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S T O A

Naturally occurring and health compromising substances in plant-derived foods: Do we have a problem?

Workshop report

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Executive Summary

General conclusions

The workshop set out to answer whether naturally occurring substances in plant derived foods pose any health problems. Broadly, there are two types of substance which could be considered, each raising different issues.

(1) **Naturally occurring plant derived compounds.** Low molecular weight bioactive components, such as polyphenols, phenolic acids and glucosinolates, are present in foods and provide positive health benefits when consumed at normal levels as part of a balanced diet. Possible risks could occur from the consumption of high doses in a more purified form such as certain supplements or over-fortified foods, and this needs to be monitored. The benefits of consumption of normal amounts of these compounds (as present, for example, in five portions of fruit and vegetables per day) **should be better communicated and consumers should be encouraged to eat more fruits and vegetables**, i.e. naturally occurring plant derived compounds. The benefits of normal consumption and the risks of too high consumption (often expressed as a U-shaped curve) are expected for almost all nutrients, including vitamins, minerals, fats and protein, and **apply to all of the population**, with subtle variations according to a person's nutritional status and genetic background. Scientific work to understand this area should have high priority, especially for work examining the exact nature of the U shaped curve in humans. **Better processing methods are required that maintain levels** of naturally occurring plant polyphenols, phenolic acids and glucosinolates, since many existing methods destroy these potentially beneficial compounds. Better food labelling would give consumers better choice and control over their diets to optimise the amount of beneficial naturally occurring substances from fruits and vegetables, and prevent possible over-consumption. This is particularly important for processed foods, where, for example, **labels could indicate the percentage of beneficial compounds retained from the original fruit and vegetables in the final product**.

(2) **Naturally occurring plant derived allergens.** On the other hand, the normal presence of certain allergens in plant derived foods, which are naturally occurring proteins, poses a **high and acute risk, but only to a small minority of the population**. These do not follow the U-shaped curve described above, but instead any exposure to allergens is best avoided. For allergens, food labelling is the key issue, both in foods sold in retail outlets and catering establishments, to enable these individuals to avoid the food in question. It is also important that new processing methods or new functional foods do not introduce new potential allergens into the diet.

In summary, there is a requirement for better food labelling, improvements in food education, and scientific research to better establish optimal dietary doses (including better biomarkers of relevance for nutrition).

Some more specific conclusions are as follows:

- Glucosinolates, polyphenols and phenolics at normal levels in foods are beneficial for health of the consumer.
- Glucosinolates, polyphenols and phenolics at very high levels in supplements or in heavily fortified foods present a possible risk for health of the consumer which needs to be assessed.
- Allergens in some plant-based foods are a high risk, but only to a small minority of the population.
- New processing methods offer a potential way to improve the quality of products made from fruits and vegetables.
- Functional foods based on naturally occurring plant compounds offer potential to improve the health of the European population. However, the risks of too-high doses need to be considered.
- The exact doses of naturally occurring plant compounds necessary to provide a benefit or which could cause a risk are not yet clearly defined.
- Labelling of foods to indicate the content of the naturally occurring substances relative to the original plant is required.
- Novel functional foods should not increase the risk of allergy.
- Better tools to establish the healthiness of individuals in studies on foods are needed.
- The information needed by the consumer to make food choices based on health is very complex.
- There is a danger of losing silent or hidden knowledge on food processing.
- Multi-interest cooperation and collaboration is important to maximise benefits and minimise risks.

Introduction

Workshop report

This workshop report constitutes the outcome of the workshop on "Naturally occuring and health compromising substances in plant-derived food: Do we have a problem" held in the European Parliament on May 15th 2008.

The workshop report includes a summary of each of the speakers' presentation and a summary of the most important discussions and recommendations from the workshop. In the back of this document the workshop programme, cv´s of the speakers at the workshop and an attendance list is included.

The power point presentations made by the speakers are available on the STOA website and on the website of the Danish Board of Technology.

The workshop was commissioned by STOA and organised by The Danish Board of Technology on behalf of the European Technology Assessment Group (ETAG).

Special thanks go to Mr. Hilmer Sørensen, Senior Associate Professor, Department of Natural Sciences at University of Copenhagen in Denmark, who contributed substantially to the arrangement of the workshop.

Background information on the workshop

During the last decade, new knowledge has been accumulated on naturally occurring and health compromising substances in plant-derived food. Substances that are not added or taken in from pollution of the environment, but may be health compromising by their own nature, through, for example, toxic effects, allergenic effects or inhibition of nutrient assimilation.

The purpose of the workshop was to explore and debate new developments in basic research; industrial food processing; novel and functional food; and consumer knowledge and behaviour in order to determine whether problems can be identified which need to be dealt with by the European Union in the years to come:

- What are the problems?
- How big are they?
- Are they properly dealt with already?
- If not, how may they be better handled?

The workshop programme was divided into four sessions and a wrap-up session at the end, intended to sum up the conclusions of the workshop. Each session included 2-4 speakers and consisted of relatively short presentations followed by debate with questions from MEPs, other speakers and invited participants.

Conclusions reached at the workshop

1. Conclusions on Session :New knowledge and legal framework

- *Glucosinolates, polyphenols and phenolics at normal levels in foods are beneficial for health of the consumer.*

Glucosinolates, polyphenols and phenolics are naturally-occurring low molecular weight compounds found in plant-derived foods. **When consumed in adequate doses, these components can have a beneficial effect on human health**. They are an important part of the beneficial components making up the reason for the 5-a-day fruit and vegetable campaigns around the world. **The consumption of fruit and vegetables containing these compounds should be encouraged amongst EU consumers**. There are potential beneficial effects which include reducing the risk of certain cancers and cardiovascular diseases, including diabetes. **Thus continuation and even enhancement of the campaigns for increased consumption of fruit and vegetables is recommended in this area**.

- *Glucosinolates, polyphenols and phenolics at very high levels in supplements or in heavily fortified foods present a <u>possible</u> risk for health of the consumer which needs to be assessed.*

Concerns arise from the consumption of large doses of these naturally occurring compounds when extracted and concentrated from the original food and sold as supplements. Although in most cases there will not be a problem, research on purified glucosinolate breakdown products (the active form of glucosinolates formed on chewing, cutting and cooking) has shown some negative effects. High doses of these pure compounds have been shown, in animal studies, to exert negative effects on liver, kidneys, pancreas and thyroid. It is less clear if polyphenols and phenolic acids could have similar effects, but some negative effects at high doses could occur, such as inhibition of digestive enzymes and impaired iron absorption. **However, these problems are unlikely to arise from consumption of normal food**. **On the other hand, supplements, or heavily fortified foods, should be viewed more cautiously and the risks assessed**. In addition, very high doses of these compounds through supplements could **affect metabolism of some medical drugs**, and this also needs to be examined further. **These risks could be examined by the European Food Safety Authority (EFSA).**

- *Allergens in some plant-based foods are a high risk, but only to a small minority of the population.*

A completely different type of food issue is the presence of certain allergens, normally proteins, present in some plant foods giving an **undesired allergic reaction in a small proportion of the population**. These allergens are always undesirable, but only to a minority. However, the problem appears to be increasing, especially in the Western World. A way to support afflicted individuals **is through better labelling**. Additionally, the problem can be managed through improving knowledge on cross-reactivity with other plant derived proteins, and on reducing or eliminating cross-contamination. It is not feasible to remove these allergens from foods since they are naturally occurring proteins present in all foods containing that source. **The individual must ensure absence of the allergen in the diet**, since the potential allergenic protein is completely harmless to most individuals. However, labelling legislation is very slow to be introduced, and in addition, **restaurants and catering establishments often do not know exactly whether the allergens are present in the food served at these establishments**. In cases of emergency, crisis management is conducted through the Rapid Alert System for Food and Feed (RASFF).

The European Commission has adopted a proposal on labelling in January 2008 which is currently under discussion, and concerns pre-packed food and food served through catering establishments.

2. Conclusions on Session : New developments in industrial food processing

- *New processing methods offer a potential way to improve the quality of products made from fruits and vegetables.*

Some conventional processes for industrial food processing can lead to the loss of certain nutrients. These include vitamins such as vitamin C, but also the naturally occurring compounds such as glucosinolates, polyphenols and phenolics discussed above. For example, highly processed and filtered apple juices contain a much lower content of potentially beneficial polyphenols (proanthocyanidins) compared to the original fruit. New processes such as High Pressure and High Intensity Electric Field Pulses may overcome some of these problems, and **ensure more of the beneficial components and nutrients from the original food are retained**. Problems are not likely to arise, but some risk assessment is necessary for these new processes, especially since these new processing methods will also better preserve potentially harmful substances as well as the beneficial ones. **Research into the positive and negative aspects of new processing methods is required**, including gentle or minimal processing. This may provide a **good opportunity to increase the healthiness of processed foods in the European Union** and should not be ignored. In addition, it seems that consumers would like products, which are more natural, which implies minimal and gentle processing to retain the beneficial compounds of the original fruit or vegetable.

3. Conclusions on Session: New developments in novel and functional foods

- *Functional foods based on naturally occurring plant compounds offer potential to improve the health of the European population. However, the risks of too-high doses need to be considered.*

There is a consumer demand for healthy foods, and food products claimed to affect mood, increase beauty, help weight management and facilitate healthy snacking are becoming more prevalent. In addition, **functional foods are already available claiming to affect many health outcomes**. Legislation should ensure that these new and existing products are acting appropriately but are treated as foods, not drugs. The distinction between the food and drug industries is important. Health benefits from food imply long term benefits to reduce the risk of disease, not to cure disease. For all nutrients, and also **for many naturally occurring substances in food, the risk-benefit is complicated and follows a U shaped curve**. A definite research need is for more information to define the dietary intakes of the U-shaped curve in humans. It needs to be ensured that supplements or fortified foods do not increase the intake above that of the second upper limb of the U shaped curve. It is unlikely that existing fruits and vegetables could provide this overdose. It is, in fact, likely that the general intake of naturally occurring plant low molecular weight compounds, such as polyphenols, glucosinolates and phenolic acids, is actually too low. New processing methods, as described above, could help this situation by increasing the intake of these desirable natural products. On the other hand, supplements and very highly fortified foods would need monitoring and some legal framework as provided by EFSA.

- *The exact doses of naturally occurring plant compounds necessary to provide a benefit or which could cause a risk is not yet clearly defined.*

The optimal dose of naturally occurring substances necessary to exert their optimal beneficial effects is not yet known, and more research is required in this area. As observed and reported for vitamins, the **requirements are likely to vary for different groups of the population**, such as children, adults, and elderly. Although it is desirable to have information on the needs of each group, it is first necessary for all consumers to obtain basic information.

- *Labelling of foods to indicate the content of the naturally occurring substances relative to the original plant is required.*

Labelling of (functional) foods could, for example, include information to **show how much of the original naturally occurring beneficial substances remained in the food after processing**. A higher percentage value could be readily understood by the consumer as more desirable than a low value. In addition, a simple system is needed to indicate on the label the amount of naturally occurring substances that are in supplements. This could be clearly indicated on the label. This could be coupled with **better and further education of consumers into food and health in general**.

- *Novel functional foods should not increase the risk of allergy.*

Another type of naturally occurring functional food ingredient is plant seed proteins, which are used to enhance the protein content of foods. The information on the safety of these additives is scarce, and would require risk assessment as provided by EFSA. In addition, the **allergenicity of these and any novel food proteins would need to be carefully tested and monitored**.

- *Better tools to establish the healthiness of individuals in studies on foods are needed.*

Potential health benefits and risks from functional food products require more experimentation and studies on humans, although these should not necessarily be randomised clinical studies. It cannot be too highly emphasised that **better biomarkers to indicate health status of the population**, and how this might be affected by food consumed chronically, **are very definitely required**.

