Food Safety

Module 32.1

Food Safety. Exposure to Toxic Environment

Learning Objectives

• To define food safety;
• To know basic terms on food safety;
• To discuss food hazards;
• To know food safety assessment criteria;
• To understand basic principles of food safety;
• To be familiar with global strategy on food safety - 5 keys to safer food (WHO).

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2. Definitions
3. Food safety criteria
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5. Food safety assessment procedure
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Key Messages

• Food safety;
• Consumers;
• Hazards;
• Risk assessment;
• Nutritional toxicology;
• Five keys to safer food.
1. Introduction

Food safety has become a global problem. There are a number of papers, revealing the negative effect of diseases caused by food on business, global economy and life quality. Every year hundred thousands of people become sick as a result of food intoxication and every year food-manufacturing companies pay off lots of money and so bear great losses.

This is why, in regard to free movement of goods and foods in the EU, special attention is being paid to food quality and food safety. Food consumed by people can cause a number of alimentary or infectious diseases, provided that it has been contaminated in any way. As a rule, contamination of food may occur in different ways - contact with dirty surfaces; contamination caused by workers who take part in food processing and transportation and who do not meet the hygiene requirements for food, etc.

Food safety has become a major issue since 1960 in the industrial farms (consolidation in massive farms, increased use of antibiotics in feed, mechanization, etc.). Thereafter, agriculture and food have become more interrelated with the use of pesticides, herbicides, insecticides and fertilizers. Clear relation has been found between certain diseases and the industrial animal-growing, such as: mad cow disease crisis (also known as BSE - bovine spongiform encephalopathy) in the 80’s and 90’s, as well as a number of diseases which have evoked fear about the food safety in Europe. Salmonellosis has also been unknown to people since 1940, while it is widespread nowadays. Food intoxications have increased 4 times in the last decades and they cost 1 - 3 billion Euro to the Europeans per year at present.

Lately there was another food safety issue, concerning the dioxin intoxication of eggs and chickens in Belgium. Other problems, which are attracting great attention at present, concern the use of pesticides and herbicides, as well as genetically modified food. These demonstrate the effects of industrial agriculture and have the potential for great damage on food safety.

This is why, the consumers’ trust in food quality and food safety has been lost in the recent years, as a result of accumulating influence of food and health-threatening crises. In order to manage the situation, the European Union worked out clear strategy, called “Farm to fork”, which aims to restore consumers’ trust in food quality and food safety. With regard to this, food safety has become an inseparable part of the EU legislation policy, concerning consumers’ health protection. All new EU members also have to follow this approach in order to ensure food safety “From farm to fork”. This is a great challenge to the EU as a whole. Issues on food safety follow two main directions, concerning food production and food consumption. They are:

- Free movement of food - deals with food legislation;
- Agriculture - deals with animal and plant-related problems, as well as animal feed.

Legislation, concerning food, includes general orders on hygiene and control, food classifying, food additives, food packaging, genetically modified food.

2. Definitions

Having regarded to the European parliament and the European council (EC) regulation No 178/2002:

- **Food safety** defines as lack of danger for human and offspring’s life and health caused by food consumption and based on public health requirement and criteria regarding food, regulations and legislation.

- **Foods or food products** define any product or substance, regardless of whether processed or raw, aimed to or is therefore expected to be consumed by people. The term food includes also beverages chewing gums and any substances including water, which are deliberately included in food during its manufacture, processing and preparation. Food does not include feed, live animal stock (except those which are to be consumed by people), plants before gathering the crops, medical products, cosmetics, tobacco, drugs and stimulants, contaminants.

- **Danger** defines existence or precondition for existence of biological, chemical or physical agent in food or feed, which has the potential to cause harmful effects on human health.
• **Dangerous food** defines food which contains physical, chemical, biological and radiological contaminants and additives above defined certain level, which as a result of normal and regular consumption may lead to toxic, carcinogenic, mutagenic, allergic and other harmful effects on human health.

• **Misleading food** is food, which does not meet regulatory requirements for contents quality and characteristics though its look, labelling, presentation and advertising claim that it does meet the requirements.

• **Food production, processing and distribution** include:
  [http://www.who.int/foodsafety/fs_management/en/](http://www.who.int/foodsafety/fs_management/en/)

• **Primary production** (defines production and growing primary products including gathering crops, milking and farming before butchering. It also includes hunting fishing and wild plants gathering) or import,

• **Storage of food,**

• **Transportation,**

• **Trade:**
  - **Retail** defines food processing, storage and end-customer supply and includes distribution terminals, public restaurants, buffets and such food related services, shops, supermarkets’ distribution centres and wholesale stations;
  - **Introduction to the market** defines owning food or feed for sale including supplying or any form of transfer free or paid, retail, distribution and other forms of transfer;
  - **Customer delivery - customer** defines the final user of certain food who is not going to use the food as a part of a company process or activity in order to produce food.
  - **Tracking** defines the ability to track certain food, feed, and animal, grown for food production, or substance, which is aimed or is expected to be included in food or feed at any stage of production, processing and distribution.

