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Mini Review

Food safety regulation in Bangladesh, chemical hazard and some perception to overcome the dilemma

*Islam, G.M.R. and Hoque, M.M.

Department of Food engineering and Tea Technology, Shahjalal University of Science and Technology. Sylhet, Bangladesh

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Abstract

This article focus on the problems arises in public health due to the presence of chemical hazard in food supply chain and supports require for food industry of Bangladesh in order to supply safe food to the end consumer. From the evidence it may be sated that in Bangladesh food safety rules and regulation not enough to deal with the problem. Now, the country is in difficult situation with chemical hazard in food stuff. Bangladesh authorities should develop: (a) adequate infrastructures including laboratory services for inspector; (b) as well as public awareness in order to manage the situation. However, strengthening infrastructures should include getting adequate trained personnel and expertise as well as tough enforcement.

Introduction

Food safety became last decades very important for both governments, producers of food products and consumers as well. Food safety is considering mainly three types of hazards: (a) microbiological hazards; (b) physical hazards and (c)chemical hazards. However, most of the chemical hazards have long term health problems for the consumers of food products. Chemical products or contaminants can be of different nature e.g. residues of pesticides or other phyto-products applied during the production of crops, fruits and vegetables, antibiotics applied in the animal production, environmental contaminants such as heavy metals or dioxins. In this group the allergens are considered as well. This are mostly natural food components e.g. proteins, which are provoking an allergic reaction with sensitive persons (Meulenaer, 2006). Problems with food safety can be very divers in Bangladesh. However, food safety must be differentiated from food quality. Food safety is the basic requirement for a food product. Consumers may not become ill from eating a food product. Food quality on the other hand, is also important as food safety. Some secondary issues are playing roles in food quality like (Figure 1).

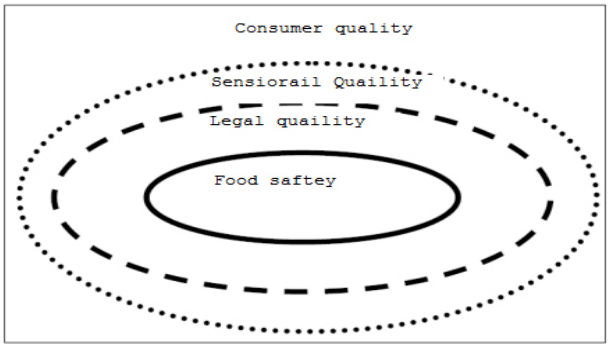

Figure 1. Relation food safety and food quality of a food product (Meulenaer, 2006)

Legal quality aspects

This demand comprises the composition of food, nutritive values and other relevant properties, as for example composition of bread, composition of chocolate, nutritive value of milk etc. This can impose differences in the same type of a food product placed on the market by different suppliers or in different countries. Some names of products are protected and can only be applied if the composition or the region of production is respected e.g. chocolate (max. 5% of other plant fats as cacao butter), e.g. champagne (sparkling wine from a specific region in France). The application of genetically modified organisms for producing foodstuffs must be seen as a legally organized quality aspect (Meulenaer, 2006).

Sensorial quality aspects

In food taste, odour, visual quality, texture etc are important because food is associated with a nice feeling; consumers are judging food products severe when buying them. Discolorations, abnormal

*Corresponding author.
Email: *rabiat14@yahoo.com*

proportions, abnormal visual aspect etc have influence on consumer behavior (Meulenaer 2006).

Commercial quality aspects

Customers can have more demands regarding food products e.g. packaging design, labeling etc which known as extra quality demands.

The complete agro-food chain needs to consider and take responsibility towards food safety in agricultural sector, transformation and distribution as well. On the other hand the consumer can play an important role in contributing towards food safety by respecting refrigerating temperatures during storage, respecting shelf-life, preventing cross contamination during preparation of the food and provided no undercooking of raw meat, fish, vegetables, etc. However, this review focuses on (i) the present rules and regulation of handling food industry (ii) some recent potential chemical hazard arises in food chain and (iii) some perception that should establish in Bangladesh to supply safe food to the end consumer.

Present status of rules and regulation related to food safety in Bangladesh

FOOD safety has become an important topic in Bangladesh as consumers of the country have become victim due to serious adulteration in food. It has been reported in the media how certain "rogue" restaurants are using dead chicken meat and sweets mixed with substances that pose health hazard. Bangladesh cannot ignore as this is a matter of life and death. We have to maintain certain standards so that consumers are satisfied with what they consumed in terms of their quality, standard and hygiene. Even the government republic of Bangladesh has to provide all necessary support to maintain the safety of foods. The constitution of Bangladesh also gives importance to food safety. Article 15 of the Bangladesh Constitution states "it is a fundamental responsibility of the state to secure provision of the basic necessities of life including food" (GB, 1972). Article 18 of the constitution states "State shall raise the level of nutrition and improve public health as its primary duties (GB, 1972)". Both the Articles imply food safety requirements for consumers and the State must be ensured through enactment of appropriate laws.

There are several laws in Bangladesh for maintaining health and safety standards. We like to give a short statement of those rules and laws so that the related official legal documents for health and safety in the past, present and future, can be better understood. All information, related there to, was gathered from a seminar of global forum for food safety regulators held in Bangkok in 2004 organized by the FAO/WHO (FAO/ WHO, 2004).

(a) The Bangladesh Pure Food Ordinance, 1959: This is an ordinance to provide better control of the manufacture and sale of food for human consumption. Now, this ordinance is under revision as 'The Bangladesh Pure Food (Amendment) Act'. Under this act, it has been proposed to constitute a National Food Safety Council, headed by the Ministry of Health and Family Welfare as well as to establish food courts.

(b) The Bangladesh Pure Food Rules, 1967: In this Rule, there are generic standards for 107 food products. Now this 'Rules' is under revision.

