5th CEFSER Training Course
Analysis of chemical contaminants in food and the environment
Faculty of Technology, University of Novi Sad,
Novi Sad, Republic of Serbia
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Chemical contaminants in food

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Food quality and safety

have become FOCAL TOPICS

that concern every citizen

in the European Union and worldwide.

Food quality could not be separated from food safety

as they are interdependent.

Food quality and safety are not important only for the consumer protection,

but also for the food industry, which stands to gain and maintain consumer confidence.

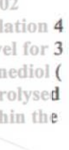
Frequent dramatic food emergencies

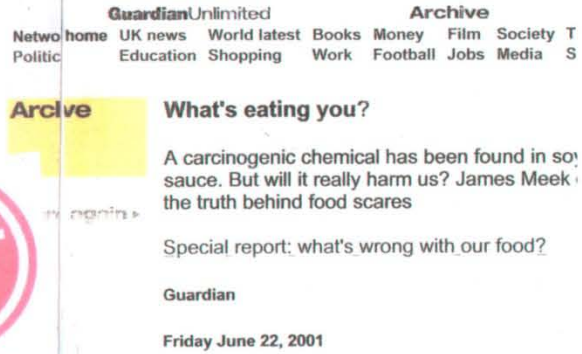
focus the attention on food safety

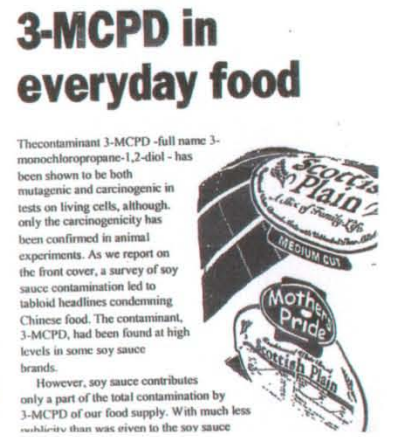
in order to manage the risks for human

health that could occur in any point of

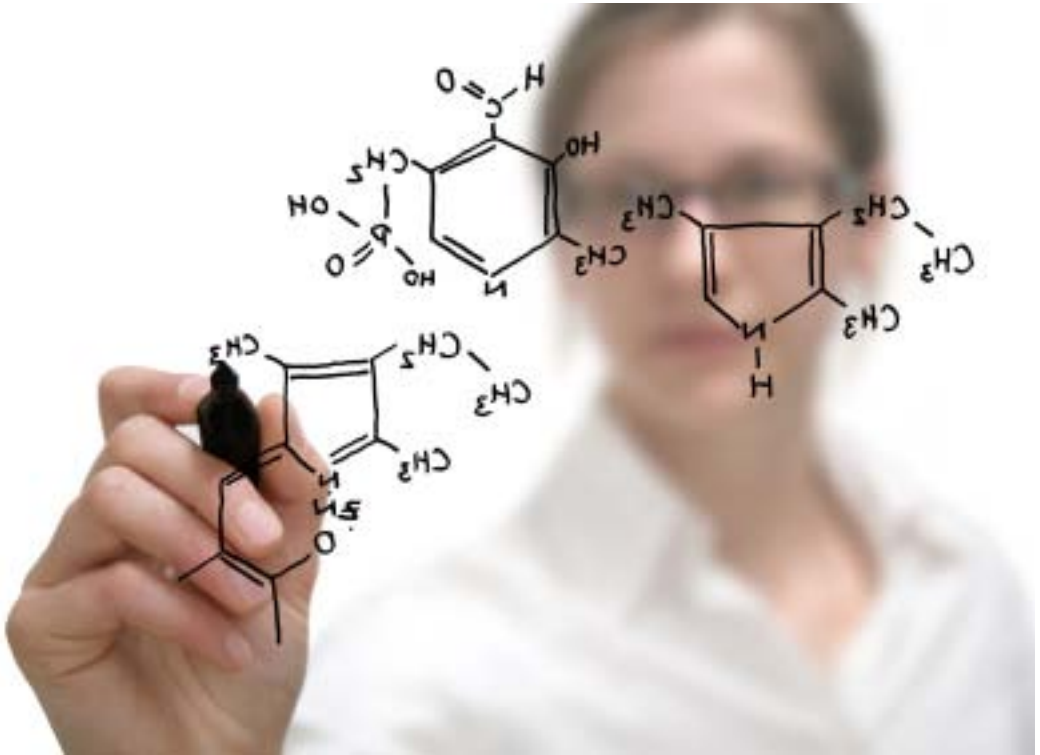
the food chain.







Chemical substances play an important role in food production and distribution.



When speaking about chemical substances in food, the following groups should be considered:

- **additives,**
- **flavoures,**
- **food contact materials,**
- **contaminants (environmental, processing, natural toxins),**

- **residues,**
- **pesticides residues,**
- **hormones,**
- **illegal substances resulting from a fraudulent practice**

►B

COUNCIL REGULATION (EEC) No 315/93

of 8 February 1993

laying down Community procedures for contaminants in food

(OJ L 37, 13.2.1993, p. 1)