It is of major importance that the food consumed by people should be safe and should not cause negative effects on the organism or diseases.

3. **Food safety criteria**

In order to ensure food to be permitted for consumption, and correspondingly safe for people, it should meet certain criteria as follows:

• Food should possess acceptable organoleptic properties (look, colour, taste, smell, consistency etc.);

• Food should possess nutrition value defined by containing nutrients (concerning nutrients which can be utilized by human organism);

• Food should posses the necessary technological properties (it should be amenable to certain processing - heat processing, freezing, liofilisation, etc.);

• Food should be epidemiologically and toxicologically safe

It is of major importance that the food should not contain toxic substances, since they are potentially dangerous to human health and can cause significant economical social and political consequences. Food technologies development has lead to food safety related problem development consecutively food toxicology as an important part of food safety criteria and evaluation.

4. **Biological and chemical contaminants**

[http://w3.whosea.org/EN/Section23/Section1001/Section1110.htm](http://w3.whosea.org/EN/Section23/Section1001/Section1110.htm)

If contaminated food reaches people a number of infectious or alimentary diseases can be caused. Food contamination may occur in different ways, such as:

• Food contamination caused as a result of contact with contaminated surfaces;

• The workers taking part in the processing or transportation of food and not meeting the hygiene requirements may contaminate food and thus cause infectious diseases to the consumers;
Sources of food contamination can be: contaminated containers, used for storage and processing of food; food which comes in contact with flies or other insects; parasites; domestic animals; dust; chemical contaminants such as pesticides contaminants, vet chemicals etc. Raw food materials themselves can also be source of contamination in case that they have been stored and transported in a contaminated medium, thus becoming location for microorganism development. Those, which are pathogenic to human organism, cause number of diseases, classified as food intoxications (Table 1). In case that contaminated food products are consumed by a large number of people, outbreak of an epidemic may occur. At present, it is accepted that alimentary carcinogenic chemical contaminants and additives, mycotoxins and substances formed as a result of cooking and storing food, cause nearly 50% of the cancer.
Table 1 - Diseases caused by food contaminants

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh milk</td>
<td>Brucellosis, salmonellosis, enterohaemorrhagig E.coli infection</td>
</tr>
<tr>
<td>Cheese</td>
<td>Brucellosis, salmonellosis, listeriosis, S. aureus intoxication</td>
</tr>
<tr>
<td>Cream</td>
<td>Salmonellosis, S. aureus intoxication</td>
</tr>
<tr>
<td>Meat and meat products</td>
<td>salmonellosis, enterohaemorrhagig E.coli infection, listeriosis, staphylococcal infection, clostridium perfringens - gastroenteritis, botulism, taenioses (T. solium, T. saginatus), trichinelloses (T. spiralis); mad cow disease <a href="http://whyfiles.org/012mad_cow/">http://whyfiles.org/012mad_cow/</a></td>
</tr>
<tr>
<td>Poultry</td>
<td>Salmonellosis</td>
</tr>
<tr>
<td>Eggs and egg products</td>
<td>Salmonellosis, mycointoxications</td>
</tr>
<tr>
<td>Fish and sea food</td>
<td>Botulism, salmonellosis, viral gastroenteritis, histamine intoxication</td>
</tr>
<tr>
<td>Rice, pasta and cereals</td>
<td>B. cereus and S. aureus intoxication</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>Shigellosis, amoebiasis</td>
</tr>
<tr>
<td>Ice-cream</td>
<td>Salmonellosis, S. aureus intoxication</td>
</tr>
<tr>
<td>Sweets</td>
<td>Salmonellosis, S. aureus or B. cereus intoxication, clostridium perfringens - gastroenteritis</td>
</tr>
<tr>
<td>Chocolate</td>
<td>Salmonellosis</td>
</tr>
<tr>
<td>Fresh water</td>
<td>Cryptosporidiosis, lambliosis, amebiasis, E. coli infection, shigellosis, abdominal typhus, hepatitis type A and E</td>
</tr>
<tr>
<td>Baby food</td>
<td>Salmonellosis, B. cereus intoxication</td>
</tr>
</tbody>
</table>
Chemical contaminants define substances, which are unnatural to the food contents. They can be toxic by nature or can acquire toxic properties under certain circumstances. They can get into the food from outside or can be formed in the food product during its production, processing and storage. Food may contain food additives and food contaminants:

- Food additives define substances that normally are not used independently as food or its ingredient and which, after being added to the food during its production, processing, packaging, transportation or storage, remain included in the food, even in changed state.