(c) The Food Grain Supply (Prevention of Prejudicial activity) Ordinance, 1956 (Ord. xxvi of 1979): This ordinance provides special measures for prevention of prejudicial activity relating to the storage, movement, transshipment, supply and distribution of food grains. It provides basis for the protection of false statement or information.

(d) The Radiation Protection Act, 1987: Under this Act, the Institute of Food and Radiation Biology (IFRB) of Bangladesh Atomic Energy Commission is primarily involved in food irradiation research and development in the country.

(e) The Iodine Deficiency Disorders (IDD) Prevention Act, 1989: The Government has enacted "The Iodine Deficiency Disorders Prevention Act, 1989 for universal salt iodination and banned non-iodised salt from market, aimed at virtual elimination of IDD from the country.

(f) The Essential Commodity Act, 1990: The purpose of administering this act is to stabilise, maintain or increase supply of essential commodities including foodstuffs. The mandate of Essential Commodity Act also includes broad spectrum of activities like storage, transport, distribution, disposal, acquisition, use or consumption of any essential commodity.

(g) Fish and Fish product (Inspection and Quality Control) Rules, 1997: Under this section of the Fish and Fish products (Inspection and Control) Ordinance 1983 (Ord xx of 1983) and in conjunction with fish and fish products Inspection and Quality Rules 1989, and other related provisions made there under, the government has made the Rules: Fish and Fish product (Inspection and Quality Control) Rules, 1997. These Rules are basically meant to develop quality improvement to promote export trade. The quality control of fish and fish products in the country has earned reputation among the importing countries.

(h) Other Laws and Regulations: In addition, a number of other Laws and Regulations exist in the country to ensure the safe and quality food viz., The Animal Slaughter (Restriction) and Meat Control (Amendment) Ordinance, 1983 (it is under revision); The Pesticide Ordinance, 1971 & the Pesticides Rules, 1985; Destructive Insects and Pests Rules (Plant Quarantine), 1966, amended up to 1989; Agricultural

Products Market Act, 1950 (revised in 1985); Fish Protection and Conservation Act, 1950 (amended in 1995);Marine Fisheries Ordinance 1983 and Rules, 1983; Procurement Specifications, Ministry of Food, Rice Mill Control Order etc.

(i) The Bangladesh Standards and Testing Institution Ordinance, 1985: This ordinance relates to establishment of an institution for standardisation, testing, metrology, quality control, grading and marking of goods. Within the framework of this ordinance, the government has established the Bangladesh Standards and Testing Institution (BSTI). One import task of this organisation is to certify the quality of commodities, materials, whether for local consumption or for export and import. The Ordinance has been amended as The Bangladesh Standards and Tasting Institution (Amendment) act, 2003.

It is known from the website (*http://www.bsti.gov.bd/about.html*) of the Bangladesh Standards & Testing Institution that it is a body made corporate under the law entitled, "The Bangladesh Standards and Testing Institution Ordinance, No. XXXVII of 1985". Since its establishment, it is the sole body to look after the quality of the products in Bangladesh.

However, there are many functions presented at the website of the institute. Among them the most important one to certify the quality of commodities, materials, produces, products and other things including food materials, whether for local consumption, or for export or import. But the real situation is another story. Recently, Bangladesh Television (BTV) channels screened a documentary on how bread was being made under very unhealthy environment and how Rapid Action Battalion (RAB) and mobile court identified the factory and took necessary action. Though BSTI authority concerned regarding the case, but always BSTI authority clam that they do not have enough manpower to carry out the job to control food safety in the industry. So what's the result? The country has all rules and regulations but not have enough manpower to implement them. However, the BSTI website makes mention of consumers protection (during the period of a license in operation) activates including actions being taken such as: (a)surprise inspections of the licensee's factory are being carried out periodically by qualified inspecting officers of the institution and random samples are being taken and tested at the BSTI Laboratory, (b) products bearing the standard mark are collected by the surveillance team of the institution directly from the open market and tested in the BSTI Laboratory. However, representatives from the Consumers Association of Bangladesh (CAB) and the respective chamber of commerce and industries help the surveillance team in performing its function.

Table 2. MRL value (ppm) of various pesticides in made tea in Bangladesh (Khisa and Iqbal, 2000)

Sl No.	Technical Name of the pesticide	EPA	Codex Commission	European Union	German law	REmarks
1.	Dicofol	45	8	0.1	2	Very vey restricted
2.	Ethion	10	5	0.2(proposed 0.1)	-	-do-
3.	Sethion	10	5	2	-	-do-
4.	Bromoprophylate	-	5	-	-	-do-
5.	Dimethoate	-	-	0.2	0-	-do-
6.	Endosulfan	24	30	30	30	Restricted
7.	Fenvelerate	-	-	0.1	-	Very vey restricted
8.	Cypennethrin	-	-	0.1	-	-do-
9.	Delthamethrin	-	-	5	-	-do-
10.	Chlorpyriphos	-	-	0.1	-	-do-
11.	Propargite	-	-	0.1	-	-do-
12.	Malathion	-	-	0.1	-	Do.

MRL: Maximum Residue Level, EPA: Environmental protection Agency

But in practice, all concerned know better about what the BSTI said regarding consumers' protection. This scribe thinks as consumers, we need hygienic, quality and standards product with the BSTI's certification. So far we understand from the web site of BSTI that Bangladesh Government, considering the health and safety of the consumers, has brought so far 64 Food and Agricultural Products for mass consumption under the mandatory certification marks scheme by issuing statutory regulatory orders (SROs) from time to time under the provisions laid down in clause 24 of the BSTI Ordinance 1985 (Table 1).

Potential chemical hazard in food stuffs

Dose residues of pesticides a real threat?