4. Conclusions on Session: Consumer knowledge and behaviour

- *The information needed by the consumer to make food choices based on health is very complex.*

Information that consumers would require to make informed choices is quite extensive. A balanced diet with no overwhelming emphasis on one particular food is good advice, but the nature of the balance changes with time once new scientific discoveries are published. In addition, there is a tendency for more developed countries to eat more meat, whereas poorer ones eat mostly plant foods. The correct balance needs to be communicated to consumers, since increasing the proportion of plant based food in the diet to ensure optimal intake of naturally occurring compounds would have a benefit for health. **Consumers perceive most plant based foods as good for health**, and have the **baseline expectation that foods will be safe to consume**. Thus the U-shaped curve is difficult to communicate since it means that most dietary constituents can be both good or bad, depending on the dose. Many consumers know this intuitively for fat, for example, but the link to naturally occurring plant substances is not so obvious. Care should be taken to ensure that any messages on the negative effects of naturally occurring plant components at high doses are not confused with messages on the beneficial effects of the same components at low doses.

- *There is a danger of losing silent or hidden knowledge on food processing.*

For handling of food, **there is substantial "silent knowledge" which is in danger of disappearing**, and this may need to be carefully monitored and retained. In addition, many consumers are not interested in potential negative effects of high doses of naturally occurring substances from supplements or heavily fortified foods. Consumers only pay attention to the information that they are interested in, and often ask questions on how the food should be prepared or eaten. As a summary, the information given to consumers needs to be simple, but **informative enough to allow consumers to make their own choice**. The option of mandatory labelling is currently being explored in the European Community.

- *Multi-interest cooperation and collaboration is important to maximise benefits and minimise risks.*

It would be beneficial for the consumer if there was **more cooperation and collaboration** between research scientists, policy makers, industry and stakeholders when dealing with naturally occurring plant substances in foods.

Presentations

1. Food Group: Cruciferous vegetables; cabbage, broccoli, cauliflower etc.

Toxic and anti-nutritional substances: glucosinolates and glucosinolate derived compounds, by Gary Williamson

Glucosinolates occur in Cruciferous plants. On damage to the plant (which would include food processing, chewing, cooking and others) the glucosinolates breakdown into a variety of products. These products are highly bioactive, and also have sensory properties, giving rise to the distinct tastes of wasabi, mustard and horseradish. The breakdown products are isothiocyanates, nitriles, epithionitriles and thiocyanates. Several decades ago, glucosinolate breakdown products were considered only as natural toxicants. Indeed, oil seed rape contained a high level of progoitrin, a glucosinolate which exhibited some toxic properties when given in high amounts to farm animals. This led to the development of varieties of oil seed rape low in glucosinolates (and also erucic acid). However, the situation for glucosinolates changed in 1992 with a report from Talalay's group which reported the identification and purification of sulforaphane, a breakdown product from a glucosinolate called glucoraphanin, which showed anticarcinogenic properties. Substantial research effort has now confirmed this, at least in vitro and in animal models. This highlights the dual nature of many naturally occurring compounds in plants, but the concept is not new to nutrition. Daily Recommended Intake (DRI) values exist for vitamins and minerals, and provide a guideline on how much is required to avoid deficiency or toxicity. Even well known vitamins such as vitamin A and D and minerals such as selenium may have toxicity at very low levels, but of course are essential. Thus the U shaped dose-response curve is now a commonly accepted concept in nutrition and toxicity, and builds on the well known comment from Paracelsus from more than 400 years ago that the dose makes the poison. This implies that all substances which are biologically active – whether from food, drugs or other chemicals – can have possible toxicity, but this depends on the dose. This applies equally to vitamins, minerals, and naturally occurring plant products. The U shaped curve indicates that compounds are actually beneficial to health at optimum, often dietary doses, and only present a health risk at very high concentrations. The high amounts are generally not achievable through normal dietary means such as food, but can only be obtained from heavily fortified foods or "mega-dose" supplements.

Intake of glucosinolates: Daily intake of two glucosinolates, glucobrassicin and neoglucobrassicin, was 5.0 and 0.5 mg/capita/day in the Danish and 2.5 and 0.3 mg/day in the Finnish population populations respectively[1]. These average values might be very different in individuals, who favour Brassica vegetables or who dislike and thus avoid Brassicas because of their distinct flavour. In the Potsdam region of Germany, the average daily cabbage consumption was 54 g/capita/day, mainly white cabbage, cauliflower and red cabbage, with consumption increasing with age[2]. The intake was slightly higher in the winter compared to the summer. The uptake of progoitrin was relatively low with only 3 and 2 mg/capita/day in winter and summer, respectively[3].

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[2] Pfaff G, Georg T, Mueller W, Seppelt B, Boing H, Lange R. Der Kohlgemueseverzehr in Deutschland - Ergebnisse einer repraesentativen Erhebung in der Region Potsdam. Ernaehrungsforschung 1994; 39:139-149.
[3] Glucosinolates in Cruciferous vegetables - Natural Toxicant or protective factors 8341. 1994.

Beneficial effect of Cruciferous vegetables: Isothiocyanates are potent inducers of Phase II detoxification enzymes, and increase the metabolism and detoxification of chemical carcinogens in vitro and in animal models. Some inhibit mitosis and stimulate apoptosis in tumour cells by blocking DNA damage, thus inhibiting the growth of tumour cells after initiation by chemical carcinogens.

Toxicological data: Glucosinolate breakdown products at high levels alter organ mass, and cause renal dysfunction or thyroid-toxicity in animal experiments[4]. Whereas the anti-thyroid effects of certain isothiocyanates are based on interference with the synthesis of thyroid hormones, thiocyanates compete with iodine and thus inhibit iodine uptake by the thyroid gland. Beside the thyroid gland, liver, kidney, and pancreas are the main target organs. In rats, toxic effects were observed with daily doses higher than 10 - 50 mg/kg body weight. At such high concentrations, certain isothiocyanates and nitriles may initiate mutagenic, cytotoxic, and carcinogenic processes[5-12]. Glucosinolate breakdown products induced genetic mutations in both bacterial and mammalian cells[13]. In vivo animal studies with benzyl isothiocyanate, allyl isothiocyanate, and phenethyl isothiocyanate have the potential to be genotoxic and probably carcinogenic, in their own right[14] [15]. The post-initiation effects of phenethyl isothiocyanate and butyl isothiocyanate on hepato-carcinogenesis and urinary bladder carcinogenesis in rats pre-treated with diethylnitrosamine and N-butyl-N-(4-hydroxybutyl)nitrosamine confers a strong promoter activity for both compounds[16].

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(8) Mawson R, Heaney RK, Zdunczyk Z, Kozlowska H. Rapeseed meal-glucosinolates and their antinutritional effects. Part 4. Goitrogenicity and internal organs abnormalities in animals. Nahrung 1994; 38(2):178-191.

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[13] Kassie F, Parzefall W, Musk S, Johnson I, Lamprecht G, Sontag G et al. Genotoxic effects of crude juices from Brassica vegetables and juices and extracts from phytopharmaceutical preparations and spices of cruciferous plants origin in bacterial and mammalian cells. Chem Biol Interact 1996; 102:1-16.

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[15] Kassie F, Knasmuller S. Genotoxic effects of allyl isothiocyanate (AITC) and phenethyl isothiocyanate (PEITC). Chem Biol Interact 2000; 127(2):163-180.

[16] Hirose M, Yamaguchi T, Kimoto N, Ogawa K, Futakuchi M, Sano M et al. Strong promoting activity of phenylethyl isothiocyanate and benzyl isothiocyanate on urinary bladder carcinogenesis in F344 male rats. Int J Cancer 1998; 77(5):773-777.

Epidemiological data: Despite some evidence of toxicity at high doses, the study of populations (epidemiology) has overwhelmingly shown a positive effect on health in human populations. These studies on Brassica vegetable consumption and cancer risk was summarised by van Poppel et al. (6 cohort studies and 74 case-control studies). High Brassica consumption was correlated with a decreased risk of cancer of the lung, stomach, colon, and rectum, and least consistent for prostatic, endometrial, and ovarian cancers[17]. The Karolinska Institute compared the diets of 2,832 women aged 50 to 74 years and diagnosed with invasive breast cancer with the diet of 2,650 women of the same age with no history of breast cancer. While there was no correlation between total fruit and vegetable consumption and breast cancer risk, postmenopausal women consuming 1 to 2 servings of Brassica vegetables daily had a 20 to 40 % decreased risk of breast cancer[18]. A follow-up of the 'Health Professionals' study followed over 47,000 men for 6.3 years and compiled food intake data for 8 years. They observed that Brassica vegetable consumption was related to a 51 % reduction in the risk of bladder cancer[19]. However, there are also human studies that failed to show any link between Brassica vegetable intake and markers of disease risk, or even a positive association[20]. Thus, the 'pooled analysis of cohort studies' conducted by Smith-Warner et al. failed to show any correlation between the Brassica consumption and the risk of cancer[21].

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2. Food group: All plant-derived food

Toxic and anti-nutritional substances: Phenolics and antioxidants
By Mariusz K. Piskula

The conclusions following from the epidemiological studies on large populations show a direct relation between the diet and the incidence of chronic diseases. Nutritional factors may be involved in preventing or slowing down the development of diseases commonly called diet-related such as coronary heart disease, stroke, diabetes, obesity, hypertension, osteoporosis, certain cancers or gastrointestinal disorders, the cause of which may be consuming large amounts of fruit and vegetables. There are indications that disturbing the balance of oxidation-reduction processes, which are essential life processes, induce the development of the above mentioned diseases as well as aging. It occurs when the human organism is not able to cope with excessive production of free radicals, i.e. highly active species ready to immediately react with the surrounding biomolecules. This means that as long as the complex system of human antioxidative protection works efficiently, the changes do not proceed. But although slow and gradual, with time they become the cause of aging and age-related diseases.

About 15 years ago attention was drawn to antioxidants present in plant-derived food, especially polyphenolics which as a group of food components with in vitro antioxidative potential might be responsible for the observed positive correlation between the consumption of fruit and vegetables and the incidence of chronic diseases. It was a come-back to a great interest in these compounds and their beneficial health promoting action from the 1930s when Szent-Gyorgyi observed a positive relation between their consumption and decrease in blood vessels permeability. It was even postulated to give polyphenolics a vitamin status (vitamin P).

Phenolic compounds are widespread in the Plant Kingdom and occur in all plant parts; therefore, they make a significant part of the human diet. The average daily intake of these compounds in the western diet is about 1 g and depends on dietary habits of the population. In general, their function in plants is similar to that which is assumed to occur in humans after consumption of plant-derived food - the protection against environmental stress generating excess of free radicals. Presently, there is a common agreement that habitual consumption of vegetable- and fruit-rich diet lowers the risk of coronary heart disease and certain cancers, the reflection of which is a wide-ranging action promoting consumption of five servings of fruit and vegetables a day. This triggered human intervention studies aimed at demonstrating that supplementation with antioxidants can be a way to suppress the development of certain diseases. Surprisingly, trials with high doses of dietary antioxidants such as beta-carotene, ascorbic acid, vitamin E, selenium and zinc over a long period have not confirmed this expected beneficial effect; moreover, some of them proved to be harmful when taken in high doses.

The message that polyphenolics are good for health resulted in the immediate appearance on the market of an array of dietary supplements labelled with ‘health claims’ without sound scientific evidence but attracting potential health-conscious consumers to their health beneficial action. At the moment is seems that the situation has almost run out of control since it is easy to buy supplements equivalent to cases of fruit and vegetables, or litres of wine or tea, each claiming miracle effects. Such health-focused behaviour propagated by media may cause that consumers can do themselves more harm than benefit via excessive supplementation as the anti-nutritional and toxic nature of polyphenolics may take over the beneficial one.

Indeed, there is also the other face of polyphenolics which recently has been almost forgotten. For years polyphenolics have been counted to the group of anti-nutritional compounds and in some cases even as mutagenic or toxic. The most important and complex anti-nutritional effects of polyphenols are those resulting from their interactions with proteins, which can clearly reduce nutrients digestibility through inhibition of proteolytic, lipolitic and glycolitic enzymes leading to lowering nutrients assimilation. This is the case of populations where legume seeds are staple food and the presence of polyphenols is a serious anti-nutritional factor. Moreover, the observed problems with minerals deficiency in humans consuming plant type diet is related to the formation of complexes between polyphenols and metal cations which interferes with metals intestinal absorption, especially for iron, calcium and zinc bioavailability.

