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New Challenges and Developments in Food/Consumer Safety

Summary Report

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SKLM Symposium „New Challenges and Developments in Food/Consumer Safety"

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1. Food/consumer safety: A global challenge

In the future, the global key challenges will be *inter alia* the growth of the world population, the sustainable food and feed production, drinking water supply and the expanding globalization of food trading. The increasing world population is leading to a worldwide raising demand for resource consuming foods. The market expansion and the profitable production are mostly realized at the expense of the environment and sustainability and might also influence the safety of food. Emerging global food chain networks exacerbate the risk of health impairment by unsafe foods. The close control of commodities at the borders is nearly impossible, especially in view of the internet market.

Global food production and trade is a dynamic reality leading to novel challenges, for example innovations such as `novel foods´, new technologies or the use of unauthorized or doubtful ingredients and food fraud as well as product piracy. The impact of the climate change will create additional problems. Accompanied by higher temperatures, the danger of contamination with mycotoxins and marine biotoxins may raise. This might lead to the change of agricultural practice and technical aids such as an increasing use of pesticides, antimycotica or other chemical aids and the use of genetically modified plants. Poorly studied neophytes, plants which colonize ectopic latitudes because of the climate change, might contaminate agricultural crops leading to potential health risks. The flooding of landscapes might redistribute residues contained in rivers such as heavy metals and persistent organic pollutants.

International networking of authorities dealing with scientific risk assessment and risk management is necessary to identify and avert potential risks and hazards associated with global food production and trade. In the future, one of the major challenges in the field of scientific risk assessment will be to keep pace with the dynamic progress of food production. This requires the continuous development of toxicity tests and new analytical strategies, especially for non-targeted analyses and the implementation of technological progresses. Global harmonization of standards, methods and data interpretation is necessary for an international working and functioning risk assessment.

The challenge for risk management is to put into practice the results of risk assessment concerning food safety, to monitor risks and to install alert systems and sanctions especially across national borders. The targeting of international flows of foods is necessary for the effective control and the recall of inadmissible foods. The standard of risk management should be supported by objective science and

evidence-based elucidation of risk, not biased by interest of stakeholders and with upmost transparency to assure safe foods in the international trade.

Independent scientific risk assessment is and will be indispensable in the future; the communication of the results as well as an appropriate risk management should be the outcome. Risk assessment must be the responsibility of independent scientific institutions, risk management of the executive. Though public agencies face similar problems all over the world, their interests may not be identical at the national and global level. At the European level a network of public authorities and institutions is installed connecting the national and European levels also regarding the EU legislation. Together with the European Food Safety Authority (EFSA), these public authorities and institutions determine(d) general principles and requirements of food law and matters in the field of food safety. It is the consumers´ right to be protected from harmful substances and false or misleading information. To achieve this, government and authorities have to cooperate with companies to guarantee food safety.

2. Novel approaches in risk assessment

The traditional risk assessment process of various foodborne hazards is divided in different steps (WHO, 2005): Initially, potential adverse effects of an agent need to be identified and qualitatively and/or quantitatively evaluated based on a dose-response assessment (hazard identification and characterization). Then, the intensity, frequency and duration of human exposures to the agent need to be evaluated (exposure assessment). The final risk characterization integrates the hazard identification, hazard characterization and exposure assessment and estimates the likelihood of the occurrence of adverse effects in a given population, including accompanying uncertainties. Furthermore, it is crucial to elucidate the mode of action underlying a given hazard to create a plausible basis for human toxicological evaluation.

In the future, risk assessment faces different challenges in dealing with numerous compounds from a broad range of sources. In addition, complete toxicological data sets from human studies are frequently not available, and it is therefore necessary to perform an adequate extrapolation from experimental animals to humans accounting for species differences, from the *in vitro* to the *in vivo* situation, and/or from high dose levels to realistic low dose levels in a complex dietary food matrix. Additionally, interindividual differences as a consequence of genetic polymorphisms or lifestyle factors may also have to be taken into account. In search for answers to all these challenges we might benefit from recent developments in the field of risk assessment. It is expected that novel approaches will be able to improve the traditional risk assessment process described above. These include, for example, profiling techniques such as “omics”-analyses, *in vitro*, *in vivo* models and computational toxicology/*in silico* models such as quantitative structure-activity relationship (QSAR)-based strategies or so-called physiologically based kinetic (PBK) modelling.