Article 1

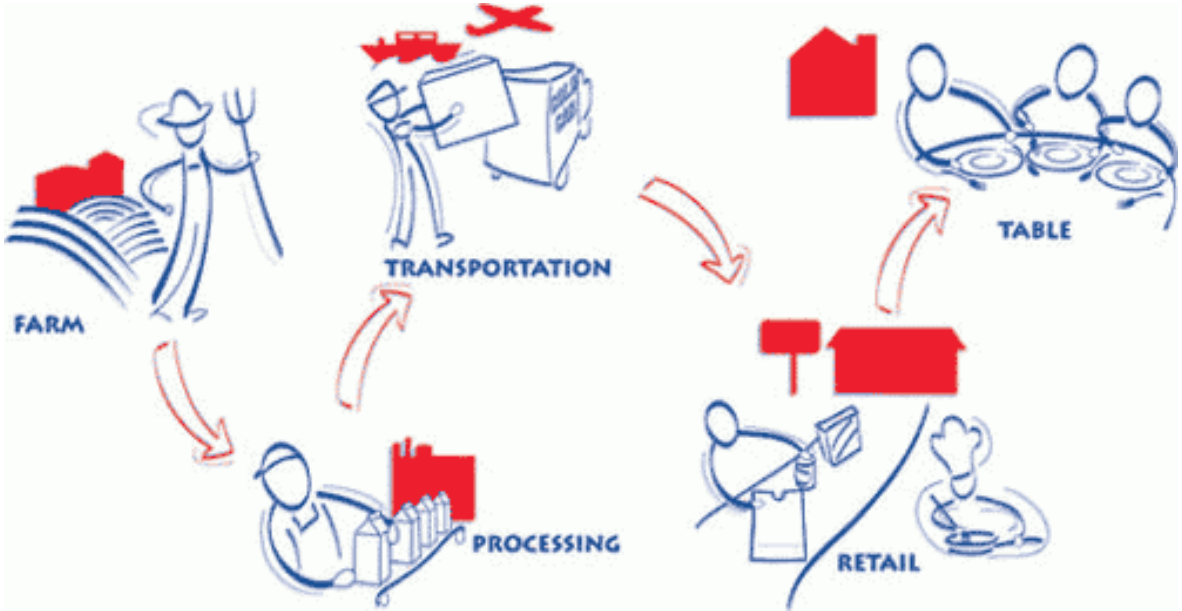
1. This Regulation concerns contaminants contained in food.

'Contaminant' means any substance not intentionally added to food which is present in such food as a result of the production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food, or as a result of environmental contamination. Extraneous matter, such as, for example, insect fragments, animal hair, etc, is not covered by this definition.

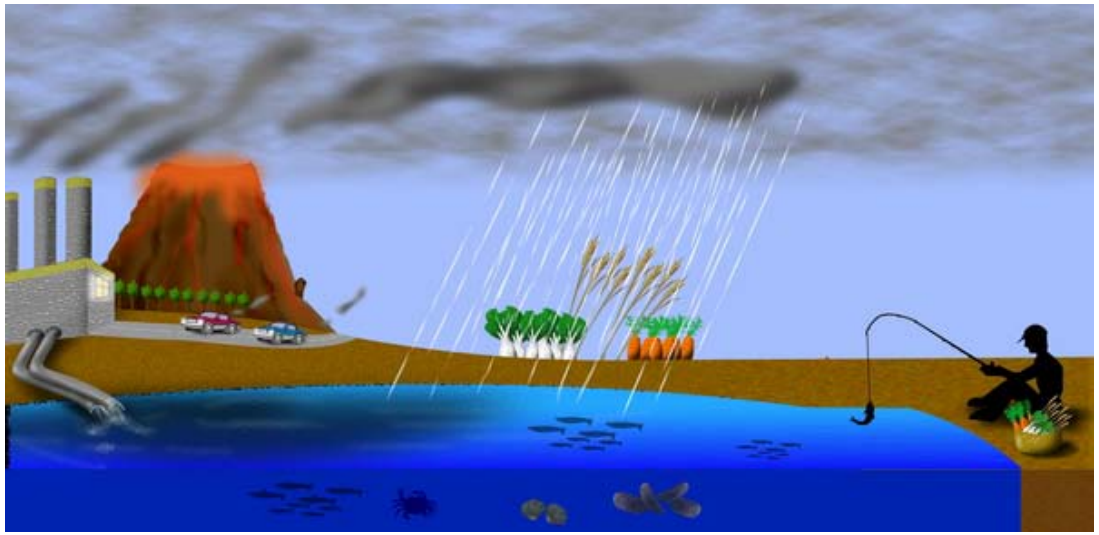
FOOD CONTAMINANTS are substances that have not been intentionally added to food.

These substances may be present in food as a result of the various stages of its

- **production,**
- **packaging,**
- **transport or**
- **holding.**



They also might result from
environmental contamination,
since there is a number of chemical substances
present in the environment as pollutants
that can enter food chain through
deposition/absorption onto plants
used as raw materials or feed.



Food, in general, reflects the environmental conditions under which is produced, handled, used.

Increased environmental pollution,
rapid expansion in international trade of food and in tourism sector
have resulted in increased risk of
HIGHER INTAKE of food chemical contaminants through diet and detrimental health effects.

Community food legislation aims at the establishment of the RIGHT BALANCE between

risks and benefits of substances that are used intentionally

and

at the reduction of contaminants

in accordance with the high level of consumer protection that is required in Article 152 of the EC Treaty.