If the exposure to pesticide residues to the consumer should be considered, it is obvious that only the edible parts of the agricultural commodity should be taken into account (Table 2). This is particularly important, since some parts of the crop are more contaminated then others and in some cases these parts are removed before consumption (Gilden and Sattler, 2010). It is obvious that most problems occur in leafy vegetables n Bangladesh as pesticide use in Bangladesh is often excessive and unregulated. Especially the use of bromide substances as a soil disinfectant in greenhouses should be taken into consideration in this respect (ATSDR, 1992). Frequently, problems occur as well with pesticides of which the use is not allowed on a particular crop. Residues in animal products are typicall as well due to persistent organo chlorine residues (Nag and Raikwar, 2011). Generally it can be concluded that the perceived risk of the presence of pesticides by the consumer is far bigger than the actual risk. It has been suggested that the environmental risk may be more important compared to the risk for human health. Nevertheless surveillance and monitoring programmes are still necessary in order to make sure that the legislation is still implemented and thus food safety is assured.

Table 1. Mandatory certification item of food and agricultural products in Bangladesh

SL.No.	Name of the products	Standard NO.	SL.No.	Name of the products	Standard NO.
1.	Fruit Juices & Nectars	BDS CAC 247:2008	33.	Milk Fat Products	BDS CAC-A-2:2008
2.	Ice cream	BDS 1083:2006	34.	Edible Sun Flower Oil	BDS CAC 23: 2002
3.	Concentrated Fruit Juice	BDS 527:2007	35.	Butter	BDS CAC-A-1:2002
4.	Chilies, Whole and Ground	BDS 1017:2001	36.	Mosquito Coil	BDS 1089: 2007
5.	Fruit Squash	BDS 506:2002	37.	Milk Powder and Cream Powder	BDS CAC 207:2008
6.	Soyabean Oil	BDS 909:2000	38.	"Malathion 57% (W/V) (Emulsifiable Concentrates)"	BDS 1179: 2001
7.	Jams(Fruit Preserves) & Jellys	"BDS CAC 79:2008"	39.	White Bread	BDS 382:2001
8.	Mustard Oil	BDS 25:2000; Amend 3:07	40.	Plywood for General Purposes	BDS 799: 2006
9.	Sytrus Marmalade	BDS CAC 80: 2008	41.	Biscuit	BDS 383:2001
10.	Turmeric Powder	BDS 991: 2001	42.	Plywood Tea-Chest	BDS 18:2006
11.	Vinegar	BDS CAC 162:2007	43.	Lozenges Skim Milk	BDS 490:2001 Amend-1:07
12.	Edible Palm Oil	BDS 999:2000	44.	Safety matches in boxes	BDS 1040:2006
13.	Fruit Syrup	BDS 528:2006	45.	Toffees	BDS 1000:2001
14.	Sugar	BDS CAC 212:2006	46.	Wheat Bran	BDS 997:2006
15.	Honey	BDS CAC 12:2007	47.	Black Tea Definition & Basic Requirements	BDS ISO 3720:2008
16.	Suji (Semolina)	BDS 190: 1991, Amend1: 01	48.	Condensed Milk and Condensed Skim Milk	BDS -A 4:2002
17.	Canned & Bottled Fruit Formula	BDS 503:2006	49.	Liquid Glucose (Glucose Syrup)	BDS CAC 9:2006
18.	Pasteurized Milk	BDS 1702:2002	50.	Refined Palm Oline	BDS 1567:2007
19.	Fruit Cordial	BDS 508:2006	51.	Dextrose Monohydrate	BDS CAC 8:2007
20.	Chips/Crackers	"BDS 1556:97;Amend1:04 "	52.	Yoghurt and Sweetened Yoghurt	BDS CAC-A-11(a):2002
21.	Sauce (Fruits & Vegetables)	BDS 512:2007	53.	Maida	BDS 381:2007
22.	Chanachur	"BDS 1564:97;Amend1:200 4 "	54.	Curry Powder (EmulsifiableConcentrate)	BDS 1205: 2006
23.	Tomato Paste	BDS 517:2002	55.	Wheat Atta	BDS 380:2007
24.	Lachha Semai	BDS 1620:2000	56.	Fortified Soyabean Oil	BDS 1769: 2006, (1st Edtn 08)
25.	Pickles	BDS 520:2001	57.	Carbonated Beverages	BDS 1123:2002, Amend 1: 07
26.	Soft Drink Powder	BDS 1586:2007	58.	Fortified Edible Palm Oil	BDS 1770: 2006, (1st Edtn 08)
27.	Canned Pineapple	BDS CAC 42:2007	59.	Noodles	BDS 1106:2001
28.	Banaspati	BDS 804:2001	60.	Refined Sugar	BDS 138: 2006
29.	Tomato Ketchup	BDS 530:2002	61	Iodized salt	BDS 1236:2001 Amend 1:07
30.	Instant Noodles	BDS 1552:2007 (1st rev)	62	cake	BDS 1574:2006
31.	Infant Formula & Formulas for Special Medical Purposes Intended for Infants	BDS CAC 72:2008	63	Drinking water	BDS 1240:2001
32.	Processed Serial based Food for Infants & Young Children	BDS CAC 72:2008	64	Natural mineral water	BDS 1414:2000

Environmental contaminants

Industrial processes emit several thousands of inorganic and organic chemicals. Due to their emission, agricultural commodities and thus also our food may become contaminated with these compounds. It would not be feasible to monitor all the possible environmental contaminants in our food. Therefore a simple and pragmatic scheme was developed, in order to select these chemicals that are considered to be of prime importance. These criteria include the following:

- production volume, since probably the amount of chemicals emitted is related to the total amount produced
- pattern of usage or emission, since for example highly diffuse usage or emission would affect a higher amount of commodities
- possible fate in the environment, since some contaminants may accumulate in the water, the soil or other environmental compartments
- likelihood of entering in the food chain
- mechanism of entry into the food chain
- persistence in the food chain, which is a key issue because of the problem of bioaccumulation and
- toxicity

Consequently, a restricted overview of some important organic and inorganic (heavy metals, nitrate) environmental contaminants should consider. Some of them are nitrate, polyaromatic hydrocarbons etc.