- Food contaminants. These types of chemical substances, also known as food contaminants, comprise substances, which are not deliberately added to the food. They can be found in the food as a result of the nature pollution. They can also get in the food during the agricultural process - production, processing, storage, packing, and transportation.

Some substances though, are deliberately included in food. This refers to pesticide contaminants in plants and animal products; vet chemicals in animal products, etc. Chronic and acute poisoning may occur as a result of consumption of food, which contains contaminants in amounts exceeding the legally defined limits.
In order to produce and distribute safe food, it is of major importance to clarify, which types of contaminants influence negatively on human organism. These are:

- Chemical substances, used in the food production process, such as:
  - Pesticide contaminants. Stimulants, used in plant-growing and animal-growing (in cases that non-certified feed, medicines and hormones are used);
  - Ferments, smoke and such chemical substances used in the food companies - toxic substances can be formed as a result of not observing the regulations, concerning heat processing, smoking of meat (benzopirens and nitrosamines are formed), ionizing radiation, etc.
- Chemical substances from outside, coming in contact with food:
  - Heavy metals and benzopirens;
  - Plastics used to contact food;
  - Detergents and disinfectants;
  - Radioactive substances;
  - Additives.

According to their origin, contaminants can be divided into the following categories:

- Anthropogenous - result of human activities leading to contamination anywhere in the food chain;
- Natural contamination, e.g. as a result of high natural concentration of toxic elements in the soil;
- Substances, formed as a result of food cooking.

5. Food safety evaluation procedure

In order to prevent the toxicological risk from chemically contaminated food, world organizations such as FAO, WHO, EU and their committees - JECFA, as well as FAO/WHO together, have brought in resolutions and directives, determining the basic requirements for food safety. European Food Safety Authority (EFSA) has also been established with its particular responsibilities for both risk assessment and communication on food safety issues. The principle objective of EFSA is to contribute to a high level of consumer health protection in the area of food safety, through which consumer confidence can be restored and maintained.

http://www.who.int/foodsafety
http://www.efsaeu.int/about_efsae/legislation/catindex_en.html
http://www.centerforfoodsafety.org/
http://www.foodsafety.gov/
http://europa.eu.int
http://www.fao.org/index_en.htm

It is important to clear out that the EU requirements on food safety are always based on risk analysis. Risk analysis helps for the free movement of food before taking preventive measures, and also helps to avoid obstacles for free movement of food. This is in power when food legislation aims to decrease and avoid health hazard. Risk analysis comprises of three interrelated components: risk evaluation, risk management, information exchange on risk.

- **Risk** defines the function of the probability of negative effects on health and the dimension of these effects, as a result of present hazard;
- **Risk analysis** defines a process, comprising of three interrelated components: evaluation, risk management and information exchange on risk;
- **Risk evaluation** defines scientifically based process, comprising of 4 stages: definition of hazard; characteristics of hazard; evaluation of possible influences of exposure to hazard; risk definition (description);
- **Risk management** defines a separate process of considering different strategies and consultations with interested parties, discussions on risk evaluation, etc., and, if necessary, choosing suitable opportunities of control and prevention;
• **Information exchange on risk** defines interactive exchange of information and possibilities during the risk analysis process, concerning hazard, risk and the corresponding risk factors and the estimation by people who are in charge of the evaluation and the management of risk, the consumers, the food and feed companies, the academic society and other interested parties, including clarifying the conclusions, concerning the risk and the reasons for taking particular decisions on management.

Risk analysis gives solid base for defining effective and aimed measures and actions which will protect the consumers' health. In certain situations, provided that there is health or life hazard and lack of relevant scientific basis, protective measures give way for risk management or actions which must guarantee for public health protection.

The food safety insurance process comprises three basic steps:
- Food safety evaluation procedure;
- Toxicological data surveying (risk identification and characteristics);
- Regulations to insure food safety.

6. **Food safety evaluation**

- **Legislation**: According to WHO, the toxicological properties of food additives and contaminants is defined after testing them in order to calculate “Maximum” daily dose;
- **Testing plan** - while conducting the toxicological evaluation of food, it is important to establish the dose-response effect. Further on, the latter serves as basis for calculation of limitation for concentration which does not cause toxic effects.