12002E152

Treaty establishing the European Community (Nice consolidated version) - Part Three: Community policies - Title XIII: Public health - Article 152 - Article 129 - EC Treaty (Maastricht consolidated version) - Article 129 - EEC Treaty

Official Journal C 325 , 24/12/2002 P. 0100 - 0101
Official Journal C 340 , 10/11/1997 P. 0246 - Consolidated version
Official Journal C 224 , 31/08/1992 P. 0048 - Consolidated version
(EEC Treaty - no official publication available)

Treaty establishing the European Community (Nice consolidated version)

Part Three: Community policies

Title XIII: Public health

Article 152

Article 129 - EC Treaty (Maastricht consolidated version)

Article 129 - EEC Treaty

Article 152

1. A high level of human health protection shall be ensured in the definition and implementation of all Community policies and activities.

Community action, which shall complement national policies, shall be directed towards improving public health, preventing human illness and diseases, and obviating sources of danger to human health. Such action shall cover the fight against the major health scourges, by promoting research into their causes, their transmission and their prevention, as well as health information and education.

The Community shall complement the Member States' action in reducing drugs-related health damage, including information and prevention.

2. The Community shall encourage cooperation between the Member States in the areas referred to in this Article and, if necessary, lend support to their action.

Member States shall, in liaison with the Commission, coordinate among themselves their policies and programmes in the areas referred to in paragraph 1. The Commission may, in close contact with the Member

The basic principles of EU legislation on contaminants in food are defined in Council Regulation 315/93/EEC of 8 February 1993, according to which:

1993R0315 — EN — 07.08.2009 — 002.001 — 1

►B

COUNCIL REGULATION (EEC) No 315/93

of 8 February 1993

laying down Community procedures for contaminants in food

(OJ L 37, 13.2.1993, p. 1)

• food containing a contaminant of an amount unacceptable from the public health viewpoint and in particular at a toxicological level, shall not be placed on the market

- contaminant levels shall be kept as low as can reasonably be achieved following recommended good working practices

- maximum levels must be set for certain contaminants in order to protect public health

For chemical substances in food,

EC legislation is divided into the following areas:

- **The legislation on food additives**
- **The legislation on flavourings**
- **The legislation on residues of veterinary medicinal products used in food producing animals and on residues of plant protection products (pesticides)**
- **The legislation on food contact materials, and …**

…concerning the food contaminants,

since food contamination generally has

a negative impact on the quality and

may imply a risk to human health,

the EU has taken measures to minimize

contaminants in foodstuffs.

Maximum levels for certain contaminants in food are set in Commission Regulation (EC) No 1881/2006.

20.12.2006 EN Official Journal of the European Union L 364/5

COMMISSION REGULATION (EC) No 1881/2006

of 19 December 2006

setting maximum levels for certain contaminants in foodstuffs

These levels are set for the contaminants of the greatest concern to EU consumers, either due to their toxicity or their potential prevalence in the food chain.

It should be emphasized that specific EU requirements only exist for a few contaminants,
although many measures exist at national level, including the Serbian legislation.

This is de facto leading to disparity in consumer health protection throughout and outside the EU,
but also to practical difficulties for control authorities and industry.

Maximum levels in certain foods are set for the following contaminants by the EC legislation:

- **nitrate,**
- **mycotoxins (aflatoxins, ochratoxin A, patulin, deoxynivalenol, zearalenone, fumonisins),**
- **metals (lead, cadmium, mercury, inorganic tin),**
- **3-monochloropropane-1,2-diol (3-MCPD),**
- **dioxins and dioxin-like PCBs, and**
- **polycyclic aromatic hydrocarbons (PAHs), i.e. benzo(a)pyrene**

The EC levels for the food contaminants are set on the basis of scientific advice provided by the European Food Safety Authority (EFSA).

In fact, EFSA provides the European Commission with independent scientific advice on all matters with a direct or indirect impact on food safety.

It is a separate legal entity, independent from the other EU institutions.

The establishment of EFSA was one of the key measures contained in the Commission's White Paper on Food Safety, which was published in January 2000.

COMMISSION OF THE EUROPEAN COMMUNIT

Brussels, 12 January
COM (1999) 719 fin

WHITE PAPER ON FOOD SAFETY

Objectives of a European Food Authority

The principal objective of a European Food Authority will be 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.

38. The Authority must meet the fundamental principles of independence, excellence and transparency to be successful in its mission. As an integral part of these principles, the Authority must demonstrate a high level of accountability to the European institutions and citizens in its actions.

Therefore the Authority must

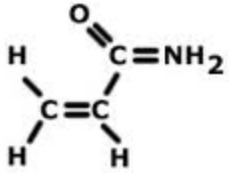
- be guided by the best science,
- be independent of industrial and political interests,
- be open to rigorous public scrutiny,
- be scientifically authoritative and
- work closely with national scientific bodies.

Facts about some of the contaminants, like mycotoxins, heavy elements, and PCBs and PAHs as groups belonging to semivolatile organic compounds (SVOCs), which are all subjects of the investigation performed in the CEFSER Lab, will be presented during the Course, including their sources, levels, legislation, etc.

Chemicals for which investigations are ongoing:

- Acrylamide
- Organotins
- Furan
- Ethyl carbamate
- Perfluorinated compounds (PFAS or PFCs)

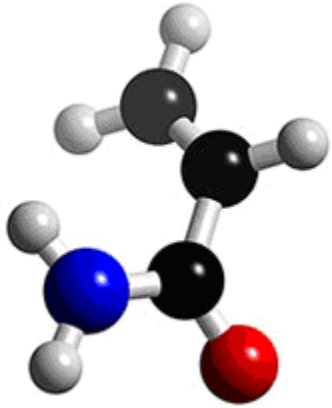
ACRYLAMIDE



- a chemical which has been shown to be present in food as a result of cooking practices, some of which have been used for many years, even centuries.

