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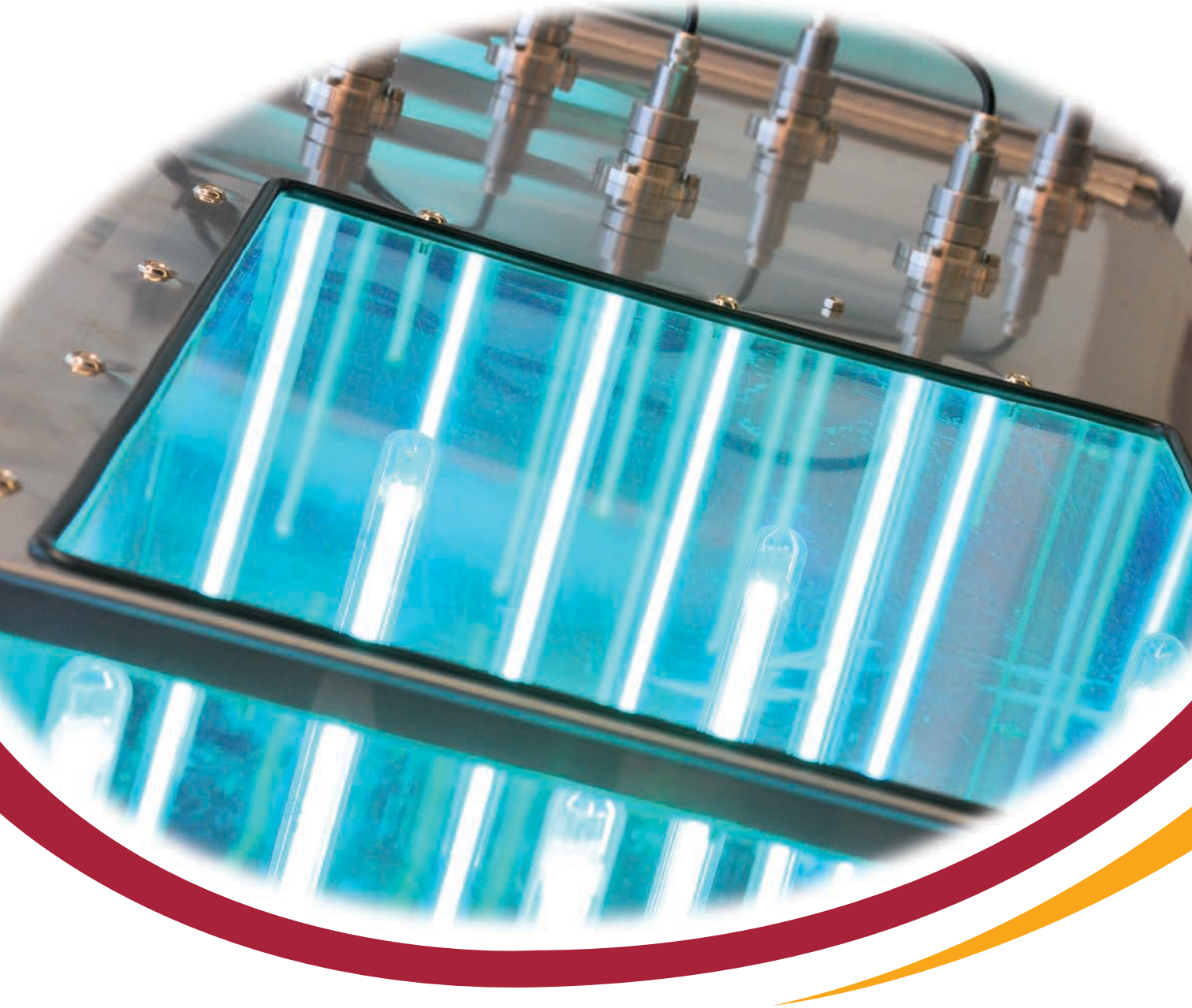
Food technology of the future

an integrated science – from farm to fork



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Looking into the future not seldom involves extrapolations from the past, so that here too we are faced with the old familiar questions, "where do we come from?" and "where are we going?" Related to the agriculture and food sectors, DARYL LUND answered these questions in 2012 with just a few words. We come from the world of "cheap", "plentiful" and "available" and want to be going to the world of "safe", "healthy" and "nutritious". For him, this situation appears to be a paradigm shift.

Such developments in the market nearly always proceed from two impulses, on the one hand from a science push, and on the other from consumer demand, whereby the latter has always played a substantially larger role in the food sector than in other sectors (HOMAYR, 1987). And the current demand is enormous – the highest possible level of food safety, the greatest possible sensory quality and a maximum of convenience, coupled with far-reaching naturalness and the longest possible shelf life, ideally without refrigeration.

Let us first cast a short look at the two driving forces.

In the year 1986, JÖRG HOMAYR from Nestlé Deutschland gave a talk on the topic "From classic to post-modern food technology". According to his remarks, food technology proceeded from various craft trades and pertinent sciences and has since developed classically in accordance with the Cartesian principle of researching the verifiable details. It is indisputable that the high status of food technology we know today was reached along this path of exact analysis of the individual constituents. However, it is also a known fact that resolution into details is not very helpful when complex problems need to be solved.