Food safety evaluation tests are always based on:

A) **Hygiene-toxico logical experiment**, which needs to define:
   a) **Acute Toxicity**:
      - Includes toxokinetics, metabolism and possible chemical reactions with food components. Experiments are conducted using laboratory animals (rats, mice, guinea pigs, rabbits, etc.), which take a single high dose of a toxic substance. The animals are being observed for 14 days. The average lethal dose LD50 is defined;
   b) **Subacute Toxicity**:
      - The experiment uses 2 species at least. The substance is introduced in lower doses and its effects are observed on laboratory animals for 40-90 days. FAO/WHO propose testing periods as follows: 90 days for rats and 1 year for dogs. The experiment gives information on cumulative properties of different substances (cumulation coefficient can be calculated), the toxic effect properties, sensitivity of species, target organs, dose-response effects;
   c) **Chronic Toxicity**:
      - Includes reproduction, embryotoxicity, teratogenicity, carcinogenicity, mutagenicity and allergic effects. The experiment requires multiple introduction of the toxic substance in low doses on 2 kinds of animals at least. The animals are being observed for 10 months to 1 year. The experiment gives information on maximum inefficient dose:
         • Genotoxicity - the experiments are conducted in vitro or in vivo for short periods of time; probable mutagenous effects of the substance are followed;
         • Carcinogenicity - the experiments last for 2 years and uses animals which belong to one species, both male and female. The aim is to establish and follow probable neoplasm growth in the laboratory animals;
         • Reproductive toxicity - single doses of the test substance are applied to both male and female animals (at certain stages of pregnancy in female). Fetotoxicity is observed in the lab animals, also lactation changes and postnatal changes are followed;
         • Provided that the test substance gives indications for being toxic in any way, further experiments are conducted. They are aimed to determine probable teratogenic effects, immunotoxicity; neurobehavioral toxicity, etc.;
   d) **Maximum daily dose**: it is calculated after gathering results from the tests.

B) **Granting the data on possible negative effects on the food industry employees’ health and working out rules for labour protection**;
C) Data and requirements in other countries;

D) Evaluation of an acceptable daily consumption of certain additives and contaminants in all food, including consumers with special needs.

7. Toxicological data surveying

After gathering toxicological data, the Maximum Daily Dose is calculated (MDD). MDD of different contaminants and additives in food defines the amount of the substance, presented in mg/kg, which can be consumed every day for the whole life without appreciable health hazard.

8. Regulations concerning food safety

It is of major importance to all countries that the food safety measures, undertaken by the EU-countries, should be based on risk analysis, except for the cases when this is inexpedient because of the situation or the measure itself. Using risk analysis before accepting such measures eases the free movement of food to escape baseless obstacles.

There is a White Paper on food, giving data on food safety, presented by the European Commission. http://europa.eu.int/comm/dgs/health_consumer/library/pub/pub06_en.pdf

There has already been extensive consultation and discussion concerning improvements to the EU’s food legislation arising from the Green Paper on the general principles of food law. (http://europa.eu.int/comm/off/green/index_en.htm)

The White paper presents the changes the Commission proposes in this area. However, in addition, the Commission envisages the creation of a European food authority as a further measure. In respect of this proposal, the Commission wishes to elicit public debate, informed comment and broad consultation.

Provided that the food legislation is aimed to decreasing, removing or escaping the health hazard, the systematic methodology of effective appropriate and aimed measures for health prevention is based on risk analysis (risk evaluation, risk management, information exchange).

Protective measures used to be applied in order to provide the community health, though they were an obstacle in the free movement of food. This is why the European Union aspires to united basis in the whole union, in order to apply these principles.

9. Conclusion

Food safety and customer protection are of growing concern to the society, non-governmental organizations, international trade partners and commercial organizations. It is necessary the customers’ and the trade partners’ trust to be guaranteed since it is of major importance and it is conducted through open and transparent food legislation as well as through undertaking relevant actions by the public institutions in informing the society. It has been proved that diseases caused by contaminated food consumption incur negative effect on business, global economy and life standard. Each year hundreds of people get sick as a result of food intoxication and each year food manufacturing companies refund large sums in order to compensate the customers.