Organic environment contaminant

Most important Organic environment contaminant in food chain is Dioxin and dioxin-like compounds, or DLCs that are found throughout the environment, in soil, water, and air. People are exposed to these unintentional environmental contami¬nants primarily through the food supply, although at low levels, particularly by eating animal fat in meat, dairy products, and fish (Hutzinger and Fiedler, 1993).

Numerous health effects have been linked to exposure to DLCs, including skin damage, cancer, non-insulin-dependent diabetes in adults, neurological and immune system impairments in infants, and endocrine system disruption. Many of these effects were identified in individuals who had high levels of exposure. However, information is limited on how low-level DLC exposure through foods, defined as occurring in everyday life, influences the development of cancer and other diseases (IARC, 1997). Dioxins on the other hand were not intentionally produced. Basically three sources of PCDD's and PCDF's are known:

- Chemical manufacture; During the production of

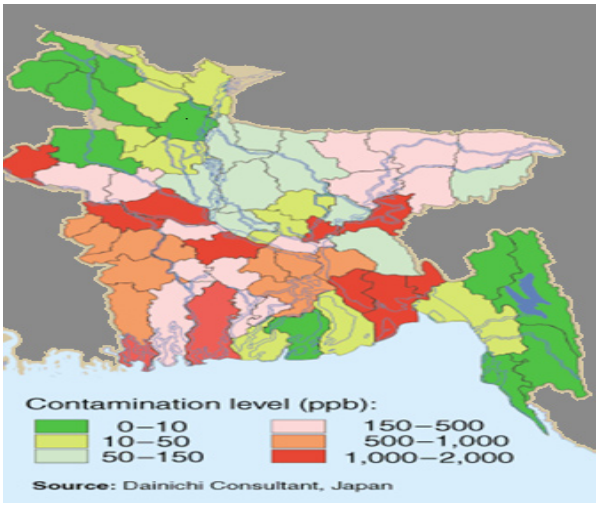

Figure 2. Arsenic affected area in Bangladesh

organo chlorine compounds, such as pesticides, dioxins may be produced as side products. Due to better control of the chemical processes however, new environmental contamination from this source is quite unlikely, but due to the persistent character of these compounds, an environmental load is still present. (Fiedler, 2003).

- Bleaching processes; traditionally chlorine was used to bleach wood pulp, resulting as well in the production of dioxins. Again due to the replacement of chlorine by non-chlorine bleaching agents, new environmental contamination via this route is unlikely (Fiedler, 2003).
- Combustion processes; during the combustion of organic material in the presence of chlorine substances, PCDD's and PCDF's are produced. The kind of combustion process may be very diverse from cigarette smoke, over emissions from incineration or steel manufacturing plants to volcano eruptions or forest fires. Stringent control on industrial plants helps to diminish the human causes of environmental contamination via combustion processes. It should be realised however that natural processes that are beyond human control cause part of the emissions. Obviously, combustion processes are nowadays the major source of PCDD's and PCDF's in the environment (Fiedler, 2003)

Inorganic environmental contaminants

Arsenic

The arsenic hazard in Bangladesh now appeared as a 'real disaster', affecting thousands physically, physiologically, mentally and economically. The futures of the Bangladesh villages are jeopardized (Figure 2). Arsenic occurs widely in the Bengal Delta Plain (BDP) aquifers in Bangladesh and India (Bhatttacharya *et al*., 1997). The inorganic of As is toxic to human being. Arsenice can inter into plants from soil and hence in food chain from contaminated soil and may infect human being as well. The terrestrial plants can accumulate a large amount of arsenic (inorganic form) soil and transfer it to the above ground biomass (Zhang *et al*., 2002). On the other hand, marine plants and animals have arsenic detoxification system and for this reason a large amount of arsenic in marine organisms is found in organic forms, such as arsenosugers in algae, and arseniobetaine, arsenocholine, arseniolipid in fish, mollusks and srustaceans (Francesconi *et al*., 1994). However, terrestrial plants do not have arsenic detoxification system and this is perhaps the reason why inorganic arsenic are predominant in terrestrial plants (Mattusch *et al*., 2000). The accumulation of arsenic in food in Bangladesh is a severe problem.

Again exists in many different chemical forms in the marine environment, of which the water soluble arsenicals are well studied, while knowledge regarding arsenolipids (lipid soluble arsenic compounds) is limited. Shrimp farming has been one of the most important economic activities in many as well as shrimp constitutes the major portion of the frozen foods exported from Bangladesh. Arsenolipids in fish oil shrimp and fresh water shrimp a potential risk factor in the food value chain (Industrial fish → Fish oil → Fish feed → Cultured fish → Consumer) not only for the people of Bangladesh but also for the people of developed country.

Lead

The exposure of lead was typically caused by the use of lead pipes in water supply systems in the past (Timbrell, 2008). Due to the extensive used of tetraethyl lead in car fuel, lead emission in the environment increased intensively. Now a day's however non-leaded fuels are used instead. Other possible contamination routes are the use of lead in the solder of some tin cans, the use of lead-containing crystal and the environmental deposition of lead containing dust on agricultural commodities. Only 10 % of the ingested lead is taken up in the digestive system (Luning *et al*., 2006). Lead is stored in the bones of our body, but is in partial equilibrium with the lead present in the blood system. Chronic exposure to lead may result in anaemia, which is rarely observed in the case of food intake. More worrying effects on young children are indications that various neuropsychological indicators show definite negative correlations with serum lead levels (Needleman, 2004). In Bangladesh Lead Poisoning in Young children is now alarming (Mitra *et al*., 2009).