When food is concerned, it is necessary to remember of its sensory properties like colour and taste. Polyphenols can bring a variety of pigmentation to food as one of their functions in plants is to attract insects necessary for pollination through palette of colours during flowering. However, in certain conditions they are the reason for food colour deterioration. Oxidation of polyphenols during food storage and processing results in product browning which can be suppressed by addition of inhibitors of this process. Bitter and astringent taste of plants serves them as predator repellent and it results from a high level of certain polyphenols which are transferred to food, which is also regarded as anti-nutritional factor since it limits plant food consumption. However, this drawback can be handled via application of taste masking food additives. Finally, their highly regarded antioxidative activity attributed to their health beneficial feature is not stable, as polyphenols have the potential to act as prooxidants under certain conditions, for instance in the presence of Al, Zn, Ca, Mg and Cd, which can be easily achieved in the dietary tract where these food components can meet thus generating all sorts of health problems related to free radicals. Still, summing up the data on at least certain groups of polyphenolics, they are regarded as health promoting plant food components.

Polyphenols potential toxicity has not yet been fully recognized and was ignored for years. From the nutritional point of view, polyphenolics are xenobiotics and once ingested are efficiently metabolised and eliminated form the organism as in ‘normal dietary situation”. The picture is different when excessive use of polyphenols containing supplements is considered. The Recommended Daily Intake (RDI) for polyphenolics is still lacking and it seems to be rather impossible to elaborate a uniform one. There is a vast number of different phenolic compounds divided into several classes forming the group called “polyphenolics’ and they exhibit different biological activities at different concentrations. They cannot be unified also because of their toxicity or adverse actions. For instance, grape seed proanthocyanidins, even when ingested in dietary unrealistically high doses (gram level), obtained a NOAEL grade (no-observed-adverse effect level). Consumption of milligram doses of soy isoflavones sold under the name phytoestrogens is still under discussion because of potentially adverse effects and their use as “natural” alternative to hormone replacement therapy, protection against hormone-related cancers or presence in infant formulas, remains controversial. Moreover, quercetin, probably one the most studied flavonoids attributed with a number of properties positive to health, is still sold by chemical companies as a pure compound labelled “hazardous”.

Another serious safety issue is polyphenols interaction with therapeutic drugs. Simultaneous intake of flavonoids and drugs can cause serious complications by modulating drug absorption and metabolism. In other words, it may result in decline of drug therapeutic effect through its low absorption or, just the opposite, cause its increase to levels that might be toxic to a patient.

The potential nutritional significance of polyphenols expressed on the systemic level depends on their behaviour in the digestive tract. Particular polyphenols classes are absorbed from food in different extent and their systemic action differs substantially. Numerous studies demonstrate that these compounds are rather low bioavailable and are intensively metabolised during absorption, which in most cases results in a substantial loss of their antioxidative activities. Polyphenols unabsorbed in the upper part of the digestive tract become the subject to microbial metabolism. In some cases deleterious to health products of microbial metabolism might be formed. Moreover, when their intensive microbial degradation in the colon and the luck of support from human intervention studies with high doses of dietary antioxidants are considered, it becomes increasingly convincing that polyphenols health promoting action is not necessarily related to their antioxidative activity. Recently, they and their metabolites have become dietary candidates for molecules with the potential of influencing metabolic pathways on other than antioxidative mechanisms.

One has to keep in mind that polyphenols, which are one of the dietary supplements sold in concentrated form alone or even in combinations with other components aiming at mimicking a certain type of food, are in fact only a minute representation of compounds which are normally consumed with food. Plant-type diet is usually composed of diverse palette of vegetables and fruits prepared for consumption in ways sometimes unique for certain populations. Therefore, all that is generally understood as a dietary habit and is associated with the protective action of plant-derived food for certain populations includes both the traditional way of food preparation and the kind of plant material used. Moreover, the health promoting effect of certain diets, single plants or their components are usually observed over a long period of exposure and it is still only a presumption.

Polyphenols are consumed in relatively low doses along with other accompanying compounds which may be still underestimated dietary factors. In the case of coronary heart disease, the suggestion coming from an epidemiological study is that people with a very low intake of flavonoids have higher risk of coronary heart disease rather than that a high intake of polyphenols provides protection. It is clear that there exist potential safety issues if mega doses of polyphenols are consumed daily. Their overconsumption may, among others, yield in generation of free radicals which are cytotoxic, hepatotoxic, co-oxidize unsaturated lipids, may cause dangerous drug-flavonoid interactions or inhibit or induce drug metabolizing enzymes and hence adverse effects may took over the beneficial ones.

It was also shown that a substantial increase in consumer exposure to dietary polyphenols can be achieved through recipes and instructions on how food should be prepared proving that dietary modifications can be as effective as taking supplements. It is also possible to provide consumers with diverse in composition and properly balanced polyphenolics load through agricultural practices and proper processing and storage. It does not mean that dietary supplementation is always wrong. In some cases consumer can benefit from the compounds which are not delivered via habitual diet. However, the health claim and recommended dose must be properly scientifically substantiated.

The problem of scientifically not supported health claims appearing on food and dietary supplements labels has been already noticed by the European Food Safety Authority and respective regulations should soon be effective; however, it does not mean that the demand for polyphenolics and antioxidants containing supplements will drop dramatically or that they will disappear from the market. Thus, potential toxicities including interactions with drugs will still be the case.

3. Food group: Plant Proteins

Toxic and anti-nutritional substances: Allergens
By Hanne Frøkjær

A substantial number of proteins in plants possess allergenic properties, and these proteins largely constitute what is called food allergens. Although food allergens are found in most plant families, their presence is particularly prevalent in certain plant families, e.g. legumes, tree nuts, and oily seeds (sesame, sunflower and mustard seeds) and, in these plant families some members are in particular serious allergy provokers.

The far most common form for allergy is IgE mediated allergy. In allergic individuals, the allergenic food gives rise to an increased level of IgE antibodies against one or several proteins present in the food and, by subsequent encounters with the allergen, the allergenic proteins bind to IgE molecules present on the surface of the mast cells, causing release of histamine and other substances responsible for the immediate symptoms experienced upon ingestion of the allergenic food.

Although the mechanisms behind most of the allergic symptoms experienced in food allergy are well-established, understanding of how in particular the allergenic foods in the first round evoke the allergy in a limited number of individuals is limited. It is, though, well- accepted that properties of the allergenic food as well as predisposition of the sensitized individual are factors required to provoke the allergy. Importantly, many cases of allergy to fruit and treenut are caused by inhalation of pollen from the respective trees. Thus, a high proportion of food allergy is induced by inhaled pollen protein with homology to the proteins present in the fruits and nuts. Whether this is the case for the majority of plant food allergies remains to be established, but there is a clear geographical prevalence of the various types of allergies, e.g. apples and hazelnuts in the Northern Europe and peach and almond allergy in the Mediterranean countries.

The symptoms evoked by food allergens are quite diverse, ranging from mild irritation in the mouth and throat over diarrhoea and eczema to severe life threatening anaphylactic shock. In order to rank the problem with food allergens, it is, therefore, necessary to regard the severity of symptoms generally evoked by a group of allergens. Peanuts and tree nuts are by far the most severe allergenic food of plant origin, while serious life threatening or life quality reducing effects may also in fewer cases be caused by soybean, celery and sesame. Many fruits (e.g. apples, peaches, apricots, mango) also have the capacity to elicit allergic reactions, but these are generally milder.

Moreover, it is difficult to set a safety limit of the allergenic food proteins in a food, as sensitized individuals respond very differently to various doses of the allergenic proteins. For example in the case of peanuts some allergic individuals react to as little as 0.1 mg proteins, while others can tolerate up to 1 g before they experience allergic symptoms.

Peanut and treenut (e.g. almonds, brazilnut, hazelnuts and walnuts) allergy is an important condition because it starts at an early age, is lifelong and can be fatal. These allergenic foods can give rise to symptoms even with minimal contact through intact skin or by inhalation. In its mildest form, treenuts allergy can be limited to a rash, sickness and headache to swelling of the tongue and lips, whereas both treenuts and peanuts allergy in its extreme form it can cause anaphylactic shock. The potential severity of the symptoms of allergic reaction to nuts dictates that sufferers have to avoid carefully any contact with nuts and to carry adrenaline (to counteract the severe allergic reaction) at all times.

Although the reactions to the various food allergens are caused by the same mechanisms, the plant food allergenic proteins constitute a diverse group of proteins. Some allergenic proteins are readily denatured by cooking and food processing, and this destroys in most cases the allergenic capacity of the protein. Other food allergens are, however, highly resistant towards denaturing and resist even extensive food processing, and few proteins are allergenic also in the denatured state.

What is the problem?

Food allergy actually constitutes two separate problems that must be addressed and handled in different ways:

- *How do we avoid allergic reactions in individuals already suffering of food allergy to one or more foods?*

As described above, the adverse health effects of food allergens are well-established. Although food allergy only concerns a minor part of the population, it has to be handled seriously. Most allergenic consumers can overcome their allergy by simply avoiding the allergenic food and many only have to avoid the non-processed food, e.g. raw apples and nut in order to escape allergic symptoms.

The major problems exist for those individuals that also react towards processed food. Newer processing techniques, such as high-pressure treatment of foods, fermentation and enzyme treatment, can help to reduce the allergenicity of some food proteins, but still reactivity is often seen in the most senisitive individuals. Moreover, allergens can be removed from oils by refining. Some of the unresolved problems of food allergy are concerned with the presence of low amounts of a given allergen in processed foods or recipe dishes served out of home.

Another major problem is cross-reactivity with proteins from other plant sources. If an individual has allergy to hazelnuts, it is most likely that he also reacts to other nuts, as plants within the same families often contain proteins with high homology, but he may also react to apples and other fruits as these plants contain proteins highly homogeneous to proteins in nuts. Accordingly avoidance is necessary, not only as regards nuts, but also a number of fruits. In some food allergies these interrelationships are not easily foreseen and, therefore, the allergic person may experience bad surprises, when eating plant food not considered to be related to the plant food he is allergic to.

- *How do we avoid that new foods –e.g. crops that have not previously been used for human nutrition or new processing methods for food preparation – gives rise to new incidences of allergy?*

The current knowledge of why some but not other relatively similar plant foods are strong provokers of food allergy is limited. For example, peanuts is known as a strong food allergy provoker, while many other legumes less frequently give rise to food allergy, but it is currently not know, what makes peanut such a strong allergy provoker.

Such lack of knowledge regarding which properties of a food that confers it its allergy provoking capabilities makes it very difficult to envisage whether introduction of new plant foods or new processing methods will pose increased risk of food allergy for the consumers.

How are the problems currently being handled?

In order to give the allergic consumer the best possibilities to avoid food containing the offending allergen(s), the EU legislation has been changed, so even minor amounts of an allergenic food must be declared. Until 2003, when the Directive 2000/13/EC was amended, the rule was that if a compound food (e.g. batter in deep fried vegetables) made up less than 25% of the final food, there was no legal requirement for listing all the ingredients used in that compound food. Accordingly the allergic consumer had a high risk for ingestion of allergens in amount sufficient to elicit an allergic reaction.

The directive 2003/89/EC, which came into effect in November 2004, amends directive 2000/13/EC and establishes a list of allergenic food ingredients that must be included on the label, if they are used in food pre-packed in Europe independently of the amount present. Moreover, these rules require that the source are indicated for all allergenic compounds on the list, e.g. if peanut oil has been used it has to be specified whereas in the past, peanut oil could be declared as 'vegetable oil'.