In particular, starchy foods have been shown to be affected, such as potato and cereal products which have been *deep-fried, roasted or baked at high temperatures.*

- On 3 May 2007 the Commission adopted a **Recommendation on the monitoring** of acrylamide levels in food, which has been extended by Commission Recommendation 2010/307/EU of 2 June 2010.



- Acrylamide data are currently being collected by EFSA.

- On 10 January 2011 the Commission adopted a **Recommendation on investigations into the levels of acrylamide in food.**

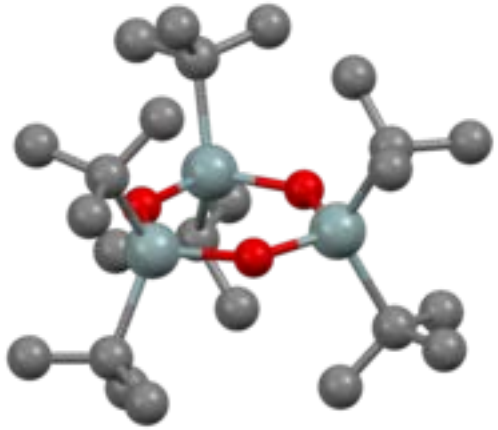
ORGANOTINS

C—Sn

chemicals which can be found in water systems due to their presence in paints as anti-biofouling agents, e.g. used on the hulls of ships and marine apparatus.

The European Food Safety Authority (EFSA) has issued an opinion on the health risks to consumers associated with exposure to organotins in foodstuffs (EFSA opinion).

The Commission's Scientific Committee on Health and Environmental Risks (SCHER) has adopted an opinion on the risks to health and the environment associated with the use of 4 organotin compounds (tributyltin TBT, dibutyltin DBT, dioctyltin DOT, triphenyltin TPT).



FURAN

it has been identified in a number of foodstuffs that undergo heat treatment such as canned and jarred foodstuffs.

Furan and its derivatives are naturally occurring compounds found at very low levels in many foods and drinks and they have been associated with the flavour of foods. These include commercially prepared foods as well as home made foods.

Furan concentrations found in some food commodities on the Swiss market

(J. *Vranová, Z. Ciesarová, Czech J. Food Sci. Vol. 27, 2009, No. 1: 1–10)*

Sample description	Furan value (PPB)		Median (PPB)	Number of samples
	minimum	maximum		
Baby food in small glass jars	1	153	12	102
Fruit and vegetable juices for babies and young children	1	40	3	4
Coffee (drink)	13	146	74	9
Hot chocolate and malt beverage	< 2	< 2		2
Canned or jarred vegetables	< 2	12	3	15
Canned soups	19	43		2
Canned fruits	< 1	6		2
Tin containing meat	4	4		1
Tin containing meat and pasta	14	14		1
Sugo, tomato and Chilli sauces	< 4	39	6	13
Soy sauce, hydrolysed vegetable protein	18	91	50	7
Vegetables, fresh	< 1	< 2	< 1	7
Bread and toast	< 2	30	< 2	7
Whole milk UHT	< 0.5	< 0.5		1
Plum beverage	6	6		1
Beetroot juice with fruit juices (organic)	1	1		1
Potato flakes for mashed potatoes (flakes, not prepared)	< 5	< 5		1

After classifying furan as

"possibly carcinogenic to humans" (Group 2B)

by the International Agency for Research on Cancer (1995),

a great concern

is given to the analysis of this substance naturally

occurring in food.

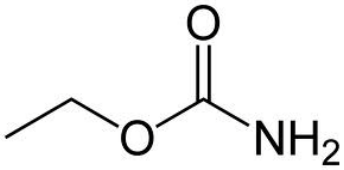
International Agency for Research on Cancer

World Health Organization

On March 2007 the Commission adopted a Recommendation on the monitoring of the presence of furan in foodstuffs.

Furan data following this monitoring recommendation are currently being collected by EFSA.

ETHYL CARBAMATE



a compound that can naturally occur in fermented foods and beverages, particularly in alcoholic beverages.

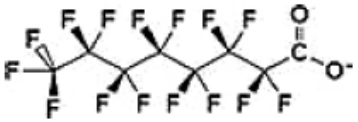
It is formed by ethanol and certain prescursors in the fruit under the influence of light during the distillation process.

On 2 March 2010 the Commission adopted a Recommendation on the prevention and reduction of ethylcarbamate contamination in fruit alcoholic bevrages and on its monitoring in these beverages.

Monitoring data following this recommendation are currently being collected by EFSA.

PERFLUORINATED COMPOUNDS

PFOS



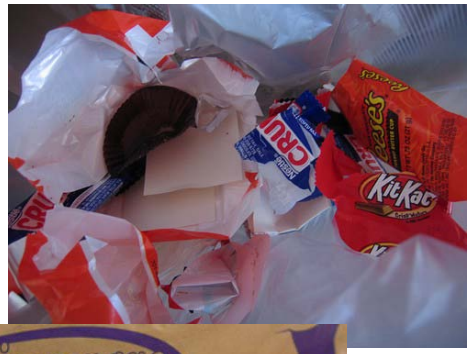
PFOA

belonging to the emerging class of persistent organohalogenated contaminants,
PFCs (or PFAS) comprise a diverse group of chemicals including perfluorinated alkylated substances.