Further key factors needed for an exposure assessment include the knowledge about the amount of an agent present in food, its bioavailability and the duration, magnitude and frequency of the exposure. Exposure assessment as well as the relevance of the output from clinical intervention studies is expected to benefit from the development and validation of novel biomarkers.

2.1. Profiling techniques

With the introduction of a wide range of “omics”-techniques biological responses to dietary and environmental factors can be investigated at different molecular scales, including the genome, transcriptome, proteome and metabolome. These profiling methods use a combination of high-throughput techniques such as DNA, RNA and protein arrays, sequences techniques, gas and liquid chromatography and mass spectrometry.

One of the strengths of “omics”-analyses lies in the fact that they can be applied in studies being performed *in vitro* or *in vivo* and may provide further information on the mode of action (molecular mechanism of toxicity), type of exposure (chemical class of compounds), level of exposure and/or type of toxicological effect. In addition, these profiles may be more sensitive (detection of subtle changes), earlier risk predictors (detection of earlier/intermediate responses) and/or help to establish causality (by understanding the mode of action) when compared to the traditionally used approaches. Another advantage lies in the fact that this methodology will also be applicable to measure the effect of exposure to mixtures of various compounds and food ingredients.

The human ‘exposome’ is defined as the overall response to all dietary and environmental exposures of an individual. It can be established based on the measurement of complete sets of biomarkers of exposure in biological material ranging from xenobiotics and their metabolites in blood (metabolomics) to covalent complexes with DNA and proteins (adductomics) with the potential to improve exposure assessment. These “omics signatures” might furthermore reflect the interaction between genetics and exposure characteristics (interactome) and complex exposure scenarios.

An example, in which transcriptome profiles might be helpful to gain new appropriate data for risk assessment, is titanium dioxide (TiO_2, E171), a broadly used food additive and whitening agent. Data from recent studies indicate that TiO_2 might stimulate the development of colorectal cancer (see the contribution by Theo de Kok). To confirm this and to identify the underlying molecular mechanisms further experiments are needed. The combination of *in vivo* experiments and whole genome transcriptome analyses could represent an adequate approach.

Another issue currently discussed is the classification of processed meat as being carcinogenic to humans (Group 1) by IARC (IARC, 2015), based on sufficient evidence in humans that the consumption of processed meat causes colorectal cancer. Suggested causal meat constituents are pyrolysis products formed during processing, haem iron and *N*-nitroso compounds. Recent publications using novel “omics”-technologies provided data to improve the risk assessment of processed

meat, e.g. results concerning the mechanisms underlying epithelial hyperplasia in the gut of haem-fed mice or the association of transcriptomic profiles with colorectal cancer risk after *N*-nitroso exposure (see the contribution by Theo de Kok). Additionally, the PHYTOME project is an example for applying results of "omics"-technologies for the improvement of food products. The aim of this project is the development of innovative and healthier meat products by introducing specially selected mixtures of biologically active compounds originating from natural plant extracts. In this context, "omics" technologies might contribute to a risk-benefit analysis of these complex mixtures.

When evaluating the benefit of "omics"-technologies for food safety, one has to take into account that transcriptome profiles have already been reported to reflect relevant gene-environment interactions. Furthermore, the relevance of evaluating e.g. gender differences and differences in genetic polymorphisms in the risk assessment process has been demonstrated and could be investigated by using "omics"-technologies. However, validated biomarkers of exposure remain to be established.

"Omics" techniques produce very complex data sets that require effective database resources for interpretation, management and analysis. For the part of data interpretation, generalised algorithms for e.g. the prediction of the modes of action need to be established and validated. Because data sets are becoming available for integrated "omics" markers, at the same time available bioinformatics tools need to be optimized. In a first step, a better understanding is needed when a response can be considered adverse or merely reflects a homeostatic event. This is an essential perquisite to link the obtained results to adverse and beneficial human health effects and to increase the value for risk assessment.

2.2. Systems-based approaches in toxicology

Systems toxicology is an approach, which integrates classic toxicology methods with network models and quantitative measurements of molecular and functional changes occurring across multiple levels of biological organization. It is a multi- and trans-disciplinary approach that combines principles of biology, chemistry, computer science, engineering, mathematics and physics, and involves the collection and analysis of high-content experimental data at the molecular, cellular, organ, organism or population level.