Mercury

The exposure of mercury may give rise to incidental and serious poisoning caused by the consumption of treated grains (Tejning and Vesterberg 1964). Environmental contamination however is typically caused by industrial pollution of water. In addition however, also natural processes such as volcano eruptions are thought to be important in the total emission of mercury to the environment (Clifton, 2007). Mercury tends to bioaccumulate as methyl mercury in the food chain. Consequently it is not surprising that again see foods seem to be contaminated at a higher level compared to other foods (Clifton, 2007). In fact cases of mercury poisoning due to the consumption of fish caught in highly contaminated bays have been described (Cocoros *et al*., 1973). Toxicological effects are particularly situated on the level of the central nervous system. Exposure to foetuses may cause serious brain damage in the unborn child (Davidson *et al*., 004). Therefore consumption of predatory fish such as tuna by pregnant women should be limited, because these fishes are particularly more contaminated with methyl mercury compared to other fishes. In Bangladesh there still need to give attention the exposure of mercury in food stuff.

Process contaminants

Processing contaminants are generated during the processing of foods (e.g. heating, fermentation). They are absent in the raw materials, and are formed by chemical reactions between natural and/or added food constituents during processing. The presence of these contaminants in processed foods cannot be entirely avoided. Examples are: nitrosamines, polycyclic aromatic hydrocarbons (PAH), heterocyclic amines, histamine, acrylamide, furan, benzene, trans fat, monochloropropanediol (MCPD), semicarbazide, 4-hydroxynonenal (4-HNE), and ethyl carbamate (Meulenaer, 2006). However, technological processes can be adjusted and/or optimized to reduce the levels of formation of processing contaminants.

Acrylamide

The Maillard reaction seems to play an important role in the formation of acrylamide in foods. Not creatine is involved however, but asparagine and especially free asparagine seems to be a detrimental factor in its formation. As shown in Figure 3, illustrating two of the possible reaction mechanisms, the acrylamide formation should be considered as a side-reaction of the classical Maillard reaction. Since other compounds, which do not participate in the Maillard reaction, react as well with asparagine in

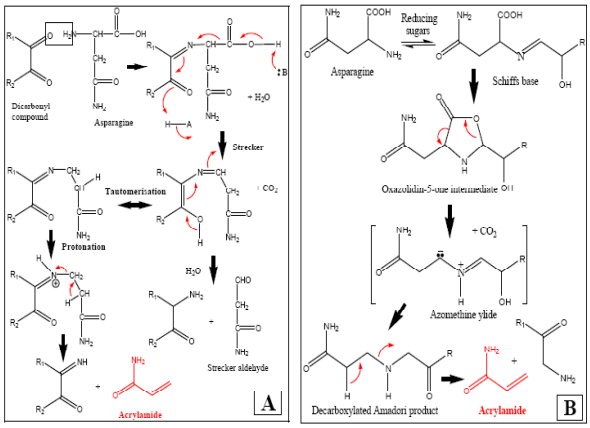

Figure 3. Possible path way of Acrylamide production (Meulenaer, 2006)

order to form acrylamide also other pathways may be operative. Apart from reducing sugars, also other carbonyl compounds may give rise to acrylamide formation upon reaction with asparagine (Meulenaer, 2006).

Especially the amount of free asparagine is considered to be important with regard to the acrylamide formation (Table 3). This is reflected in the kind of foods susceptible for acrylamide formation and their asparagine content. Unfortunately, important staple foods seem to be susceptible for acrylamide formation. It should be realised as well that for some of these products, such as potatoes, the content of respectively free asparagine and reducing sugars, may vary during storage and from variety to variety (Meulenaer, 2006).

Apart from endogenous factors, it is quite clear that also process parameters will influence the acrylamide formation. During boiling, no relevant acrylamide production is reported. Unless, temperatures are considerably lower in a cooking process compared to a frying process, it is especially the excessive amount of water that inhibits the acrylamide production. Heating processes that induce a surface dehydration of the food, such as a frying or oven baking process on the other hand give rise to appreciable acrylamide production. Temperature of course is also important, but in practice remains a parameter difficult to alter, since at lower temperatures, desirable processes such as drying, colour and aroma production are slowed down as well. Despite the fact it seems that at higher temperatures (> 200°C) acrylamide is degraded, higher process temperatures are frequently no option as well, since other undesirable reactions will be favoured (Meulenaer, 2006) .

Particular concern about the dietary intake of acrylamide exists because of its carcinogenicity, its neurotoxicity and its reproductive toxicity (Meulenaer, 2006; Hogervorst *et al*., 2007). Acrylamide also occurs in many cooked starchy foods and is of concern as a

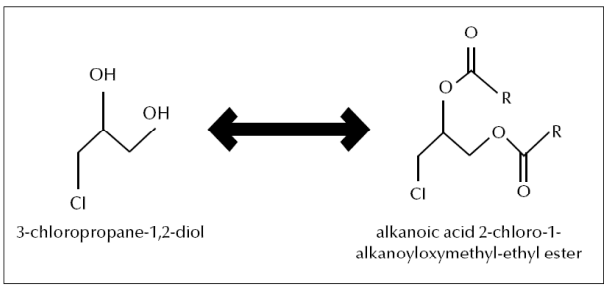

Figure 4. Chemical structure of 3 MCPD and its fatty acid diester (Robjohns *et al*., 2003)

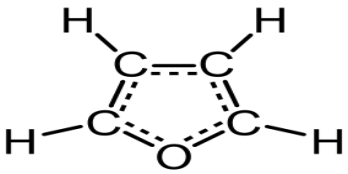

Figure 5. chemical structure of furan

possible carcinogen (Tareke *et al*., 2002). Acrylamide was accidentally discovered in foods in April 2002 by scientists in Sweden when they found the chemical in starchy foods, such as potato chips, French fries, and bread that had been heated (production of acrylamide in the heating process was shown to be temperature-dependent) (Tareke *et al*., 2002).

