risks related with chemical food contamination. Risk management of chemical hazards includes two objectives: (a) food production that ensures chemical contaminants are regulated (b) when contamination is unavoidable, the contamination level should not only be safe but also follow ALARA. Effective risk management of chemical hazards involves consideration of Paracelsus' dictum for ensuring suitable limits be set, a complete knowledge of farm-to-fork scale, together with the suitable tools for responding to an ever-changing environment.

Acknowledgments Authors thankfully acknowledge the Indian Council of Agricultural Research (ICAR) for providing funds, and facilities for experimentation under ad hoc research project on fermented sausages. F. M. is thankful to U. G. C., New Delhi for financial assistance in the form of Postdoctoral Research Fellowship for Women.

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