The most studied compounds within PFCs group are ***perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA)*** *and their derivatives such as perfluorinated sulfonates (PFSAs), perfluorocarboxylic acids (PFCAs) and further perfluorinated telomer alcohols (FTOH), perfluorinated sulfonamides (FOSA) or perfluorinated phosphonic acids (PFPAs)*

These compounds that have been widely used in industrial and consumer applications including

- **stain- and water-resistant coatings for fabrics and carpets,**
- **oil-resistant coatings for paper products approved for food contact,**
- **floor polishes,**
- **insecticide formulations,**
- **fire-fighting foams, and**
- **mining and oil well surfactants.**



Although these chemicals have been used in countless products since the 1950s, they have been subject to little control until now.

There is still an insufficient knowledge of their sources, occurrence, and hazards for food safety decision making.

Concentration of PFCs in samples of food and milk collected in Norway (in pg/g fresh weight), drinking water and tea (in ng/L)

(L.S. Haug et al. / Chemosphere 80 (2010) 1137–1143)

	PFBuS	PFHxS	PFOS	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnDA	PFDoDA
pg g^{-1} fresh weight										
Lettuce	<0.12	<0.06	*0.17*	**0.98**	*0.43*	**1.8**	<1.0	**0.78**	<1.3	1.3
Carrot	<0.25	<0.11	**0.67**	<1.3	<0.89	**2.0**	<2.1	<1.4	<2.5	<2.4
Potato	<0.48	<0.22	**1.0**	*3.1*	**1.1**	**5.3**	<4.1	**3.0**	**2.2**	<4.8
Cheese	<1.5	<0.65	**12**	<7.7	**7.4**	*13*	**16**	*6.6*	*4.1*	*<15*
Margarine	<1.6	**1.3**	**2.3**	**2.5**	<5.6	**12**	<13	<8.6	<16	<16
Milk	<0.24	<0.11	**7.0**	**1.5**	<0.87	**4.7**	<2.1	**4.0**	<2.5	<2.4
Bread	<1.5	**1.7**	**17**	**14**	**11**	**51**	**9.5**	**17**	<15	<15
Strawberry jam	<1.3	<0.59	**3.0**	<7.0	<4.7	**14**	**3.7**	**8.70**	<13	<13
Pork meat	<0.81	**1.2**	**17**	<4.3	**2.8**	**15**	*5.5*	**16**	<8.2	<8.0
Beef	<0.63	<0.28	**60**	<3.3	*7.6*	**12**	**15**	*23*	<6.4	<6.2
Chicken meat	*3.2*	<2.3	**21**	<13	**20**	**52**	*6.8*	<23	**13**	<9.2
Egg	*2.0*	**3.50**	**39**	**13**	<16	*30*	<7.4	*12*	**9.9**	<8.1
Fish sticks	*5.0*	*1.6*	**13**	<18	*21*	*49*	<11	*17*	**18**	<13
Canned mackerel	<5.5	<3.0	**43**	<18	<24	*24*	<11	<31	**19**	<12
Salmon	*2.2*	**5.5**	**55**	*11*	*16*	*46*	*10*	*26*	*4.5*	*<12*
Cod	<3.4	**2.8**	**100**	<11	<15	*30*	*5.9*	*13*	**21**	<7.5
Cod liver	<15	<8.2	**310**	<48	<66	*51*	*14*	*39*	**230**	<33
ng L^{-1}										
Drinking water 1	<0.045	**0.15**	**0.23**	**0.78**	**0.76**	**2.5**	<0.22	**1.0**	**0.35**	<0.22
Drinking water 2	<0.045	**0.12**	**0.31**	**0.31**	**0.32**	**1.2**	<0.22	**0.52**	**0.20**	**0.43**
Drinking water 3	<0.045	**0.045**	**0.071**	<0.11	<0.12	**0.65**	<0.22	*0.22*	*0.065*	*0.13*
Tea	<0.045	<0.057	<0.030	<0.11	**0.47**	**9.5**	<0.22	<0.33	**0.17**	**0.74**

Bold: concentrations above LOQ.
Italic: concentration above LOD but below LOQ.
<: concentration below the given LOD.

On 17 March 2010 the Commission adopted Commission Recommendation 2010/161/EC on the monitoring of perfluoroalkylated substances in food.

Monitoring data following this recommendation are currently being collected by EFSA.

L 68/22 EN Official Journal of the European Union 18.3.2010

RECOMMENDATIONS

COMMISSION RECOMMENDATION

of 17 March 2010

on the monitoring of perfluoroalkylated substances in food

(Text with EEA relevance)

(2010/161/EU)

More about food contaminants and the relevant regualtions could be found in

- **the EC factsheet "Managing food contaminants: how the EU ensures that our food is safe“ and on**

- **the EC site “HEALTH AND CONSUMERS” ec.europa.eu/food/food/chemicalsafety/index_en.htm**