MCPD

3-MCPD or (3-monochloropropane-1,2-diol or 3-chloro-1,2-propanediol, see figure 4) is an organic chemical compound which is carcinogenic and highly suspected to be genotoxic in humans, has male anti-fertility effects, and is a chemical byproduct which may be formed in foods, the most commonly found member of chemical contaminants known as chloropropanols (Robjohns *et al*., 2003).

3-monochloropropane-1,2-diol (3-MCPD) is a substance which may be formed in fat and salt-containing foods through a chemical reaction when these foods are exposed to high temperatures during the production process. 3-MCPD, also referred to as "free" 3-MCPD, has been detected in numerous foods, amongst others in dark toast, in the crust of bread and in soy sauces (ILSI, 2009)

Furan

Furan (Figure 5) is found in a wide variety of cooked or heat-processed foods. Scientists believe that the furan forms during traditional heat treatment techniques such as cooking, canning and baking. Furan has previously been detected in a small number of heat-treated foods, including coffee, canned meat, baked bread, cooked chicken and caramel (CFSAN, 2004). Derivatives of furan are also used as flavoring agents in food and tobacco products. New developments in monitoring technology have recently detected very low levels of furan in canned soups, sauces, beans, pasta meals and jars of baby foods (U.S. FDA, 2004.) Serious health problems, including cancer and liver toxicity, have been found in laboratory animals from exposure to high doses of furan, although the potential to cause cancer in humans has not been confirmed (CFSAN, 2004).

Food additives and processing aids

Food additives are substances added to food to preserve flavor or enhance its taste and appearance. Some additives have been used for centuries; for example, preserving food by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulfur dioxide as in some wines. With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin.

One the other hand processing aids means any substance not consumed as a food by itself, intentionally used in the processing of raw materials, foods or their ingredients, to fulfill a certain technological purpose during treatment or processing, and which may result in the unintentional but technically unavoidable presence of residues of the substance or its derivatives in the final product, provided that these residues do not present any health risk and do not have any technological effect on the finished product.

Large amount of tropical fruits are produced in this subcontinent including Bangladesh. But in recent times consumption of fruits becomes extremely hazardous due to artificial ripening of fruits by different toxic chemical agents. Normally fruits produce a ripening hormone ethylene that induces the natural process of maturation. This process is artificially accelerated by using different chemicals of which calcium carbide is the commonest. Calcium carbide in contact with moisture produces acetylene which is an analogue of natural ripening hormone ethylene. Acetylene is a highly reactive substance used mainly in welding and allied industries. Industrial grade calcium carbide also contains trace amounts of more toxic arsenic and phosphorous that converts the healthy fruits poisonous (Kader, 2002).

Calcium carbide is used as ripening agent for mangoes, bananas, jackfruits, litchis and other fruits as well. Packets of calcium carbide powder are kept in the container of fruits where in contact with moisture, acetylene gas is produced and acts as a ripening agent. Traders pick green fruits before maturation, ripen artificially to serve in the market earlier than the season for higher profit .Moreover green fruits

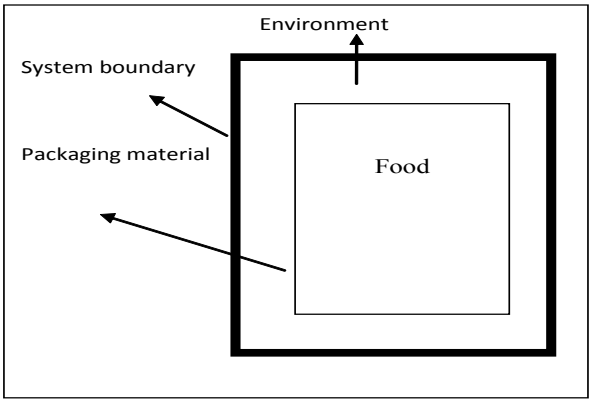

Figure 6. The three phases of a packaging system (Meulenaer, 2006)

are transported easily with minimum damage and ripened at the place of retail sell. Consumption of carbide ripened fruits is extremely hazardous for health, mainly for the nervous system. Acetylene, generated from carbide reduces oxygen supply to the brain. In acute stage, it causes headache, vertigo, dizziness, delirium, seizure and even coma. In the long term, it may produce mood disturbance and loss of memory (Fattah and Ali, 2010). Immediately after consumption, there may be abdominal pain, vomiting and diarrhoea. Other toxic effects include skin burn, allergy, jaundice and carcinogenic potential (Fattah and Ali, 2010). Bangladesh pure food ordinance 2005 prohibits use of any poisonous chemical like calcium carbide, formalin, pesticides or toxic colour/ flavour in any food that may cause harm to human body The (Daily Star, 5th June,2010). The Bangladesh high court recently issued some directives to the government to stop this practice and some administrative drives are also been taken. Despite this legal prohibition, chemically treated fruits are selling openly in all markets and ripening agents are also available.

In Europe for all approved additives to regulate these additives, and inform consumers, each additive is assigned a unique number, termed as "E numbers". This numbering scheme has now been adopted and extended by the Codex Alimentarius Commission to internationally identify all additives, regardless of whether they are approved for use (Meulenaer, 2006).