Accordingly, the currently rules give the consumers suffering from food allergy a high protection, although the allergic individual is still at risk for allergenic provocation, in certain cases:

- *Contamination of food products not intended to contain the food allergen.*

This is often caused by the use of the same production plan for production of different food products. This risk is often prevented by labeling all products from the production plant with 'may contain traces of..' or similar declarations

- *Cross-reactivities between the food allergen and other plant foods.*

Precisely which cross-reactivity the allergic individual experiences varies. Accordingly it is not strait forward to establish labeling for possible cross-reacting food allergens. Rather the consumers should have easy access to all relevant knowledge concerning crossreactivities, e.g. through easily accessible web-sites addressing the consumer, and which are regularly being updated with new knowledge.

With respect to novel food and novel processing methods concerns regarding the risk of introducing food allergy in a consumer segment should be addressed. Although rules for risk assessment in relation to introduction of such new foods have been established, which seek to envisage the allergenic risks, e.g. by assessment of cross reactivity and other similarities with known allergenic food, the current knowledge is still too limited to ensure prevention of introduction of new allergenic foods on the marked.

4. Legal framework for food safety in the European Community

By Helen Lee

The basic framework regulation on food and feed safety in the European Community is Regulation No. (EC) 178/2002[1] which concerns general food law. This Regulation provides a framework to ensure a coherent approach in the development of food legislation covering all stages of food/feed production and distribution. To achieve this goal:

- it establishes the European Food Safety Authority (EFSA)
- it lays down the over-arching definitions, principles and requirements on which all EC food legislation is based.

In particular, the Regulation establishes:

- the principles of risk analysis in relation to food and establishes the structures and mechanisms for the scientific and technical evaluations which are undertaken by the EFSA;
- the Precautionary Principle as an option open to risk managers when decisions have to be made to protect health but scientific information concerning the risk is inconclusive or incomplete in some way;
- the basic principle that the primary responsibility for ensuring compliance with food law, and in particular the safety of food, rests with the food business.

An example where legislation has been specifically enacted in relation to naturally occurring toxicants is regarding spices and herbs and other source materials that are used for the production of flavourings. Council Directive 88/388/EC[2] lays down maximum limits for food and beverages to which flavourings and other food ingredients with flavouring properties have been added. The limits in the Directive are based on a list of maximum limits proposed by the Committee of experts on flavouring substances of the Council of Europe. They cover food and beverages in general with exceptions for certain food categories. The Commission wants to protect against too high intake of such substances. The limits proposed continue to allow habitual use of these herbs and spices, the main aim is to avoid exaggerated use.

In the proposal for a new regulation on flavourings, maximum levels are maintained for the food categories which contribute most to the intake. In addition restrictions are proposed for certain source materials for production of flavourings[3] and food ingredients with flavouring properties. The maximum levels and the restriction are based on the scientific opinions adopted by the SCF or EFSA.

[1] Regulation No. (EC) 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (OJ L 31, 1.2.2002, p. 1)

[2] Council Directive of 22 June 1988 on the approximation of the laws of the Member States relating to flavourings for use in foodstuffs and to source materials for their production (OJ L 184, 15.7.1988, p. 61)

[3] Proposal for a Regulation of the European Parliament and of the Council on flavourings and certain food ingredients with flavouring properties for use in and on foods and amending Council Regulation (EEC) No 1576/89, Council Regulation (EEC) No 1601/91, Regulation (EC) No 2232/96 and Directive 2000/13/EC (COM(2006) 427 final, 2006/0147 (COD))

In addition, Council Regulation (EEC) No 315/93[4] lays down Community procedures for contaminants in food and provides that food containing a contaminant in an amount which is unacceptable from the public health point of view shall not be placed on the market. Where necessary to protect public health, maximum levels for specific contaminants shall be established. The definition of a contaminant implicitly includes inherent naturally occurring toxicants. For the time being, no specific provisions have been established yet for inherent naturally occurring toxicants in the frame of Regulation (EEC) 315/93.

Another legislative approach is to provide the necessary information so that consumers who might be at risk from specific substances in foods can make informed dietary choices. Usually consumers are informed through the labelling of foods. The general food labelling Directive 2000/13/EC[5] requires all ingredients to be indicated on the label and establishes a list of ingredients liable to cause allergies or intolerances. The presence of ingredients that contain substances that may cause allergies or intolerances must be mentioned on the label, including on alcoholic beverages. In addition, there specific rules may be adopted regarding the labelling of certain substances or ingredients an example is certain labelling statements must be included on the label of foods containing glycyrrhizinic acid or its ammonium salt.

Other legislation that might be relevant to substances in plants is:

Regulation (EC) No 258/97[6] on **novel foods and novel food ingredients** defines novel foods as those which have not been consumed to a significant degree in the Community prior to 1997 and which belong to one of the categories laid down in the Regulation. These include foods which result from technological innovation (such as cholesterol lowering margarine containing phytosterols) and foods which originate from third countries and have never been imported in the Community (such as exotic fruits and nuts). In order to ensure the highest level of protection of human health, novel foods must undergo a safety assessment before being placed on the EU market. Only those products considered to be safe for human consumption are authorised for marketing.

The European Commission has adopted a proposal to revise Regulation (EC) No 258/97 with a view to improving the access of new and innovative foods to the EU market, while maintaining a high level of consumer protection and ensuring food safety. Under the draft Regulation, novel foods would be subject to a centralised authorisation procedure following the scientific assessment on the product by the EFSA. A notification procedure is introduced for foods which have not been traditionally sold in the EU but which have a safe history of use in third countries.

[4] Council Regulation (EEC) No 315/93 of 8 February 1993 laying down Community procedures for contaminants in food (OJ L 37, 13.2.1993)

[5] Directive 2000/13/EC of the European Parliament and of the Council of 20 March 2000 on the approximation of the laws of the Member States relating to the labelling, presentation and advertising of foodstuffs (OJ L 109, 6.5.2000, p. 29)

[6] Regulation (EC) No 258/97 the European Parliament and the Council of 27 January 1997 concerning novel foods and novel food ingredients (OJ L 43, 14.2.1997, p.1)

Regulation EC 1925/2006[7] on the addition of vitamins and minerals and of certain other substances to foods provides the basis for scrutinising and, where necessary, regulating the addition of substances with nutritional or physiological effect, other than vitamins and minerals, to foods. The Regulation introduces a procedure that would allow to restrict or even forbid, after consultation of the European Food Safety Authority, the use of substances other than vitamins and minerals that are used in or added to foods (including food supplements), under conditions that would result in the ingestion of amounts of these substances greatly exceeding those reasonably expected to be ingested under normal conditions of consumption of a balanced and varied diet and/or would otherwise represent a potential risk to consumers. In case of scientific uncertainty the concerned substances could be inserted in a "scrutiny list" where they can remain up to 4 years. During this period those substances will remain subject to national legislation and manufacturers will be invited to provide data on their safety to EFSA. Within the 4 years a decision must be taken on whether the substances will be restricted, forbidden or generally allowed.

In conclusion, the General Food Law requires that food that is placed on the market is safe and the primary responsibility for ensuring the safety of the food is the food business. In addition there are specific legislative measures that are relevant to the management of potential risks associated with harmful substances in foods.

[7] Regulation EC 1925/2006 of the European Parliament and of the Council of 20 December 2006 on the addition of vitamins and minerals and of certain other substances to foods (OJ L 404, 30.12.2006, p. 26)

5. New developments in industrial food processing

By Dietrich Knorr

Introduction:

New process developments such as high hydrostatic pressure and pulsed electric field treatment of raw materials and foods are low energy, low process intensity and mainly waste free technologies applicable for preservation and modification of foods with the goal to replace or to support existing thermal processes. This consumer driven development for safe, high quality and high functionality food processed via sustainable technologies is also aimed to retain or enhance the nutritional quality of products and to overcome some of the disadvantages of conventional thermal processing such as destruction or loss of nutrients, induction of unwanted substances, creation of waste products and high energy and water consumption. Figures 1 and 2 illustrate the key differences between thermal processing and the new technologies.

Fig 1: Limitation and advantages of thermal and non-thermal processes.

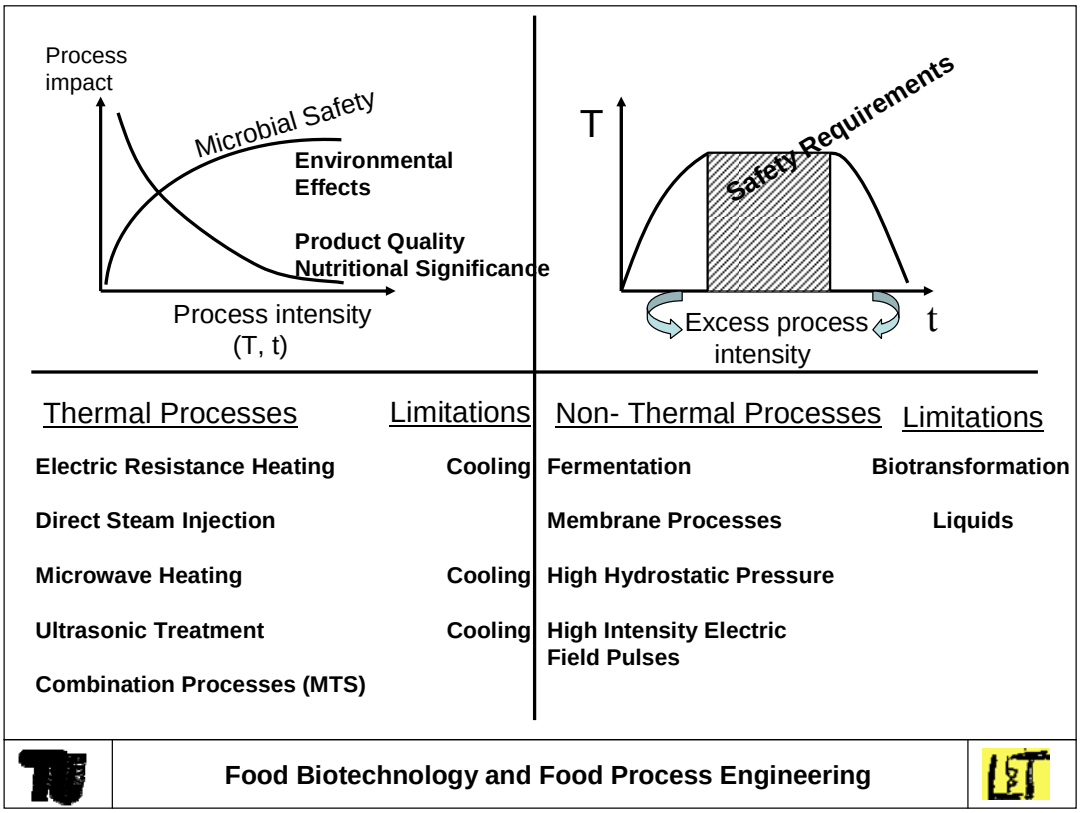
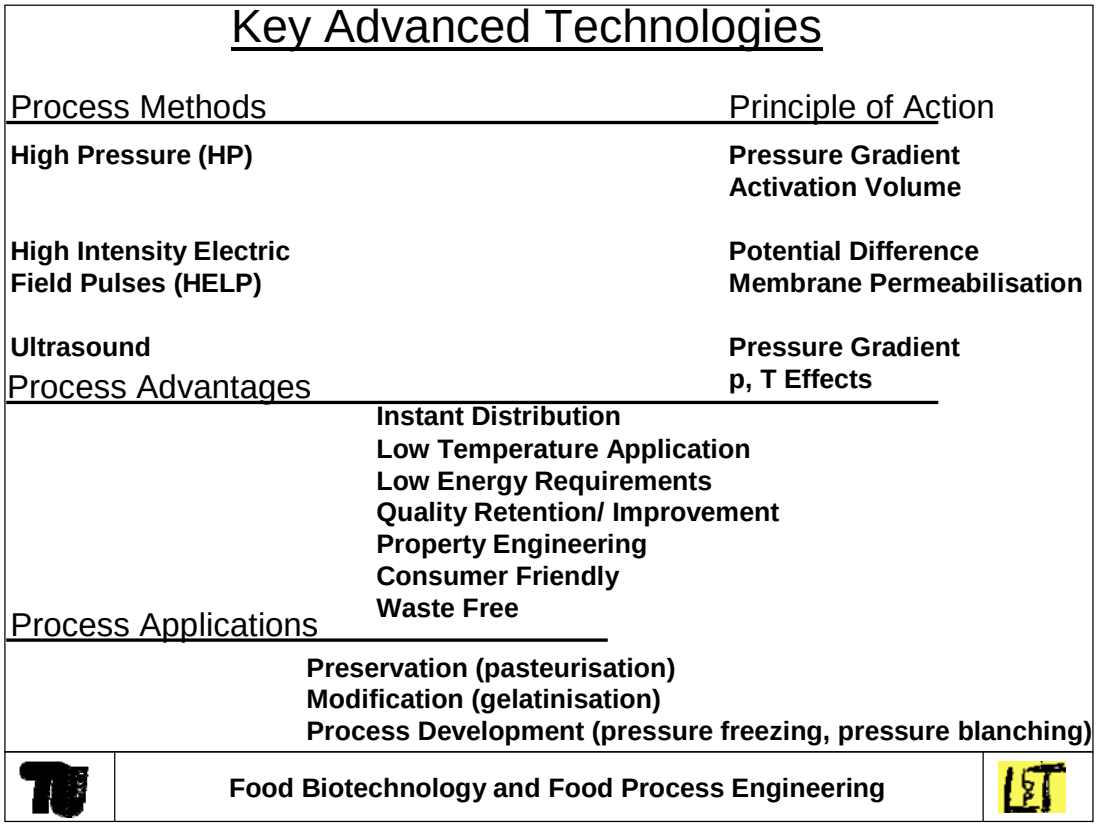


Fig 2: Principle advantages and process application of key advanced technologies.