Health & Consumer Protection Directorate-General

FACTSHEET

Food contaminants

January 2008

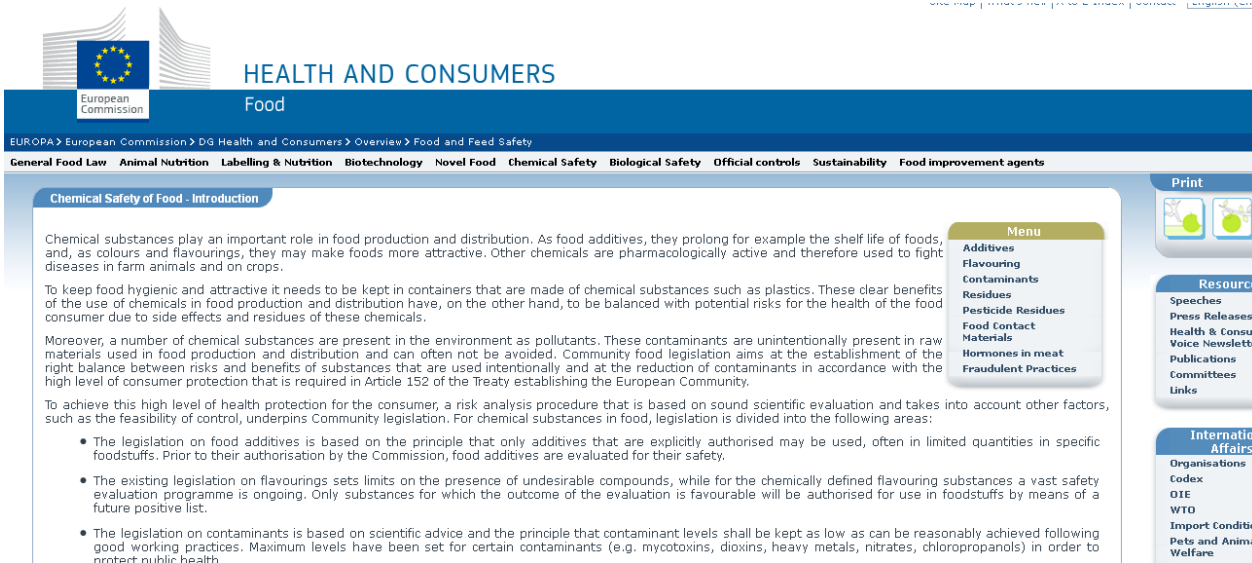
Managing food contaminants: how the EU ensures that our food is safe

Food contaminants are substances that may be present in certain foodstuffs due to environmental contamination, cultivation practices or production processes. If present above certain levels, these substances can pose a threat to human health. EU rules ensure that food placed on the market is safe to eat and does not contain contaminants at levels which could threaten human health.

Some contaminants are formed naturally, carried over to food from water, air or soil, or created as a by-product of the food production process itself. The chemical compound acrylamide sometimes found in potato crisps, for example, is the result of cooking practices. Another example are mycotoxins, such as aflatoxin, produced by fungi which can be found in nuts.

OVERVIEW OF EU RULES

When it comes to food contaminants, EU legislation stipulates


European Commission

HEALTH AND CONSUMERS

Food

EUROPA > European Commission > DG Health and Consumers > Overview > Food and Feed Safety

General Food Law | Animal Nutrition | Labelling & Nutrition | Biotechnology | Novel Food | Chemical Safety | Biological Safety | Official controls | Sustainability | Food improvement agents

Chemical Safety of Food - Introduction

Chemical substances play an important role in food production and distribution. As food additives, they prolong for example the shelf life of foods, and, as colours and flavourings, they may make foods more attractive. Other chemicals are pharmacologically active and therefore used to fight diseases in farm animals and on crops.

To keep food hygienic and attractive it needs to be kept in containers that are made of chemical substances such as plastics. These clear benefits of the use of chemicals in food production and distribution have, on the other hand, to be balanced with potential risks for the health of the food consumer due to side effects and residues of these chemicals.

Moreover, a number of chemical substances are present in the environment as pollutants. These contaminants are unintentionally present in raw materials used in food production and distribution and can often not be avoided. Community food legislation aims at the establishment of the right balance between risks and benefits of substances that are used intentionally and at the reduction of contaminants in accordance with the high level of consumer protection that is required in Article 152 of the Treaty establishing the European Community.

To achieve this high level of health protection for the consumer, a risk analysis procedure that is based on sound scientific evaluation and takes into account other factors, such as the feasibility of control, underpins Community legislation. For chemical substances in food, legislation is divided into the following areas:

- The legislation on food additives is based on the principle that only additives that are explicitly authorised may be used, often in limited quantities in specific foodstuffs. Prior to their authorisation by the Commission, food additives are evaluated for their safety.
- The existing legislation on flavourings sets limits on the presence of undesirable compounds, while for the chemically defined flavouring substances a vast safety evaluation programme is ongoing. Only substances for which the outcome of the evaluation is favourable will be authorised for use in foodstuffs by means of a future positive list.
- The legislation on contaminants is based on scientific advice and the principle that contaminant levels shall be kept as low as can be reasonably achieved following good working practices. Maximum levels have been set for certain contaminants (e.g. mycotoxins, dioxins, heavy metals, nitrates, chloropropanols) in order to protect public health

Menu

Additives
Flavouring
Contaminants
Residues
Pesticide Residues
Food Contact Materials
Hormones in meat
Fraudulent Practices

Print

Resources
Speeches
Press Releases
Health & Consu Voice Newslett
Publications
Committees
Links

Internatio Affairs
Organisations
Codex
OIE
WTO
Import Conditi
Pets and Anim Welfare

The only way to know which chemicals and how much of them are in food is the chemical analysis.