Traditional approaches assessing the risk of human health impairment by chemicals in food focus on one chemical at a time. Thus, long-term animal studies on toxicity or carcinogenicity are normally conducted with single pure compounds dosed at high concentrations by gavage, with drinking water or feed in the absence of the natural food matrix. Exposure to chemical mixtures is a more realistic scenario. However, this can result in adverse health outcomes, which are more difficult to predict, due to the increased likelihood of additive, synergistic or antagonistic interactions between individual chemicals with similar or dissimilar mode of action. Such mixture effects cannot be reliably predicted by extrapolating data from single chemical exposures. Moreover, it is virtually impossible to test experimentally all possible mixtures. To

draw conclusions from experiments to real-life exposure it is necessary to use approaches that analyse cumulative effects of aggregate exposure to multiple chemicals and to develop efficient testing strategies that combine state-of-the-art *in vitro* and *in silico* tools. This issue is being addressed by the European research consortium Euromix, which intends to develop an experimentally verified, tiered strategy for the cumulative risk assessment of chemical mixtures. For example, recent studies suggest that a systematic proteomic approach can be effectively used to identify critical components in mixtures and predict toxicity even at sub-toxic concentrations of individual components (see the contribution by Shana Sturla).

Furthermore, by using a systems toxicology approach it is possible to investigate food-drug interactions in the course of a DNA alkylating chemotherapy, e.g. the effects of bioactive food ingredients on chemotherapeutic drug activation. These bioactive compounds can influence the efficiency of drugs by affecting drug transport or metabolism, for example by inducing or inhibiting transport proteins or by activating or inhibiting drug metabolizing enzymes. It has been shown that the combination of data obtained from various *in vitro* tests and cluster analyses by "omics" technologies using a systems toxicology approach helps to understand the interplay of drugs and food components and could be further used to develop new cancer treatment strategies (see the contribution by Shana Sturla). However, it is necessary to improve systems-based approaches to gain insight into the **complexity of real-life exposures** (acute/chronic, combined exposures with benefits to be weighed against toxicity, low concentrations, and potential functional interactions amongst different chemicals) and to identify and characterize ***in vitro*** **phenotypes** that are **relevant to *in vivo* outcomes.** Otherwise, this approach will most probably remain theoretical.

Thus, it can be noted that by using systems-based approaches it is possible to predict and to characterize effects of chemicals that differ in modes of action and phenotypic outcomes. By characterizing a large number of scenarios that cannot be addressed by traditional approaches, systems toxicology is expected to be useful for establishing tiered strategies for risk assessment. Continuous rapid advances in instrumentation capabilities and bioinformatics tools will further improve the existing techniques for high-throughput, accurate quantitation of even small changes and/or low abundance markers. Concurrently, this progress will reduce the need for animal studies.

2.3. Physiologically based biokinetic modeling

A physiologically based biokinetic (PBBK) model is a set of mathematical equations that together describe the absorption, distribution, metabolism and excretion (ADME) characteristics of a compound within an organism. It provides unique possibilities, as demonstrated when analyzing genotoxic and carcinogenic alkenylbenzenes as model compounds (see the contribution by Ivonne Rietjens), e.g. to account for species differences and to build models reflecting the human situation. Furthermore, an insight into interindividual differences can be obtained, since PBBK models for

individual human subjects can be defined. Based on this approach, a distribution frequency for the whole population can be quantified, thereby enabling modelling-based predictions of bioactivation and detoxification for the population as a whole. A further advantage lies in the fact that responses under realistic low dose regimens, which are often experimentally inaccessible, can be predicted. With a PBBK model, physiologically relevant concentrations of a compound or, if relevant, its active metabolite(s) in any target organ of interest can be calculated for a certain dose and route of administration. In addition, PBBK modeling can simulate effects occurring upon exposure with complex mixtures even at low doses. In the absence of *in vivo* toxicity data, the use of alternative non-animal based testing models might be considered in current human safety testing. However to enable the use of *in vitro* concentration-response data in risk assessment the *in vitro* data have to be translated to *in vivo* dose-response curves. PBBK models might contribute to this translation and thereby to the development of novel testing strategies of chemicals. Several *in vivo* predictions made by these models, mainly based on *in vitro* data, have been reported to be in agreement with the *in vivo* data available in the literature.