An integrated EC project (www.novelq.org) is currently evaluating critical issues regarding the development of these new technologies including safety, toxicity, allergenicity, quality, chemical, nutritional and consumer aspects. Documents on the safety assessment of high pressure and pulsed electric field processes spearheaded by the German Research Foundation (www.dfg.de) suggest in principle limited amount of existing data for a comprehensives safety assessment and the need for a case-by-case assessment.

High hydrostatic pressure treatment:

High hydrostatic pressure (HP) treatment of foods has been initiated more than 100 years ago and has been put into commercial use for the fist time in Japan in 1990. Meanwhile approximately 120 industrial high pressure processing units exist worldwide.

The USA is currently the main user of this technology because inactivation of food pathogens such as salmonella and listeria (especially in meat products) proved to be more effective by high pressure processing than via conventional routes.

Research data accumulated so far indicate that this technology can be used effectively for pasteurisation and sterilization of foods. Proteins and polysaccharides can be modified providing the potential for new product development via a physical process rather than a chemical / biochemical. Further it has been shown that nutrients, flavours, colour, aroma and texture of foods can be well retained by pressure processing and that prions (the most likely cause of BSE) and viruses can also be inactivated effectively.

In summary the safety assessment of HP processing as given by the German Research Foundation (www.dfg.de) states that findings derived from a few already marketed products have not yet revealed any evidence of any microbial, toxicological or allergenic risk as a consequence of high-pressure treatment but do not suffice for a general evaluation. At present an individual case-by-case examination of high-pressure treated foodstuffs is necessary. For any future safety evaluation of high-pressure treated food according to recognised standard criteria the development of product- and process-specific test parameters is desirable.

Pulsed electric field treatment:

The pulsed electric field (PEF) process promotes permeabilization of biological cells (plant, animal, microbial) thus allowing the efficient extraction of cellular contents as well as the inactivation of microorganisms in foods. In addition to this irreversible permeabilization, reversible permeabilization (e.g. the "infusion" of material in biological cells) as well as induction of stress responses with low energy pulses (e.g. increased biosynthesis of antioxidants such as phenols in plants or phytosterols) is possible. The energy input required is much lower than by conventional processes and it can be considered as a waste free technology. Currently one industrial application exists in the USA; Industrial and pilot scale equipment exists in the Netherlands, in Germany and Sweden.

A survey regarding the safety assessment of the PEF process (www.dfg.de) concludes that a consistent evaluation of the PEF process is hindered due to the limited number of studies and the lack of standardisation of process parameters. Development of criteria to assess the process requires, among other things, the characterisation of suitable indicator substances and measuring parameters. According to the assessment criteria given in the document, products treated with the PEF technology require a case-by-case assessment.

Recent data accumulated within a collaborative research project (www.fei-bonn.de) provide evidence that substantial equivalence of PEF treatment vs. conventional treatment for the production of fruit juices is given.

Benefits of PEF include high juice yields from fruits and vegetables (including sugar beets), oils from oilseeds, higher drying and extraction rates and as a result of stress reactions higher concentrations of antioxidants and antimicrobial substances in plant materials as well as the retention of valuable natural antimicrobial components in milk while inactivating pathogenic microorganisms.

Current EC funded research (www.novelq.org) attempts to identify the impact of PEF on allergens and toxins as well as to determine whether stress induction via PEF might lead to the generation of antinutritional or potentially toxic metabolites. The potential of generation of electrochemical reaction products and release of ions from electrodes is being evaluated.

Strategic Research Agenda 2007-2020:

The European Technology Platform (ETP) on Food for Life (http://etp.ciaa.eu) which outlines the Strategic Research Agenda within Europe for the 15 years suggests under its key challenge: Developing quality food products the following goals:

(1) Producing tailor made foods

(2) Improving process design, process control and packaging

(3) Improving understanding of process-structure-property relationships

(4) Understanding consumer behaviour in relation to food quality and manufacturing

Outlook:

As identified in the ETP document the key challenges for future food research and development are:

(1) Ensuring that the health choice is the easy choice for consumers

(2) Delivering a healthier diet

(3) Developing quality food products

(4) Assuring safe foods that consumers can trust

(5) Achieving sustainable food production

(6) Managing the food chain

This clearly indicates that European food RRD is taking a highly responsible role in ensuring highest food quality, sustainability and safety as well as dealing with other key issues such as weight control, consumer trust and optimum integration of the entire food chain. Through implementation of this concept and through the establishment of more targeted EC as well as nationally founded research on key food related issues the EU can become a global role model for responsible food production and processing.

6. Natural Food Toxicants: Food Safety Management Aspects

By Anton J. Alldrick

Introduction:

Food businesses have both a moral and legal (Regulation (EC) No 178/2002) requirement to produce and manufacture safe food. A key component in achieving this objective is the use of appropriate food-safety management techniques. These are based on the concepts of hazard identification and risk reduction. World-wide, the most commonly favoured approach involves application of the principles of HACCP (Hazard Analysis Critical Control Point) and within Member States; European legislation (Regulation (EC) No 852/2004) requires food businesses to operate in accordance with these principles. Although originally developed from the point of view of microbiological hazards; developments in the philosophy underpinning HACCP mean that its principles can also be applied to assure consumer safety in terms of natural toxicants. The purpose of this paper is to review the nature of the hazards presented by toxicants arising as a consequence of the innate properties of the raw material and/or subsequent chemical reactions occurring during processing, together with the management systems necessary to reduce the likelihood of the consumer experiencing some form of adverse reaction from them.

Due to their diversity, natural toxicants provide a number of challenges which have been recognised by food-safety management practitioners. These relate to both how they arise and what proportion of the consumer-base is affected by them. In terms of their occurrence they can arise as a consequence of:

- The innate nature of the food concerned (examples discussed at this meeting include glucosolinolates, polyphenols and food allergens)
- Contamination as a consequence of other organisms present in the food (e.g. the production of mycotoxins by certain moulds)
- Production during the processing of particular foods (e.g. acrylamide).

It should also be noted that these materials either have the potential for eliciting adverse responses in all of the population or particular subsets of it (as in the case of food allergens).

There appear to be three fundamentals which have to be addressed in the food-safety management of natural toxicants, these are:

- Its origin;
- The composition of the population at risk;
- The effect of food processing.

The application of these fundamentals will be discussed by reference to examples of specific natural toxicants

Innate Toxicants:

For the purposes of this paper, innate toxicants are those produced by the plant during its normal growth. These may either have the potential to exert adverse effects towards the whole of the population; examples include lectins, glucosolinolates and alkaloids (e.g. morphine in poppy seeds); or a limited group of the population as in the case of food allergens. Depending on the toxicant of concern, the food industry can adopt one or a number of control mechanisms, as detailed below.

Plant breeding:

This approach requires plant breeders to develop new varieties of crops with reduced levels of the toxicant of concern. An example of this is the development of "double zero" rape (Brassica campestris). Original varieties of rape often had high levels of both glucosolinolates and the carboxylic acid erucic acid, consumption of either being associated with adverse effects. Classical plant breeding techniques have led to the development of varieties (e.g. canola) with far lower levels of these compounds. This has made them acceptable for food and feed use (reviewed by Bell, 1984). The challenge for the food processor is that erucic acid is also a useful precursor in the chemical industry. Consequently varieties have been bred with elevated levels of this compound (so-called HEAR (high erucic acid rape seed) varieties). It is therefore incumbent on the agri-food sector to ensure that appropriate segregation systems are in place and their efficiency maintained to ensure that food-safety is not compromised by HEAR varieties entering the food chain.

Food processing:

Some natural toxicants can be denatured by food processing (often through cooking). A classic example of this is the phytohaemagluttenin (lectin) produced by legumes and in particular vegetables such as red kidney beans (Phaseolus vulgaris). Lectins can be destroyed by cooking and retrospective analysis suggests that food-poisoning incidents associated with lectins are due to consumption of either raw or inadequately cooked beans (e.g. Rodhouse et al., 1990). This problem is recognised by industry. In the commercial processing of such vegetables for immediate consumption by the general public, use has been made of the knowledge-base developed on the conditions for inactivating these compounds (e.g. Marconi et al., 2000). An important point to note is that although process parameters may have been optimised for lectin destruction and monitored during processing, in accordance with HACCP principles, it is still necessary to verify the efficacy of the process. This would include chemical analysis, and depending on the risk of the hazard occurring, might be done on a periodic or an every-batch basis.

Active Management:

In some cases, innate toxicants cannot be removed by either breeding or food processing. Such a situation applies for a number of food allergens. Food allergens provide particular challenges in that they are an integral component of the food, they affect sub-populations and it has not proven possible to identify levels of safe exposure (discussed by the European Food Safety Authority, 2004). In this case an integrated management approach (again based on HACCP e.g. see Alldrick, 2006) which addresses all activities within a food business is used. Regulators at both European and Member State levels have provided both a legislative framework to enable consumers to make informed choices as to the food-allergen content of foods (Commission Directive 2007/68/EC) and guidance to manufacturers & caterers in allergen management (e.g. UK Food Standards Agency, 2006, 2008). This is further augmented by advice from Trade Associations (e.g. British Retail Consortium, 2004) and consumer groups (e.g. Anaphylaxis Campaign 2008).

Contaminant & Process Toxicants:

As discussed above, it could be argued that natural plant toxicants include those that arise by virtue either of contamination by other organisms (e.g. mycotoxins) or as a consequence of processing (e.g. acrylamide). Both groups of compounds provide useful case studies of how regulators and industry have combined to develop an environment whereby the risk to the consumer is controlled.

Mycotoxins:

Mycotoxins are toxic metabolites produced by certain moulds. Legislation (Regulation (EC) No 1881/2006) prescribes the maximum levels permitted for a number of them in foods. In many cases, mycotoxins are resistant to food processing and thus persist into the finished product. Mycotoxin control therefore begins with the raw material through adoption of a 'prevention is better than cure' approach by producers and raw material handlers. This approach is based on an accumulation of knowledge concerning the production of mycotoxins in particular commodities, which is often encapsulated into guidelines produced by government organisations within Member States. For example, in the United Kingdom, the Home Grown Cereals Authority has a whole area on its website (www.hgca.com) devoted to grain storage - a key factor in the control of grain contamination by the mycotoxin ochratoxin A and another area devoted to Fusarium sp. mycotoxins. Compliance with these guidelines is assured at a commercial level by virtue of the fact that many food processors require their raw material suppliers to be accredited under an appropriate crop quality standard scheme (e.g. the Assured Combinable Crops Standards, www.assuredcrops.co.uk). For a supplier to be accredited to this scheme it is necessary for him to demonstrably adhere to relevant guidelines concerning grain storage (with regard to minimising ochratoxin A formation) and minimising the formation of Fusarium sp. mycotoxins (Assured Combinable Crops Standards, 2007).