Most needs for food analysis arise from

- **nutrition and health concerns,**

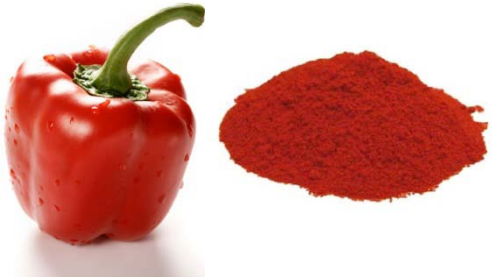
but other reasons for food analysis include

- **process-control or quality-assurance purposes,**
- **flavor and palatability issues,**
- **checking for food adulteration,**
- **identification of origin (pattern recognition), or**
- **"mining" the food for natural products that can be used for a variety of purposes.**

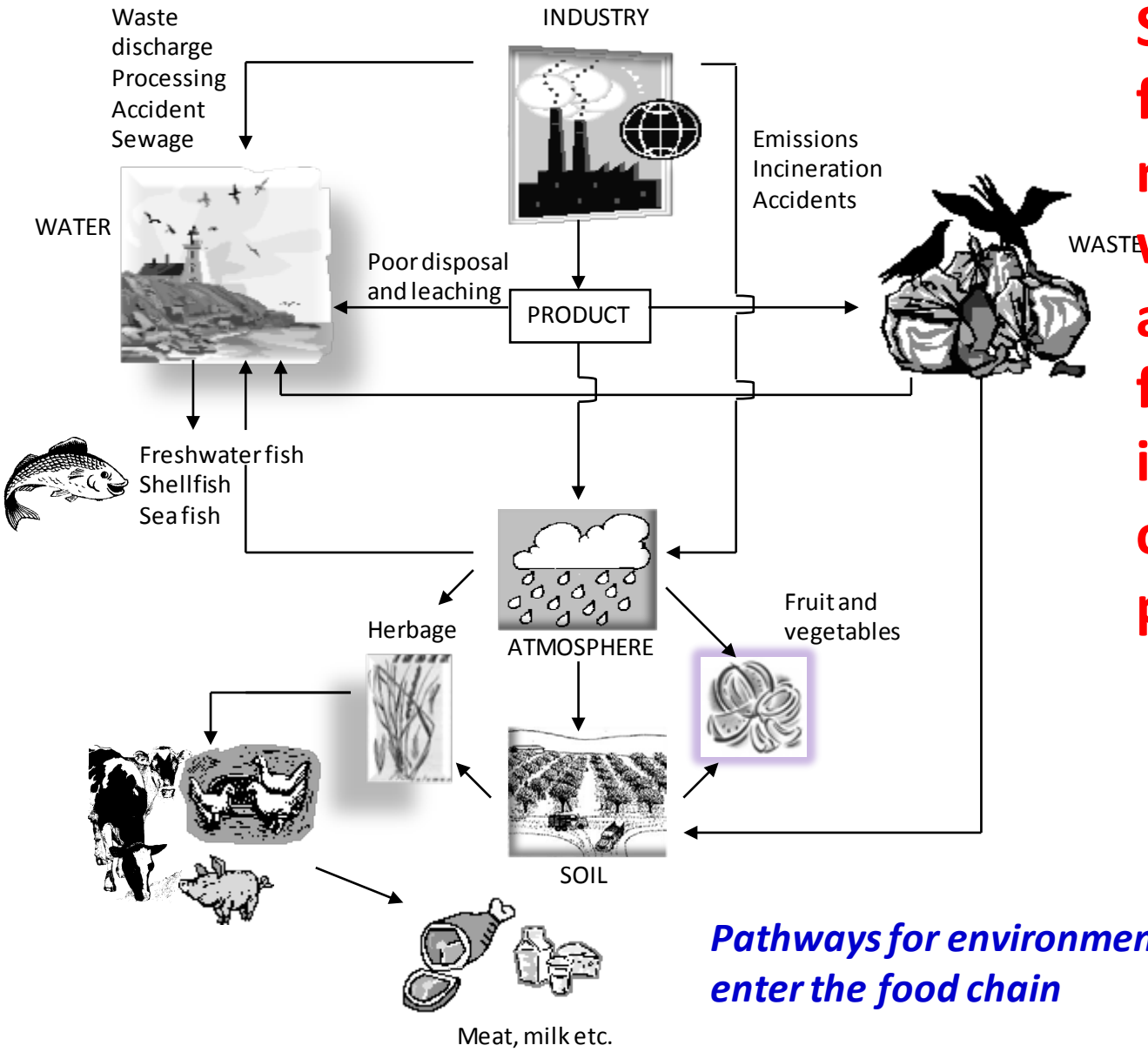
- **Food analysts require analytical methods**

to detect and identify

the nature and concentration of chemicals in all components of foodstuffs from the raw materials to the end products.