E numbers are all prefixed by "E", but countries outside Europe use only the number, whether the additive is approved in Europe or not. For example, acetic acid is written as E260 on products sold in Europe, but is simply known as additive 260 in some countries. Additive 103, alkanet, is not approved for use in Europe so does not have an E number, although it is approved for use in Australia and New Zealand. Since 1987, Australia has had an approved system of labelling for additives in packaged foods. Each food additive has to be named or numbered. The numbers

Table 3. Acrylamide levels in processed foods and asparagine content of some foods (Meulenaer, 2006)

food	acrylamide (µg/kg)	asparagine (mg/kg)
almonds, roasted	260	980-6410
asparagus, roasted	143	11000-94000
baked products: bagels, breads, cakes, cookies, pretzels	70-430	
beer, malt and whey drinks	30-70	
biscuits, crackers	30-3200	1500 (wheat)
breakfast cereals	30-1346	1500 (wheat)
chocolate powder	15-90	300 (cocoa)
coffee powder	170-351	
corn chips, crisps	34-416	
crisp bread	800-1200	
fish products	30-39	
gingerbread	90-1660	
meat and poultry products	30-64	0.4-11
peanuts	140	
potato, boiled	48	1700-3500
potato chips, crisps	170-3700	
potato, French fried	200-12000	
potato puffs, deep-fried	1270	
snack, other then potato	30-1915	
soybeans, roasted	25	
sunflower seeds, roasted	66	
taco shells, cooked	559	

are the same as in Europe, but without the prefix 'E' (Baert *et al*., 2005). Bangladesh still needs to improve positive list of food additives and processing aids.

Migration from food contact materials

In a food packaging system, three phases should be considered: the food, the package and the environment (Figure 6). In between these phases interactions may occur, resulting in energy or a mass transfer. The mass transfer can be macroscopic as in the chipping of a glass container or microscopic as in the contamination of food by micro-organisms. The sub microscopic mass transfer however involves the diffusion of individual molecules in one phase and their sorption by the other.

If the mass transfer involves the three phases of the packaging system, volatiles are transported from the environment via the contact material to the food or vice versa. This phenomenon is known as permeation. No net uptake or removal of chemical substances from the food contact material takes place. The permeation process may significantly affect the quality of the food. Mild preservation techniques such as modified atmosphere packaging, which are used successfully to prolong the shelf life of minimally processed foods, are based on the selective permeation of particular gasses through the packaging material. Chemical contamination due to permeation of organic volatiles (e.g. solvents) through the packaging material has been reported as well.

If mass transfer is restricted only to the food and the packaging material, the phenomenon is also known as migration. Migration can take place

from the contact material to the food and vice versa. The latter case is also known as negative migration, while the former is simply identified as migration. A typical example of negative migration is the flavour scalping in fruit juices due to the partial absorption of flavour compounds by the plastic contact material. Due to this phenomenon the fruit juice aroma deteriorates. Another example resulting however in an improvement of food quality is the use of oxygen scavenging materials in the packaging of foodstuffs sensitive to oxidation (Barnes and Sinclair, 2006a).

The mass transfer from the packaging material to the food can have both deteriorating and improving consequences for the food. Migration of toxic packaging compounds to the food is a serious risk to food safety. Similarly, migration of particular substances could induce sensorial deterioration of the food (e.g. styrene migration). On the other hand, migration of particular food additives such as antioxidants and anti-microbial agents could improve the shelf life of the product and at the same time minimize the direct use of these additives in the food manufacture. Since the fundamental mechanisms of the migration from polymeric materials are fairly well understood, mathematical models can be formulated in order to predict the migration from these materials (Meulenaer, 2006).

Legislative aspects on the migration from plastics

From the principles of migration from plastics to foods it is obvious that this phenomenon can be a food safety issue. Plastics may contain compounds which should be considered as carcinogens (e.g. vinylchloride, acrylonitrile) or which exhibit another type of toxicity. In order to ensure consumer protection, legislation has been developed through the years in various countries with regard to food contact materials in general and plastic food contact materials in particular.

Within the European Union, a process of harmonisation, started in 1972, tries to bring all existing legislation in the various member states in correspondence or implies new directives. Especially with regard to the plastic food contact materials most initiatives were elaborated. In addition to the European initiatives however, also in the United States legislation was developed. In this chapter however, only the basic principles about the EU legislation on plastics will be presented (Barnes and Sinclair, 2006b).

Basically, the established legislation deals with the following aspects: (1) a list of authorized substances, (2) a restricted amount of migration and (3) a system of checking migration. The lists of

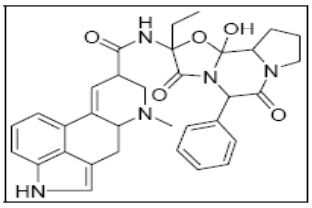

Figure 7. The chemical structure of ergotamine, the most abounded ergot alkaloid

authorized substances consist of monomers, other starting substances and most types of additives (except colorants and catalysts) which can be used for the production of plastic food contact materials. These lists rule out the use of unlisted materials, so they should be considered as so-called positive lists.

Apart from the fact that compositional restrictions are imposed on plastic materials, also the migrated amount of substances to the food should be limited. Two general restrictions are applied: (a) an overall migration limit (b) a specific migration limit .The overall migration limit, set at 60 mg kg^{-1} of food or 10 mg dm^{-2} contact materials is the total amount of substances which can migrate out of a plastic material to the food. This limit is set to ensure the inert character of the packaging material. In addition it avoids that for every listed compound a specific migration limit should be specified. The specific migration refers to the restricted migration of particular substances of toxicological relevance. The specific migration limit (SML, [mg kg^{-1}]) is calculated on the basis of the acceptable daily intake (ADI) or tolerable daily intake (TDI) laid down by the SCF for the particular substance. Supposing that 1 kg of the food, containing the migrating substance, is consumed daily by a 60 kg adult, it is obvious that the specific migration limit is given by : SML= ADI×60 or SML= TDI× 60. The specific migration limit for a particular substance is specified in the positive lists issued by the European legislator. Finally the EU legislation specifies in which practical manner the migration from a plastic material can be estimated from laboratory experiments. Therefore, food stimulants are defined, depending for example on the lipohpyllic or hydrophyllic character of the food contacted with the material. Furthermore, specifications with regard to contact time and contact temperature should specify (Meulenaer, 2006). Bangladesh should also improve positive list of food packaging materials.