Acrylamide:

The presence of acrylamide in a wide range of foods produced at high temperature was first brought to light by Swedish researchers in 2002 (World Health Organisation, 2002). The exact toxicological significance of this finding is still being elaborated; however application of the precautionary principle requires that steps should be taken to reduce its occurrence wherever possible. Since 2002 then there has been considerable research into the mechanism of formation and routes to reduce its occurrence (e.g. the EU 6th Frame-Work project 'Heatox', Contract Number Food-CT-2003-506820-STREP'). Outputs from this and other research have been used both to develop guidelines as to how to reduce the amount of acrylamide formed during processing and also the development of innovative food process aids which can also contribute to reduced acrylamide formation. In terms of guidelines, the European Food Industry in the guise of the CIAA (Confederation des Industries Agro-Alimentaires de l'UE) working together with academic and regulatory organisations has developed, "The CIAA Acrylamide Toolkit" (CIAA, 2007). The 'tool kit' is currently in its 11th revision and reports on recent and validated developments in mitigating acrylamide formation. For example, the use of the asparaginase in some products to remove one the precursor compounds (asparagine) has been validated as a route to ameliorate acrylamide formation in certain foods and at least two European food ingredient companies are now marketing asparaginase as a processing aid with this function in mind (Haliday & El Amin, 2007).

Discussion:

Analysis of RASSF alert data published by the Commission for the period 19th March 2003 to 29th April 2008 indicates of that of the innate natural toxicants usually discussed, the only issue warranting regulatory intervention concerned elevated levels of morphine in poppy seeds (nine). No notifications relating to other innate toxicants or acrylamide were found. In the 52 weeks previous to 29th April 2008; 163 alerts relating to microbiologically-related issues, 84 alerts concerning mycotoxins and 32 alerts relating to food allergens, had been reported. Such data give some idea of the relative significance of each category in terms of overall food-safety within the community.

Natural food toxicants are recognised by both regulators and the food industry as presenting a potential hazard to the consumer. What is important for assuring consumer safety is the risk-reduction strategy adopted. Depending on the nature of the contaminant one or a combination of strategies can be used. These include:

- The selection of plant varieties low or deficient in innate natural toxicants;
- Ensuring agronomic practices are such that the risk of toxin production is minimised;
- Development of processing strategies capable of removing either the toxin or its precursor;
- The use of integrated management solutions.

Irrespective of the perceived level of risk, the hazard must be managed to ensure that risk levels do not compromise consumer safety and that whatever management strategies are used must be verified.

Acknowledgement:

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7. New developments in novel and functional food: Are seed proteins a problem or a boon?

By Marcelo Duranti

Despite the consistent drop of oil-, starch- and protein-crop production in many countries in the last years [FAOSTAT, 2006], these seeds still remain an unabated sustainable and cheap source of valuable nutrients for food and feed. Moreover, improved industrial separation techniques have increased the interest for individual seed components, such as oil, proteins, starches, fibres and minor constituents. Concurrently, the unveiling of biological activities of specific non-protein and protein components relevant to consumers' health promotion is further augmenting the interest toward these seeds [see for reviews Duranti 2006; Scarafoni et al. 2007]. In this context, pulses, which include peas, various beans, lupins, lentils, chickpeas and several other minor species, but also oil-crops, such as soybeans and peanuts, represent nutrient sources of planetary interest. Therefore, an increasing exploitation and diffusion of legume seeds and particularly of legume seed components as food ingredients does require a careful evaluation of potential beneficial/adverse effects related to their consumption, as well as the monitoring of the effects of processing on these properties. Actually, various research activities in this area have been carried out by many European and overseas laboratories since the '80s, but various limiting factors, which will be in part considered in this presentation, have sometimes prevented ultimate conclusions to be drawn. Just to give a quick example: much concern was given to the area of seed anti-nutritive compounds in the past years prior to acknowledging the beneficial properties of some of them, while more serious problems for the celiac individuals have unexpectedly arisen from "harmless" food proteins such as gluten proteins used to make pasta, bread and other bakery products. This remark simply highlights how far from a deep understanding of the biological properties and physio-pathological effects of dietary and particularly vegetable proteins still we are.

In this presentation, I will illustrate the current knowledge in the field of seed dietary protein utilisation, compare beneficial vs. detrimental effects, identify the bottlenecks in this area and draw some possible guidelines to overcome the limitations.

Dietary proteins are generally recognised as nutritious and safe food constituents in force of their almost complete degradation to amino acids during the gastro-intestinal transit. Nonetheless, various food proteins have been proved to exert a number of undesirable effects, including food intolerances, allergic reactions, inhibition of intestinal enzymes, and other effects which are scarcely characterised at molecular/physio-pathological level. Conversely, the same phenomenon of incomplete protein degradation is believed to increase the possibility that whole proteins or peptide fragments thereof exert specific effects on the organism which may turn out to be beneficial.

A typical example of the dual effect of a protein family commonly found in many legume, and non-legume, seeds is that of serine-protease inhibitors. The anti-nutritional role of this protein class is evident if one considers that the most important proteolytic enzymes in the human intestinal tract are serine-proteases, i.e. trypsin, chymotrypsin, elastase and others, but the same inhibitory activity has been proved to be effective in the systemic control of the activities of other proteases involved in inflammatory and carcinogenic processes [Clemente and Domoney, 2008]. It is not a case that a number of patents on the control and therapy of pre-cancerous conditions, tumours, auto-immune syndromes, multiple sclerosis, ulcerative colitis brought about by Bowman-Birk inhibitors have been deposited.

Other legume seed proteins, most of which belonging to the family of storage proteins, do possess specific properties which can be beneficial to the organism with no apparent adverse effect. This is the case of one polypeptide subunit of the soybean main protein b-conglycinin with a marked blood lipid lowering effect [Duranti et al. 2004]. The potential role of this biological activity in the prevention and control of cholesterol- and trygliceride-related syndromes, such as cardiovascular diseases, hypertension, obesity and others, is clear. One further example is the observed blood glucose lowering activity of a lupin seed protein, g-conglutin [Magni et al. 2004]. The interest for this biological activity resides in the possibility of controlling glycemia whose augmented levels are notoriously responsible of the pathogenesis of diabetes and metabolic syndrome. It is noteworthy that all the mentioned pathologies are increasingly being recorded especially, but not exclusively, in the affluent countries. In the case of the lupin protein, a probable allergenic activity has also been associated to it. Therefore, as in most cases when dealing with foods and drugs, the overall health benefit to detriment balance has to be carefully evaluated.

These examples highlight the complexity of the matter related to the occurrence of the positive vs. adverse activities of plant food proteins. Understanding the molecular reasons of such behaviours and elucidating the biological effects of these bioactive proteins and peptides are difficult tasks, which require integrated multidisciplinary experimental approaches. A modern integrated strategy should consist of rigorous, fundamentally based, strongly interdisciplinary structural/functional analyses of individual target compounds, demonstration of their biological activity in cell and animal models and, last but not least, elucidation of the mechanism(s) of action. This scientific platform has been referred to as ‘‘molecular nutraceutics’’ [Scarafoni et al. 2007]. Nowadays, these studies can benefit of various innovative tools and disciplines, including the many “–omics” ones, i.e. genomics, transcriptomics, proteomics, nutrigenomics, pharmacogenomics, etc., that can help answering several still open questions, most of which of basic nature. Just to mention some of the most critical ones:

1. stability of the polypeptide backbone and the native protein conformation during gastro-intestinal transit;
2. modalities of absorption of proteins or large fragments through the intestinal barrier;
3. metabolic fate and clearance of absorbed proteins and peptides;
4. topical vs. systemic effects;
5. effects of individual responses, ways of administration (presentation), food matrix;
6. intrinsic polymorphism of seed proteins;
7. homogenisation and validation of analytical protocols;
8. identification of biomarkers for unequivocal measurements of the effects of biological activities.

Conclusion:

Grain legumes are a valuable source of food proteins. Their exploitation is expected to grow in relation to the growing world's food needs, and many other value-added uses can be foreseen, provided we can get a better knowledge of their molecular properties and biological activity. Under all circumstances, an integrated multidisciplinary approach is crucial, if the commitment is to go beyond the generic health claims and to establish a science-based approach for the development of a functional food science. This promising area of plant protein drug discovery is significantly expanding in these years and novel outstanding achievements are expected soon in many directions. The body of information which are expected to be gathered is the gateway to the development of new, safe and healthy foods which may respond the increasing consumers' awareness of the role of dietary habits on human well-beings.

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8. New developments in novel and functional food: Industrial perspective

By Lisbeth Munksgaardi

The European agro-food industry formed in 2004 the European Technology Platform (ETP): "Food for Life". The ETP is hosted by the European Food & Drink organisation CIAA. The European academia and the private food sector have together created a Food for Life vision document and a strategic research agenda which aims at making the healthy choice the easy choice for the consumer. The European agro-food industry is seeking to develop affordable products, which incorporate healthiness, convenience, are of high quality and safe to eat. Thus the ETP focuses delivering delicious food, which can address the western life style challenges such as obesity and related complications. Read more about the ETP on http://etl.ciaa.eu.

The frequency for obesity is rapidly increasing. For Europe it is estimated that more than 40 % of the population will have a body mass index higher than 30 in 2030. All stakeholders are responsible for changing this situation.

Functional foods are the most rapidly growing sector of the food market in most developed countries. In 2007, it has been estimated that the European market for health-giving foods and drinks is worth €12.8 billion with a growth rate of 10.1%. The Food for Life has identified foods for health as the specific lead market target. The European food sector aims at taking a leading position.

Some of the most health promoting ingredients of today and their health benefits have been know for several decades. Only a limited number of really new health promoting ingredients will be invented in near future. But we may have a much better understanding of the nutritional benefits of the food components. Modern nutritional science is needed for obtaining more knowledge about the mechanisms and the variety of functions of plant extracted material such as polyphenols and other secondary metabolites, oils, proteins and carbohydrates.

Health promoting ingredients can be functional, health promoting ingredients or enablers, that will improve the texture or taste of a health promoting food in order to make the health promoting food delicious.

The presentation describes trends in consumers' choice within the functional food market.

A high level of food safety is mandatory. The level of food safety has never been higher than now in the western world. The dose of a functional ingredient must be safe.

Functional ingredients to food should be included in amounts that promote healthiness at intake during a lifespan rather than high doses for curing diseases. This is the function of pharmaceuticals. Thus food regulation should promote the low dose that may not prove effects over short time, rather than demanding clinical, short terme effects. The effect of functional ingredients should be based on sound science. Thus we need research in biomarkers (similar to blood cholesterol levels) that can prove health promoting effects of food.

The harmonisation of the European regulation for novel food and health claims is welcomed. Future regulations should balance risks and benefit in a way that can avoid barriers to innovative and beneficial products.

The presentation concludes that:

- Public and private funding dedicated for research within the food for health area will be essential for sound science based regulation of the area.
- Functional food is food and not drugs. Valid biomarkers should be identified for testing the benefits of functional ingredients rather than clinical trials.
- Future regulations of the area should balance risks and benefits in order to avoid built in barriers for new beneficial products.

9. Consumer behaviour and knowledge: Good or bad, or both? Processing information and silent knowledge

By Liisa Lâhteenmakii

Food is an essential part of our life and our eating habits are deeply rooted in cultural conventions. Food fulfils biological need for fuel, yet in everyday life we talk more about the pleasure and sensory experiences derived from food. Food also carries shared social meanings within cultures we are not even consciously aware of until we are confronted with alternative views. During eating we literally incorporate food as part of our own bodies and this makes food-related safety issues very sensitive consumer topics. Although eating seems as a simple everyday behaviour, food-related behaviours cover the complex field from basic physiological responses to cultural conventions and individuals' choices in between.