‘Farm-to-Fork’ Integrated Food Chain

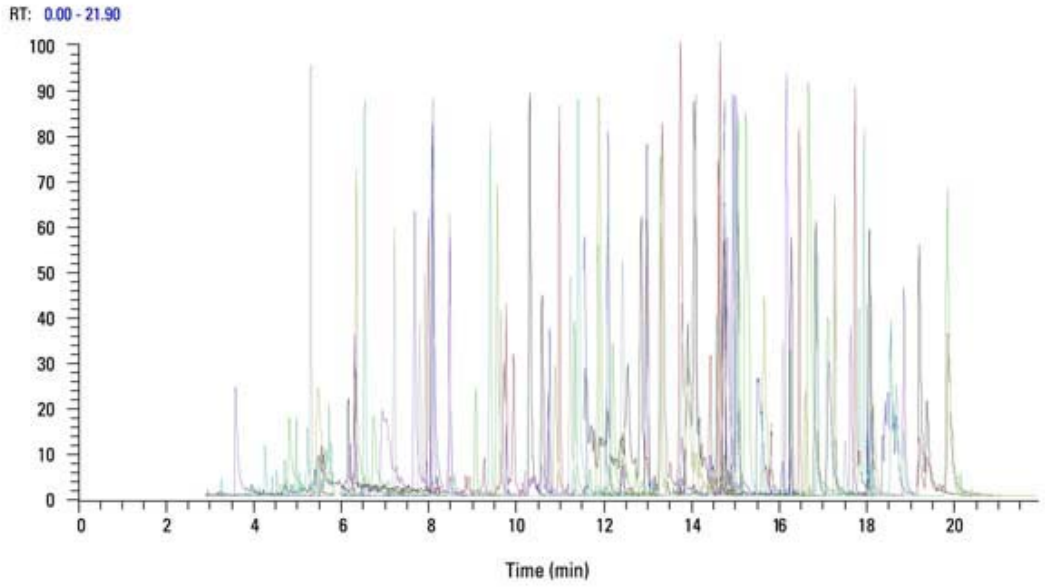


Segments of the food chain could not be separated – whatever happens at any point from farm-to-fork will impact ultimately on the final product.

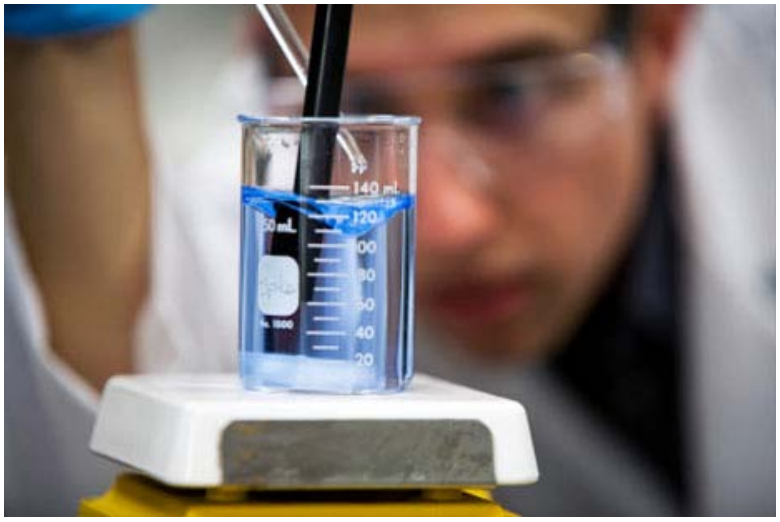
Pathways for environmental contaminants to enter the food chain

- **Toxic compounds are often present in food at ppb levels or lower.**
- **Thus, food contaminants analysis is challenging due to the complexity of the matrix compounds in food extracts,**

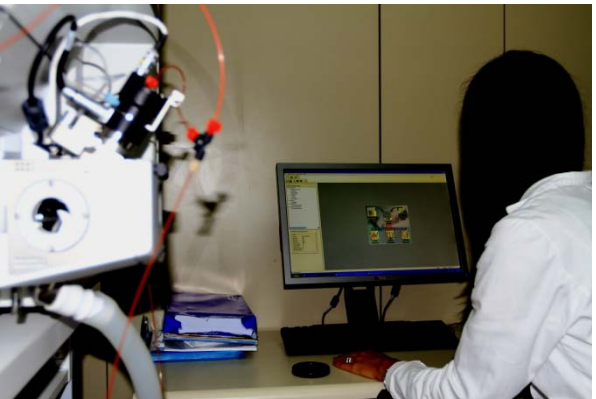
which often interfere with detection of target compounds and elements.

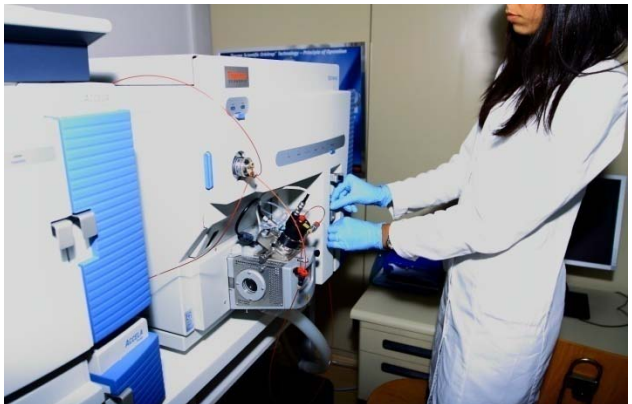


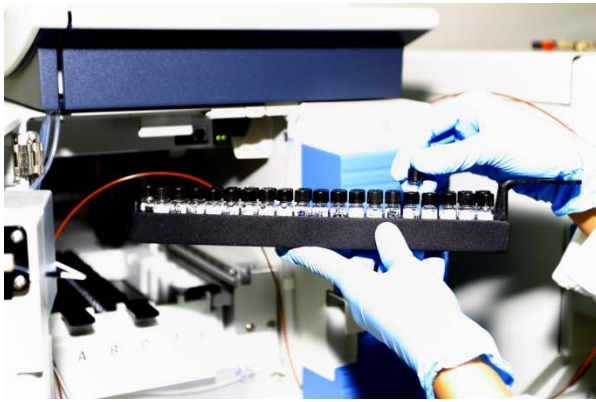
The use and development of new analytical techniques in food science runs parallel with the increased consumer concern what is in their food and the safety of food they eat.



One of the main aims of the 5th CEFSER Training Course is to give an overview of the analytical techniques and methods established in the CEFSER Lab for the chemical contaminants analysis either in food or the environmental matrices.








Thank you for the attention!