Since the calculation of a PBBK model for each individual compound is resource and time consuming, the development of generic PBBK models for large groups of compounds is an important challenge and research need for the near future. An initial strategy to define such generic PBBK models has been described including plasma protein binding, metabolic clearance measured at two concentrations using hepatocytes, bi-directional permeability of an intestinal barrier using Caco-2 cells in a transwell model and red blood cell partitioning (see the contribution by Ivonne Rietjens).

Overall, the use of PBBK modelling in risk assessment can facilitate the extrapolation from compounds, exposure regimens or species, for which *in vivo* toxicity studies are available, to compounds, exposure regimens, species or even individuals for which no or only limited toxicity data have been described. Therefore, these models might contribute to an improved risk assessment and might be an alternative to animal testing.

2.4. Exploring biomarkers

Exposure assessment is a major step in the process of risk assessment for which an estimation of the aggregate exposure from all routes is needed. In this respect, new tools have become available, as for example the metabolome analysis (see the contribution by Theo de Kok), which enables researchers to determine the total metabolite spectrum in a given body fluid or compartment and, thus, to monitor the influence/interaction of a specific food constituent on/with the organism. However, the development of selected biomarkers of human exogenous and endogenous exposure is still the preferred option. Significant progress has been achieved in this field of research based on the availability of increasingly specific and sensitive methodologies. For human studies, the monitoring of short-term biomarkers in urine, such as mercapturic acids, and long-term biomarkers in the blood, such as

hemoglobin or serum albumin adducts, is considered of great promise and may support current risk assessment strategies (see the contribution by Gerhard Eisenbrand).

These biomarkers do not only allow for aggregate dietary exposure estimates, but are also able to reflect relative rates of toxification and detoxification at diet-related, low exposure levels. They are therefore of particular value for intervention studies, since they can easily be validated by duplicate diet dosimetry. Furthermore, they are regarded as useful to address short-term or long-term kinetics and to further investigate the question of background exposure. In molecular epidemiology, for example, they may complement or replace the parameter of external exposure to dietary and environmental carcinogens, thereby supporting the detection of hitherto unknown associations between exposure and biological effects. Furthermore, the protein adduct levels or the mercapturic acid concentration resulting from a defined dose of a particular substance in humans may be compared to the same parameter in animal models, for which also carcinogenicity data may be available. This allows to compare the metabolic bioactivation and detoxification rates in humans and animals and to support risk assessment.

Another approach is the monitoring of DNA adducts as an exposure biomarker for genotoxic carcinogens. However, it has to be kept in mind that this might be a conservative approach with regard to potential biological consequences. Although the induction of DNA damage is the first key event in the chain of cellular processes (potentially, not necessarily) leading to malignant cell transformation, not every DNA lesion translates into a fixed mutation due to e.g. efficient repair systems of the organism. However, the monitoring of DNA adducts represents a significant step forward, since reliable dosimetry at low levels of consumer exposure can now be achieved. In the future, this might obviate the high to low dose extrapolation mainly used in classical risk assessment of genotoxic carcinogens (details are given in section 3.1 on “Risk assessment of genotoxic carcinogens” below).

3. Emerging challenges in risk assessment

Since the risk assessment process of foods was established, a large number of risks and hazards of food constituents or contaminants were identified and continuously monitored and evaluated. Food constituents of relevance for food safety comprise compounds present in minor to trace concentrations, including chemicals of natural origin, such as polyphenols, alkaloids, saponins, steroidal and other organic and inorganic compounds or contaminants such as mycotoxins, heavy metals or dioxins. In addition, food is invariably at risk to become contaminated throughout the food chain as a consequence of various production, storage, transport and processing techniques (process contaminants, processing aids) or due to the migration of food contact materials into food. Furthermore, risk assessment has to deal with the continuous evaluation of food additives, flavorings and residues of pesticides or (veterinary) drugs. A special challenge is the detection of multiple contaminants, an issue that is becoming more and more relevant. Some of the constituents or

contaminants may be genotoxic carcinogens or possess allergenic potential. Technologies for food processing may reduce the risk by separation or degradation of hazardous constituents or contaminants but, on the other hand, may pose new hazards by generating process contaminants. These are, among others, challenges with a great significance in the future and will be discussed below.