10. Five keys to safer food

WHO introduced the Five Keys to Safer Food poster in 2001, translated in 25 languages, (for Bulgaria adapted by M. Stavreva). The WHO Five Keys to Safer Food are simple rules elaborated to promote safer food handling and preparation practices: keep clean, separate raw and cooked food, cook thoroughly, keep food at safe temperatures, use safe water and raw materials. (http://www.who.int/foodsafety/consumer/5keys/en/print.html)
KEY 1: KEEP CLEAN (prevent the growth and spread of dangerous microorganisms)

- Wash your hands with soap and water (or other means such as wood ashes, aloe extract or dilute bleach) after toilet visits, before and after handling raw food and before eating;
- Avoid preparing food directly in surroundings flooded with water;
- Wash/sanitize all surfaces and equipment - including hands - used for food preparation;
- Protect kitchen areas and food from insects, pests and other animals;
- Keep persons with diarrhoea - or other symptoms of disease - away from food preparation areas;
- Keep faecal material away from food-preparation areas (separate kitchen and toilet areas);
- Avoid eating food raw if it may have been flooded, e.g. vegetables and fruits - see also Key 5.

Why?
Dangers microorganisms are widely found in the gut of animals and people and therefore also in water and soil in areas with poor sanitation as well as in areas with flooding. These microorganisms can be transferred to food and can, even in low numbers, cause foodborne disease.

KEY 2: SEPARATE RAW AND COOKED FOOD (prevent the transfer of microorganisms)

- Separate raw meat, poultry and seafood from ready-to-eat foods;
- Separate animal slaughtering and food preparation areas;
- Treat utensils and equipment used for raw foods as contaminated - wash and sanitize before other use;
- Separately store raw (uncooked) and prepared foods;
- Avoid contamination with unsafe water: ensure water used in food preparation is potable or boiled;
- Peel fresh fruits before eating.

Why?
Raw food, especially meat, poultry and seafood and their fluids may contain dangerous microorganisms that can be transferred onto other foods during food preparation and storage. Prevent the transfer of microorganisms by keeping raw and prepared food separate. Remember that cooked food can become contaminated through the slightest contact with raw food, unsafe water or even with surfaces where raw food has been kept.

KEY 3: COOK THOROUGHLY (Kill dangerous microorganisms)

- Cook food thoroughly, especially meat, poultry, eggs and seafood until it is steaming hot throughout;
- For cooked meat and poultry to be safe their juices must run clear and no parts of the meat should be red or pink;
- Bring foods like soups and stews to boiling and continue to boil for at least 15 minutes to make sure all parts of the food has reached at least 70°C;
- While cooked food should generally be eaten immediately, if necessary thoroughly reheat cooked food until it is steaming hot throughout.

Why?
Proper cooking kills dangerous microorganisms. The most important microorganisms are killed very quickly above 70°C, but some can survive up to 100°C for minutes. Therefore all cooked food should generally reach boiling temperatures and be cooked at such temperatures for extended periods. Remember that big pieces of meat will only heat up slowly. It is also important to remember that in emergency situations with the potential for significant contamination levels in food, the food should be cooked for longer periods.
KEY 4: KEEP FOOD AT SAFE TEMPERATURES (prevent growth of microorganisms)

- Eat cooked food immediately and do not leave cooked food at room temperature longer than 2 hours;
- Keep cooked food steaming hot (more than 60°C) prior to serving;
- Cooked and perishable food that cannot be kept refrigerated (below 5°C) should be discarded.

Why?
Microorganisms multiply quickly if food is stored at ambient temperature - the multiplication is quicker the higher the temperature - and quickest at around 30-40°C. The higher the number of microorganisms in the food the higher the risk for foodborne disease. In general discard food that cannot be eaten within 2 hours - if necessary, food should be kept really hot or really cold. Most microorganisms cannot multiply in food which is too hot or too cold (higher than 60°C or lower than 5°C).

KEY 5: USE SAFE WATER AND RAW MATERIALS (prevent contamination)

- Use safe water or treat it to make it safe - e.g. through boiling or treatment with chlorine tablets;
- Wash or preferably cook vegetables and peel fruits that are eaten raw;
- Use clean containers to collect and store water and clean utensils to dispense stored water;
- Select fresh and wholesome foods - discard damaged, spoiled or mouldy food;
- Breast-feed infants and young children at least up to the age of 6 months.

Why?
Raw materials, including water, may be contaminated with microorganisms and dangerous chemicals, especially in areas hit by flooding. Likewise the risk of vegetables and fruits being contaminated with water containing sewage is high under a flooding disaster. Toxic chemicals may be formed in spoiled and mouldy foods. Safe water may be seriously contaminated with dangerous microorganisms through direct contact with hands or unclean surfaces. Breast-feeding protects infants against diarrhoea through its anti-infective properties, and minimizes their exposure to dangerous foodborne microorganisms.

References

5. WHITE PAPER ON FOOD SAFETY, 2000