Plant-derived foods are mainly regarded as healthy and safe. Nutrition guidelines promote the use of fruit and vegetables and cereal-based products, especially whole grain products. The material produced for the public by Food Safety Authority in Finland (EVIRA) demonstrates that most of the safety concerns are related to products of animal origin. The biggest safety concern related to vegetable and fruit was cross-contamination from animal products in the kitchen via surfaces and utensils. This safe and healthy basic image can create a barrier if consumers need to be informed about any risks or negative aspects related to foods from plant origin.

When new negative discoveries about familiar foods are made communicating them in sensible messages to the consumer is a challenge. If food has many good attributes but also contains some harmful components, the latter message should not overrun the existing positive image, and furthermore scare people unnecessarily. What makes these messages even more complicated is that the harmful components may affect some specific subgroups of people or in large quantities everyone. Targeting the messages to the right audience is important. For consumers, understanding the importance of dose is hard, e.g. something that is good in reasonable amount is risky when eaten in excess. Making sense out of foods that contain both positive and negative aspects requires a risk-benefit analysis which demands active processing of information. By default consumers tend to use dichotomies when categorising foods or other objects in everyday thinking: foods are perceived either bad or good and weighing pros and cons require special effort.

The positive health image is supported by the impression that plant-derived foods are natural since many of them can be eaten as such or need little preparing. Often all natural things are regarded as good for you per se. Yet, this thinking may often be misleading and thus provide a misplaced confidence in safety of all plant-derived foods. Even now we have a number of food products from plant origin that need special treatment to remain or become edible. Some vegetables and pulses require cooking, potatoes should be kept in dark and certain mushrooms need to be cooked in plenty of water. Most of these naturally occurring hazards are something we have learnt to deal with and also to tolerate them. Appropriate handling methods are passed on within cultures as silent knowledge from one generation to another. When the cultural mediation fails these old hazards become new and they need to be informed by formal routes and externalised information. People moving to new geographical and social environment need this information, but passing the silent cultural knowledge may discontinue within cultures as well if these foods are not prepared at home. At EVIRA's web pages there are examples of information about handling the traditionally used but poisonous Gyromitra Esculenta mushroom.

Similar warning is about handling and cooking the pulses and beans before eating, since these have not been widely used in Finland traditionally. The problem with silent cultural knowledge is that it is difficult to estimate when it needs to be made explicit before an adverse incident occurs.

Consumers tend to be more suspicious towards foods that have been produced outside home than those prepared at home. For example with fruit-based products any processing decreases the perceived healthiness of the original fruit. However, this decrease is smaller if processing is carried out at home as one has a total control over the process, even though home processing is more likely to result in loss of vitamins and minerals and even lacking hygienic standards than industrial processing. On the other hand, consumers expect that all foods sold in the market are safe. They consider themselves responsible for nutritional choices, but not for microbial safety or safety of novel foods, e.g. any risks related to vegetable sterols were considered to be primarily the responsibility of food industry and society.

Products with specific bioactive compounds and health claims are relative newcomers on the market. Consumers' ability to understand the benefits of these products and the possible risks of getting too much of these components have been brought forward in discussions. In a Nordic survey with over 4 500 respondents from Denmark, Finland, Iceland, Norway and Sweden, the great majority of respondents did not think that eating more than recommended by the manufacturer would bring them extra benefit. Consumers were also able to link the promised benefit correctly with the appropriate health outcome. Adding a bioactive compound did not interfere positively with the overall healthiness perception of the product; on the contrary products with bioactive compounds were perceived as clearly less natural and thereby also less attractive options. These results suggest that consumers are not in general easily susceptible to overestimate the benefits of products with health claims, although this cannot guarantee in the case of any single claim.

Communicating about the possible new risks of plant-based products is difficult since consumers have a strong existing positive health image of these products and any negative piece of information has to challenge this image without destroying it. When consumers receive any news about single foods they need to adjust this piece of information to their existing beliefs. The nutritional quality of consumers' diets need to be assessed at diet level, and extensive favouring or avoiding single products is likely unbalance this overall quality of the diet. When negative information need to be shared with consumers this should be done in connection with the possible benefits in order to avoid unnecessary scares that limit people's food choices unnecessarily. Sufficient variety in diet is one way of making sure that there is no excess intake of those products that may contain also some harmful substances.

Annex 1 Workshop programme

STOA Workshop:

Naturally occurring and health compromising substances in plant-derived foods: Do we have a problem?

Chair: Ms. Lily Jacobs (MEP) and Mr. Jorgo Chatzimarkakis (MEP)

10 – 10.20: Welcome, Mr. Jorgo Chatzimarkakis, MEP, and ETAG

10.20 – 12.20: New knowledge and legal framework

Basic research within the fields of biochemistry and microbiology has given new insights with regards to the anti-nutritional nature of naturally occurring substances in plant-derived food. The aim of this session is to uncover these new insights and to present the legal framework dealing with them.

- What new knowledge has been uncovered?
- What are the possible adverse health effects?
  - Regarding non-processed food.
  - Regarding processed food.
  - Regarding novel and functional food.
- How big are these problems?
- To what extent are they currently being handled?

10.20 – 10.40:
Food group: Cruciferous vegetables; cabbage, broccoli, cauliflowers etc.
Toxic and anti-nutritional substances: Glucosinolates and glucosinolate derived compounds
Professor Gary Williamson, University of Leeds

10.40 – 11.00:
Food group: All plant-derived food
Toxic and anti-nutritional substances: Phenolics and antioxidants
Dr. Mariusz K. Piskula, Polish Academy of Sciences

11.00 – 11.20:
Food group: Plant proteins
Toxic and anti-nutritional substances: Allergens
Hanne Frøkiær, Associate professor, Nutritional immunology Group, Center for Biological Sequence Analysis, Institute of Systems Biology, Technical University of Denmark

11.20 – 11.50: Questions and debate

11.50 – 12.05 The legal framework

Ms. Helen Lee, European Commission, SANCO E4 - Food Law, nutrition and labelling

What is the legal framework in the EU for handling naturally occurring substances in plant-derived food that may be health compromising through for example toxic effects, allergenic effects or inhibition of nutrient assimilation?

- Regarding non-processed food.
- Regarding processed food.
- Regarding novel and functional food.

12.05 – 12.20: Questions and debate

12.20 – 13.20: New developments in industrial food processing

Industrial food processing has increased and new technologies applied, which may provoke health-compromising effects of naturally occurring substances in plant-derived food. The aim of this session is to discuss to what extent this development causes health problems that need to be dealt with:

- What are the new developments within food processing?
- To what extent do these developments involve the provocation of health-compromising effects of naturally occurring substances in plant-derived food?
- How big are these problems?
- To what extent are they currently being handled?

12.20 – 12.35: Dietrich Knorr, Berlin University of Technology, Department of Food Biotechnology and Food Process Engineering

12.35 – 12.50: Dr. Anton J. Alldrick, Campden & Chorleywood Food Research Association

12.50 – 13.20: Questions and debate
13.20 – 14.30: LUNCH BREAK

14.30 – 15.30: New developments in novel and functional foods

Various novel and functional foods contain bioactive substances from plants. These substances are used because they are considered healthy, but used wrongly or excessively, they may have adverse, i.e. anti-nutritional, effects. The aim of this session is to discuss to what extent this development causes health problems that need to be dealt with:

- What are the new developments within novel and functional foods, involving substances from plants?
- To what extent does the use of these plant substances give cause to health adverse effects?
- How big are these problems?
- To what extent are they currently being handled?

14.30 – 14.45: *Professor Marcello Duranti, Dipartimento di Scienze Molecolari Agroalimentari, University of Milano*

14.45 – 15.00: *Lisbeth Munksgaard, Senior Manager, External Scientific Affairs, Danisco A/S*

15.00 – 15.30 Questions and debate

15.30 – 16.45: Consumer behaviour and knowledge

While knowledge about the naturally occurring and health compromising substances increases among experts, things may look differently in private homes, restaurants and canteens in hospitals, education facilities and other work places as well as various catering facilities. Basic knowledge about how to store, handle and prepare foods such as fruit and vegetables may not be sufficiently widespread and new initiatives may be needed to deal with that. Changing consumer habits may also call for new initiatives.

Knowledge on this issue is very scarce, but the speakers in this session will address the following issues with examples from related areas:

- Is plant-derived food being stored, handled and prepared in ways that may cause health problems related to toxic, allergenic and anti-nutritional substances? - by private consumers, restaurants and canteens in hospitals, education facilities and other work places, as well as by various catering facilities.
- How big are these problems?
- How are they currently dealt with and is it sufficient?

15.30 – 15.45: *Kees de Winter, Food Policy Advisor, BEUC*

15.45 – 16.00: *Liisa Lähteenmäki, Chief Scientist, VTT Technical Research Centre of Finland*

16.00 – 16.30: Questions and debate

16.30: Wrap-up session

Each speaker wraps up the day giving their conclusions (2 minutes each) on what are the most serious problems, how big they are and what needs to be done about them.

Questions from MEPs

17.45 Closing remarks by Mrs. Lily Jacobs, MEP

Annex 2 CVs of the workshop speakers

Hilmer Sørensen

Co-organiser of the workshop

Master of Science in Agriculture, March 1964, from: The Royal Vet. and Agric. University, Copenhagen (RVAU). Ph.D. in Organic Chemistry at Professor Anders Kjær and Physical Chemistry at Dr. Kai Julius Pedersen, October 1967, both from: Chemistry Department at RVAU. Higher education in biochemistry at the University of Copenhagen, 1969-1972. University Lecturer/Assistant Professor at Chemistry Department, RVAU, from 1967-; from 1989- docent/Associate Professor. In the first period mainly in Organic Chemistry, changing to be mainly in Natural Product Chemistry and Biochemistry for graduate students. Author and co-author throughout this period to several manuals for laboratory experiments in both Organic Chemistry and in Biochemistry.

Research:

The research during 40 years Hilmer Sørensen has comprised various subjects: Organic Chemistry, Natural Product Chemistry, Biochemistry. A result of the research has been more than 500 publications within the areas mentioned below, 25 publications with 15 colleagues from 10 countries in addition to publications together with colleagues from Denmark.

Major Areas for Research:

Food/Feed Quality: Crucifers, legume, potatoes, vegetables, aminal and fish products, their proteins, peptides, lipids, carbohydrates and dietary fibres, glucosinolates, oligosaccharides are studied in relation to their properties and effects on food/feed quality. The studies of food/feed quality comprise also identification and evaluation of biochemical-physiological effects of beneficial or essential nutrients, allelochemicals and antinutritional-toxic effects of natural products comprising xenobiotics, heteroaromatics, amino acids, biogenic amines, phenolics, glycosides, glycoproteins, and enzyme inhibitors. The physiological effects of the natural products of interest are investigated by use of isolated compounds fed to animals in balance trials. These studies are performed in close collaboration with animal and human nutritionists as well as toxicologists. *Isolation and identification of natural products* including studies of their stereochemistry. These studies have comprised compounds as*:* amino acids, carboxylic acids, phenolics, flavonoids, anthocyanins, aromatic choline esters, amines, alkaloids, heteroaromatics, carbohydrates and glycosides including glucosinolates and derivatives thereof. *Tracer techniques (14C & 13C); metabolic studies*. In addition to identification of new natural products, biosynthetic and catabolic investigations of the compounds are important areas of the research. The metabolic studies include often enzymes involved in transformation of the compounds of interest. Metabolic and hereditary studies of some plant constituents and hereditary diseases in animals/humans have also been part of the research projects. *Processing techniques****:*** The effects on quality of feed and food from various processing techniques are studies in close collaboration with industrial organisations. Pilot Plant scale isolation of proteins, lipids and various types of natural products from plants have been developed as e.g. aqueous enzyme aided green chemistry techniques.