Mycotoxin

Mycotoxins are secondary metabolites produced by moulds. It is well established however that not all molds are toxigenic and not all secondary metabolites from molds are toxic (Meulenaer, 2006). Historically, probably the oldest documented human

mycotoxicosis is ergotism. This disease, known in the middle ages as St Anthony's fire, is characterised by disorders of the central nervous system (convulsion, hallucinations), contraction of the blood vessels (gangrene) and gastrointestinal disorders. It is caused by ingestion of grains parasitized by C*laviceps purpurea* and some other *Claviceps* species, which invade the female portion of the host plant (barley, rye and wheat). After invasion, the moulds associated to dormant cells, known as purplish-black sclerotia, which have a similar size as the cereal grain. The chemicals causing the mycotoxicosis were much later proven to be very potent alkaloids, known as lysergic acid derivatives (Figure 7). Currently however, the disease is rather rare. Similar derivatives however are also present in a very potent hallucinating drug, known as LSD (De-Vries *et al*., 2002).

Depending upon the kind of agricultural commodities, some important mycotoxins or classes of mycotoxins can be distinghuised. Generally, moulds could produce mycotoxins on living plants, on decaying plant material and on stored plant material. Considering the stored plant material, probably cereals and cereal products are extremely important. For these products, especially moulds in the genera *Aspergillus*, *Penicillium*, *Fusarium* and *Alternaria* are the most important. For living plants, especially the *Fusarium*, *Aspergillus* and *Claviceps* genera are important to consider. Apart from the Aspergillus, these genera are also found on decaying plant material.

Mycotoxicoses is the term used for poisoning associated with exposures to mycotoxins. The symptoms of a mycotoxicosis depend on the type of mycotoxin; the concentration and length of exposure; as well as age, health, and sex of the exposed individual (Bennett and Klich, 2003).The synergistic effects associated with several other factors such as genetics, diet, and interactions with other toxics have been poorly studied. Therefore it is possible that vitamin deficiency, caloric deprivation, alcohol abuse, and infectious disease status can all have compounded effects with mycotoxins (Bennett and Klich, 2003). In turn, mycotoxins have the potential for both acute and chronic health effects via ingestion, skin contact, and inhalation. These toxins can enter the blood stream and lymphatic system; they inhibit protein synthesis, damage macrophage systems, inhibit particle clearance of the lung, and increase sensitivity to bacterial endotoxin.

Action need to hit out urgently in Bangladesh

Food safety policies and strategies

In this strategy actions should include the development of a coordinated, risk-based food control programme that covers the entire food supply chain from farm-to-table. This should supported by a coherent legal framework, which facilitates the development of risk based food regulations and standards. A further action would be to establish a documentation centre containing readily accessible information and data on current food safety issues impacting on Bangladesh.

Food inspection and enforcement services

Bangladesh needs as well to strengthened national food inspection and enforcement services. The goal of this strategy should to develop and implement risk-based inspection programmes, enforced by properly trained, resourced and supervised food inspectors. The action will be based upon an analysis of the current food inspection system in Bangladesh, and this will guide the direction of proposed capacity building. Enhancements in food inspection are expected to take the form of risk-based and coordinated inspection programmes. This will also include revision of the organizational framework for food inspection and the introduction of standardized inspection procedures and practices. There should also include the enhancement of inspector skills through updated training materials and progress towards the development of a Food Safety Policies and Strategies as well.

Preventive approaches to food safety management

Prevention of food borne illness and improvements in food quality requires the development and delivery of enhanced education on how to improve food safety and quality. This component should target small-to-medium scale food business, as well as consumer education about food safety, quality, and nutrition with a special focus on rural populations. These actions will result in increased public awareness of food safety and hygiene issues and how to prevent illness, with consumers being the major target. There should also be enhanced support for consumer associations. Training activities and technical support materials should also be developed for food businesses, and assistance in the introduction of food safety management programmes. The delivery of such activities should include training trainers and technical units to provide guidance on implementation of Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) and the introduction of the Hazard Analysis Critical Control Point (HACCP) System for small-to-medium sized food enterprises.

Food analysis capability and capacity

Bangladesh should urgent enhance food analysis capability and capacity through the establishment of well equipped national laboratories, operated by trained analysts utilizing standard methods which are performed under laboratory quality management arrangements. The objective should perform an assessment of resources and needs, ahead of the development of plans to modernize and strengthening core laboratories in chemical and microbiological analysis of foodstuffs. Significant laboratory equipment and support infrastructure should procured, ahead of the initiation of comprehensive analyst training programmes and the introduction of standardized methods of analysis and the application of standardized laboratory quality assurance program. A further activity may be the establishment of a system for food borne illness close watch to provide information for planning, implementing and evaluating the performance of preventive approaches to food safety as well.

Conclusion

Eating a wide range of chemicals is part of our daily life. Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent food borne illness. This includes a number of routines that should be followed to avoid potentially severe health hazards. Recent time long-term toxic effects of food chemicals are usually the prime concern in the world. Harmful chemicals may disrupt body metabolism, cause cancers, damage genes, alter organ functions, affect reproduction and development, etc. Food trade should exercise due care in applying and choosing food chemicals; add only the right type and right amount of food chemical which could serve the desired technological function. Food safety is an important and growing challenge for Bangladesh and an issue that has to be addressed by introducing preventive measures throughout the food chain from farm-to-table. Food contamination and adulteration that are highlighted in this review as significant challenges is needed to be addressed in close collaboration with all concerned stakeholders.

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