3.1. Risk assessment of genotoxic carcinogens

An important challenge is the risk assessment of genotoxic carcinogens. Even though manifold attempts have been made to reduce exposures and/or substitute these compounds associated with a known or potential hazard, their complete elimination appears to be impossible. Thus, low concentrations of known or suspected genotoxic carcinogens are present in food, in the environment and at workplaces. However, by considering human exposure scenarios important questions arise: (i) whether there is a relevant carcinogenic potential under realistic exposure conditions and (ii) whether it is possible to define threshold values which protect from carcinogenicity. The extrapolation from measured values in experimental animals to the low dose range of human exposure is currently a matter of debate. In recent years, different concepts have been established to deal with this situation, such as the TTC (Threshold of Toxicological Concern) concept, the ALARA (As Low As Reasonably Achievable) principle and the MOE (Margin Of Exposure) approach, based on the ratio between concentrations being carcinogenic in experimental animals and the actual exposure of humans, for example via food. They assume that there is no safe level for genotoxic carcinogens and *inter alia* aim to set priorities for risk management. Other classification approaches are based on the mode of action of chemical carcinogens, such as e.g. the carcinogen categories 4 and 5 of the German MAK Commission and the categories B, C and D of the Scientific Committee on Occupational Exposure Limits (SCOEL) at the European level.

One of the key challenges for the future is the establishment of health-based and/or risk-based threshold/limit values for genotoxic carcinogens. Usually, linear dose-response relationships have been used as default assumption for genotoxic carcinogens. Nowadays, a further discrimination can be achieved, since adequate analytical methods now provide the perspective to monitor induction, repair and mutagenicity of DNA lesions at low exposure scenarios (see the contribution by Andrea Hartwig). Currently, an evaluation has to be done on a case-by-case basis. For this purpose, it is necessary to determine all types of DNA lesions and the significance of the different lesions for mutagenicity and carcinogenicity. Frequently, a linear increase of DNA adducts is observed at doses within the low dose range. However, in some cases the increase in mutation frequencies follows a nonlinear dose-response curve. Therefore, the establishment of more sensitive mutagenicity assays, especially to perform an *in vivo* mutagenicity assessment, such as the PigA assay, is needed. Furthermore, potential proficient detoxification mechanisms should also be addressed, including DNA repair, which may protect from irreversible genetic damage.

In the absence of adequate tumor data, novel approaches such as PBBK modelling or toxicogenomic analyses can contribute to an improved risk assessment of genotoxic carcinogens. PBBK modelling may facilitate a read-across from compounds for which *in vivo* toxicity studies are available to a compound for which only limited toxicity data have been described. Results obtained with profiling techniques, e.g. toxicogenomic analyses, may provide additional hints on the mode of action of a compound.

Various genotoxic compounds are also endogenously generated in the organism, e.g. formaldehyde, acetaldehyde or lipid peroxidation products. Nowadays it is possible to distinguish between DNA lesions generated endogenously during normal metabolism and the same type of DNA lesion induced via the respective chemical exposure. Thus, the extent of exposure-induced DNA lesions may be related to endogenous DNA damage. To achieve this, it will be essential to expand the data base on background DNA lesions/surrogate biomarkers in human tissues or body fluids and to explore a read-across approach for groups of similar DNA lesions. Overall, the determination of a potential impact of a genotoxic carcinogen on a steady-state background of human DNA damage may become a key element of case-by-case evaluations of human health risk to a given genotoxic carcinogen (see the contribution by Gerhard Eisenbrand).

A current working group on „Genotoxic carcinogens“ of the Senate Commissions MAK and SKLM of the Deutsche Forschungsgemeinschaft deals with the development of concepts for integrating the manifold mechanisms of carcinogenicity including current knowledge of cell biology into the risk assessment and classification of carcinogens.

3.2. Novel developments in the risk assessment of food allergens

The risk assessment of food allergens has undergone enormous development during the last decade. Adverse reactions to food due to allergy or other forms of hypersensitivity are considered to be a serious contemporary cause of human diseases. In many countries, the prevalence of food allergy/hypersensitivity appears to increase. At the same time the range of novel and innovative foodstuffs placed on the market that possess an allergenic potential is continuously growing.

In comparison to toxic effects, which possibly affect most of the population, adverse effects mediated by a food allergy or hypersensitivity generally affect a comparatively minor part of the population. This class of effect is further divided into an intolerance response, which does not involve the immune system, and the food allergy, which is based on immunological mechanisms. In most cases food allergy is mediated by immunoglobulin E antibodies that are formed upon the primary contact of an individual with an allergen. A second contact of the sensitized individual then leads to an allergic reaction, in serious cases to an anaphylactic shock or even death. A potentially lethal condition affects around 3% of the Western population.