The objectives are development of improved methods for industrial processing of agricultural crops for production of high quality products to feed, food and non-food purposes. *Development of analytical methods*. The above mentioned investigations are based on advanced analytical methods; GLC, HPLC, FPLC, various forms of electrophoresis, HVE, IEF, PAGE, capillary electrophoresis (CE, FZCE, MECC). The separations and purifications are based on various forms of chromatography, as Fast Chromatographym (FC), ion-exchange, solid phase extractions (SPE), affinity chromatography and supercritical fluid techniques (SFT=SFE, SFC, EFLC-ELSD). Identifications of the compounds involve in addition to the analytical methods various spectroscopic methods; UV, Vis, NMR (1H & 13C), MS, enzyme kinetics and immunochemical methods.

Gary Williamson

Professor of Functional Food at University of Leeds, UK in the Procter Department of Food Science, University of Leeds, Leeds, LS2 9JT, UK; Research interests in Nutritional and Food Biochemistry with >200 refereed scientific publications, ~30 refereed reviews, ~20 book chapters, and ISI highly cited author in Agricultural Sciences. More than 100 invited research seminars, including plenary and keynote, at International scientific conferences and Research Centers/Universities, and successful supervision of 20 PhD students. The research group focuses on dietary phytochemicals in foods, their metabolism and health effects. The aim is to advance knowledge on phytochemicals and human health, especially in the area of absorption and metabolism.

Previous positions:

2002 to 2007: Head of Nutrient Bioavailability Group, Nestle Research Center, Lausanne, PO Box 44, CH-1000 Lausanne 26, Switzerland
1985 to 2002: Head of Phytochemicals Group, Institute of Food Research (IFR), UK, including co-ordinator of multinational projects on phytochemicals and health and Director of a Europe-wide training programme for PhD students in phytochemicals.
1983 to 1985: Emory University, Atlanta, GA, USA; postdoctoral researcher with Dr Dale Edmondson on redox-active flavoproteins.
PhD, Sheffield University, UK, 1980-1983, Biochemistry Department.

Mariusz K. Piskula

PhD, D.Sc. Postdocs in Japan at National Food Research Institute, Tsukuba (2 years) and at Kikkoman Corp., Noda (2 years) where he began to work on polyphenolics – starting from antioxidative properties in vitro, through absorption and metabolism to physiological functions in vivo. Now he is Associate Professor at the Institute of Animal Reproduction and Food Research in Olsztyn, Poland, where he is the Scientific Director of Food Division and Head of Food Technology Department. Now he works on the relation between changes of food matrix during processing and bioavailability of polyphenols, on modifications of food processing targeted at minimizing losses of food components potentially beneficial to human health and on new sources of dietary polyphenols and their application to food.

Hanne Frøkjær

Ph.D in biochemistry from Department of Biochemistry and Nutrition, Technical University of Denmark ("Production of monoclonal antibodies for the investigation of antigenic properties in trypsin inhibitors in soy beans. - Identification and characterization of epitopes in trypsin inhibitors").

Occupations:

Danish Ministery of Patents (1.10.86-31.11.87)
Teacher in mathematics, VUC, Amager (1.09.86-1.07.87)
Research assistant, Dept. of Biochemistry and Nutrition, DTU (1.12.87- 31.05.91)
Post Doc., Dept. of Biochemistry and Nutrition, DTU (1.06.91- 31.12.93)
Assistant professor, Dept. of Biochemistry and Nutrition (1.01.94-31.12.96)
Associate professor, Biocentrum-DTU, Biochemistry and Nutrition Group (1.01.97-)
Maternal leaves 15.09.97-1.06.98 and 1.09.01-1.08.02

Main research activities:

Nutritional immunology: the effect of food components on the immune system, with special emphasis on microorganisms, lipids, and bioactive proteins, and their effects, singly or in combination, on cellular in vitro responses (dendritic cells, monocytes, T cells, and NK cells; human and murine), in vivo and ex vivo upon feeding (animal studies and human intervention studies). Effect of food matrix on the immune response against food proteins. Production of antibodies and development of antibody-based food analyses.

Publications in peer reviewed journals and book journals:

1. Foss, F.N., Duranti, M., Magni, C. & H.Frøkiær(2006): Assessment of lupin allergy in the cholera toxin model: induction of a specific IgE response depends on intrinsic factors of the conglutins. Int. Arch. Allergy Immunol, 141:141-150.
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Helen Lee

Administrator of Health and Consumers Directorate General, European Commission (Unit E4 - Food Law, nutrition and labelling)

After completing a Human Nutrition BSc and Information Science MSc, Ms Lee joined the UK Civil Service in 1985. She has experience of working in scientific and regulatory affairs particularly in the area of nutrition in different Governmental departments. In 2001 she was seconded from the Food Standards Agency to the European Commission's Health and Consumer Protection Directorate General to work in the area of foods for particular nutritional uses. In 2005, she became directly employed by the European Commission and continued to work on nutrition and related legislative measures such as dietetic foods and nutrition labelling in Unit E.4 Food law, nutrition and labelling.

Dietrich Knorr

Professor, Director of the Institute of Food Technology and Food Chemistry since 2001 and Head of the Department of Food Biotechnology and Food Process Engineering at the Berlin University of Technology since 1987.

Dietrich Knorr received an Engineering Degree (Dipl.-Ing.) in 1971 and a PhD in Food and Fermentation Technology from the University of Agriculture in Vienna in 1974.He was Research Associate at the Dept. of Food Technology in Vienna, Austria, Visiting Scientist at the Western Regional Research Centre of the US Department of Agriculture, Berkeley, USA; at the Department of Food Science Cornell University, Ithaca, USA and of Reading University, Reading, UK. He was Visiting Professor at the Association of Biotechnological Research, Braunschweig, Germany, Associate Professor, Full Professor and Acting Department Chair at the Department of Food Science, University of Delaware, Newark, DE, USA.

Prof. Knorr is Editor of the Journal of Innovative Food Science and Emerging Technologies (editor of Food Biotechnology until 2000), Research Professor at the University of Delaware, USA, and Adjunct Professor at Cornell University, USA.

In 2004 Dietrich Knorr got the Marcel Loncin Research Prize of the Institute of Food Technologists (IFT), the Alfred-Mehlitz Award of the German Association of Food Technologists and the EFFoST Outstanding Research Scientist Award.

Anton J. Alldrick

Special Projects Manager within the Cereals and Cereal Processing Division at Campden & Chorleywood Food Research Association, the world’s largest, independent, membership-based food research and development organisation.

Anton J. Alldrick studied at the University of London, obtaining a BSc in Biochemistry in 1976 and a PhD (studying the genetics of bacterial drug metabolism) in 1980. From 1980 through 1981 he was a postdoctoral research fellow at the University of Maryland Baltimore County working on the molecular biology of ultraviolet light damage in bacteria. In 1981 he returned to the UK and joined BIBRA International as a research and regulatory toxicologist, specialising in the effects of diet on carcinogen metabolism. From there he moved to the Flour Milling & Baking Research Association (now part of Campden & Chorleywood Food Research Association, CCFRA) in 1990; where he has held a number of management positions before being appointed as Special Projects Manager. In Anton J. Alldricks current position he provides consultancy and project management services in the areas of quality management, product/process design and optimisation as well as the application of developments in nutrition and toxicology to the food industry. In recent years he has been particularly active in the areas of functional foods, food allergy and mycotoxins. His clients include the food industry, government organisations and legal firms. He has written over 60 publications aimed at either scientific and/or industrial audiences.

Marcelo Duranti

Professor of Biochemistry at the Department of Agri-Food Molecular Sciences, Faculty of Agriculture, University of Milano. He leads the Plant Protein Group of the Departmental Biochemical Section. His main field of interest are the studies on structure/function relationships and modifications of plant proteins and nutraceutical activities of legume seed proteins. To these aims, his group makes use of conventional and innovative biomolecular and biotechnological approaches, including proteomics, DNA recombinant techniques, advanced separation techniques. He collaborates with a number of national and international reputed research teams. He has coordinated and participated to various research financing programs, including contracts with private companies. He has published over 100 scientific publications mostly on peer reviewed journals, 4 scientific books and 3 international patents on the food uses of legume seed proteins.

Lisbeth Munksgaard

Senior Manager for external science and innovation at Danisco A/S, which is a world leading producer of bio based food ingredients.

Lisbeth Munksgaard is Msc. in Food Science (1978). She was a dairy scientist (1979-1990) at the Danish Dairy Research institute. During the following 14 years (1990-2003) Lisbeth Munksgaard had positions in the Danish food and feed administrations dealing with food and feed regulation and control. She was involved in introducing and approving HACCP-systems in food and feed premises, in risk management and risk communication. In 2003 she was Director of Centre of Advanced Food Studies, which is a public-private consortium facilitating the cooperation within food science in Denmark. She is a member of the board of the European Food for Life technology platform, which is an industry led driver of industrial relevant food science in Europe.

Kees de Winter

Kees de Winter has since May 2007 been Food Policy Advisor at BEUC, the European Consumers' Organisation. His job is to assist BEUC and BEUC's member organisations in campaigning to influence EU policies relating to food and food production in the consumer interest. From 1998 till 2007 he worked as a consultant in the area of food and life sciences. In this period he was, amongst others, active as Project Technical Assistant for the Directorate-General Research of the European Commission and prepared several courses on EU Food Law for professionals in the food sector. From 1992 till 1998 he worked as Food Officer at BEUC. Before he worked as a Civil Servant for the Dutch Ministry of Agriculture, as a Food Researcher for a Dutch Consumer Organisation, as a teacher at a teacher training College and as a researcher at the Wageningen University Research. Mr De Winter graduated as nutritionist and food technologist.

Liisa Lâhteenmaki

MSc (Nutrition; U Helsinki) 1985, PhD (Psychology; U Birmingham) 1991. Professional experience includes working in an advisory organization as a food and nutrition consultant, and at the University of Helsinki as a Research Fellow and an acting Associate professor in Sensory Food Science. Leader of the Consumer Studies -group at VTT Technical Research Centre of Finland since 1997. Visiting Professor at MAPP Centre, Aarhus Business School, University of Aarhus for four months during spring 2007.

Liisa Lâhteenmakis research interests involve factors affecting food choice especially hedonic responses, food-related attitudes, novelty, perceived healthiness and health claims, and new food production and processing technologies. Recent projects have explored the role of healthiness and naturalness in perceiving cereal and fruit-based products and perceived responsibility in different kind of food-related incidences.

Annex 3 List of participants

A.D. Quintart	Syngenta
Andrew Smith	UK Research Office
Anton J. Alldrick	Campden @ Chorleywood Food Research Association
Bjørn Bedsted	The Danish Board of Technology
Celik Spela	MEP Assistant
Clara Thompson	CIAA
Clara Ward	
Debra Burton	Burton Coaching
Dietrich Knorr	Department of Food Biotechnology and Food Process Engineering
Etienne Cools	Ministry of the Belgian-French community
Gaj Novsak	MEP Assistant
Gary Williamson University of Leeds	Chair of Functional Food Procter Department of Food Science,
Hanne Frøkjær	Institute of Systems Biology, Technical University of Denmark
Helen Lee Commission	Health and Consumer Protection Diretctorate-General, European
Hervé Maryse	ECCO
Jamie Paul Rubbi-Clarke	STOA
Jarka Chloupkova	STOA
J. Brobald	Syngenta
Jorgo Chatzimarkakis	MEP
J. Pouvek	MEP Assistant
Katarina Flereannua	ULB/UK
Kate Trollope	EU Food Law Magazine
Kees de Winter	Food Policy Advisor, BEUC
Liisa Lähteenmaki	VTT Technical Research Centre of Finland

Lily Jacobs	MEP
Lisbeth Munksgaard	Danisco A/S
Marcello Duranti	Dipartimento di Scienze Molecolari Agrolimentari, Universitá degli Studi di Milano
Mariusz Piskula	Polish Academy of Sciences, Institute of Animal Reproduction and Food Research
Michael Rader	ITAS/ETAG
Nikolaus Tacke	The Coca Cola Company , EU Affairs
Pascal Ntahompagaze	PASOAF
Phoebe Duen-yi SHIH	Taipei representative Office
Signe Skibstrup Blach	The Danish Board of Technology
Ulla Bertelsen	EFSA
Vivian Linssen	IMNRC