Since the prevention of food allergy development as well as the cure of food allergy are not yet possible, the main risk management strategy is the avoidance of allergenic food. To achieve this, the production of hypoallergenic foods, the labelling of major allergenic ingredients and a precautionary warning for the unintended allergen presence are pursued. However, these hazard and zero-risk based approaches often lead to non-conclusive assessments or impractical conclusions and may lead to unlimited efforts in reducing allergen levels, improving analytical sensitivity or proving absence of allergenicity. There is a need for methods to quantify the risks of allergens and for quantitative guidance.

Therefore, **probabilistic modeling** (see the contribution by Geert Houben), which was first proposed and developed by The Netherlands Organization for Applied Scientific Research (TNO), is a reasonable alternative strategy in food allergy risk assessment. Although it is still poorly understood how exposure patterns influence sensitization or tolerance inducing processes in food allergy, nowadays there is consensus that thresholds exist with respect to elicitation of an allergic reaction. Threshold data and population threshold distribution curves are now available for many of the major allergenic foods. The world's largest food allergy threshold database as well as a food consumption database were developed specifically matched to the data requirements for probabilistic risk assessment. The threshold data base contains data on dose levels minimally required to elicit allergic reactions in individual patients and data on the distribution of these minimal eliciting doses among the allergic population. Together with information on allergen levels in food products, models to quantify risks were established. Probabilistic principles allowed e.g. the development of a quantitative guidance for precautionary warning and are already used in the Voluntary Incidental Trace Allergen Labeling (VITAL® 2.0) approach developed by the Australian-New Zealand Allergen Bureau with the support of the VITAL Scientific Expert Panel. The aim of this approach is the establishment of reference doses for precautionary labelling of unintended allergen presence. Thereby, this approach can give insight into the magnitude of risks and can be used as a basis for deriving "safe" levels of exposure. However, it needs to be mentioned that a risk-based approach requires the agreement among stakeholders on how to deal with risks (risk perception and risk acceptance).

3.3. Novel technologies in food processing

Food processing can be thermal or non-thermal; in the latter case chemical, biotechnological or non-thermal physical techniques are used. Foods are treated for preservation (pasteurization, sterilization), modification (gelatinization, homogenization) and edibility (softening, digestion, denaturation, inactivation of critical substances). Most important is the minimization of foodborne risks, for example the inactivation of microorganisms to prevent spoilage or foodborne infections, the inactivation of natural toxic substances and the reduction of the allergenic potential. The challenge in developing novel technologies for food processing is the balancing act to reduce or eliminate these foodborne risks without generating new risks such as the formation of adverse process contaminants or an

increase of the allergenic potential. Some examples of process contaminants are acrylamide, 3-MCPD, furan or glycidol fatty esters. Besides the maintenance of the nutritional value and ensuring safety, the consumer demands a good food appearance and sensory quality. From the technological point of view, the processing of the treated foods, the influence on food texture and the energy input are further aspects that need to be taken into consideration. The different techniques are not equally applicable for all foods regarding safety and quality aspects, so that often a case-by-case assessment is required. A major step forward to an industrial application of the developed technologies is the upscaling with particular attention being paid to risk reduction. Besides establishing new techniques, the existing processes are continuously evolving.

Nowadays, new technologies involving low temperature application, e.g. irradiation, high pressure, pulse electric field and cold atmospheric plasma, together with other parameters than heat, such as free radicals or electric fields have been established (see the contribution by Dietrich Knorr). Nevertheless, it cannot be excluded that unknown adverse effects may evolve. Therefore, a scientifically guided development of new technologies as well as an adequate risk assessment to guarantee the consumer safety is recommended. In this context, novel technologies in food processing are of great importance and are continuously discussed by the SKLM. In recent years, the SKLM has proactively dealt with new technologies such as plasma treatment and ohmic heating of food.

Another aspect of food processing is the utilization of novel/non-conventional food sources and, if necessary, techniques for their processing. This issue might play a very important role in the future to fulfil the need for food of a continuously growing world population. Thus, the SKLM has discussed safety aspects of the production of foods and food ingredients from insects, which are consumed as a whole in many countries outside the EU. Recently the outcome has been published (find this and other opinions on the SKLM homepage[1]).

[1] http://www.dfg.de/dfg_profil/gremien/senat/bewertung_lebensmittel/publikationen/index.html