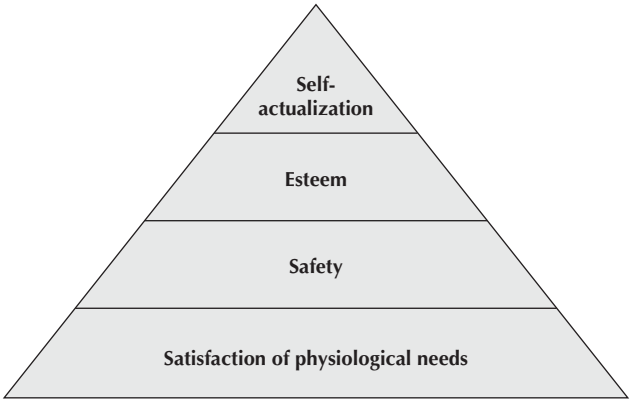
In view of this dilemma, it is not surprising that the modern, which was indivisibly connected with belief in progress, had to be relieved by a new epoch – the post-modern – in which alongside purely purpose-oriented, material activity there is an equally important moral and aesthetic dimension, perhaps even a certain kind of nostalgia. In connection with food technology, for HOMAYR in 1987 this meant, "… that we need to think more holistically, in overall terms. We should only do what demonstrably does not cause any harm in the long term. We must learn to live and act in harmony with nature. During enjoyment of food, the aesthetic aspect will develop a new dimension via presentation, odour, taste, exchange of ideas, atmosphere, perhaps also through abstinence and relinquishing cherished bad habits."

If we now take a look at consumers, we can ascertain that here too immense changes have become manifest. Originally, there was probably hardly any other field of life in which humans displayed such conservative behaviour patterns in all cultures and across the millennia as in their diet. As parents passed on their dietary habits on to their children, a vast behaviour continuity developed across generations along with a view termed neophobia, according to which new foods are potentially dangerous. In 1979 WASSERMANN expressed the opinion that this consideration is one of the essential causes of the distinctly conservative structure of our food law right up to the present day.

In the industrialized countries, the current dietary reality, especially among young people, reveals hardly any indication of this traditional behavioural continuity anymore. Instead, parallel with the industrialization of food production, there have been far-reaching shifts in the collective and individual framework conditions, which according to HORX in 1993 are based on sound, socio-demographic changes and technical innovations. And so as early as 1995, on the basis of pertinent market research, the consumer and market research association Gesellschaft für Konsum-, Markt- und Absatzforschung e.V. [GfK, 1995] drew a picture of individualized, multi-optional consumers who increasingly do not want a ready-made life but instead prefer to create their own individual mix from different life concepts. For modern consumers, health, convenience and gourmet orientation are important, but no longer any prototypical dietary styles. Instead, these factors represent possibilities of satisfying the consumers' own individual concepts [BERGMANN, 1999].

MASLOW's hierarchy of needs pyramid, shown in Figure 1, offers an explanation for this lifestyle orientation of consumers or the dominance of motive in social processes. It shows clearly that the needs by which we measure the value of a good change, the more readily this good is available. While the satisfaction of physiological needs forms the base of the pyramid, the next stages comprise safety, esteem and finally self-actualization needs [MASLOW, 1970].

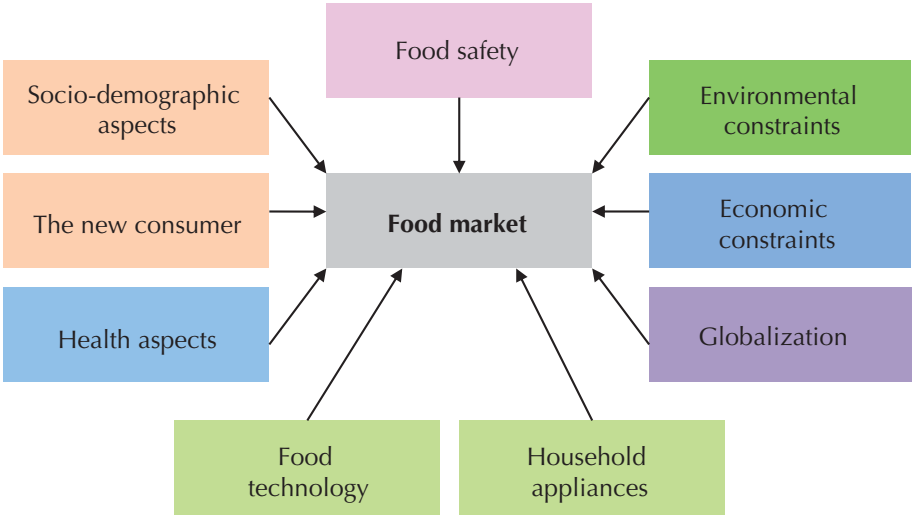
Figure 1: MASLOW's hierarchy of needs, 1970



In order to be able to operate successfully on the market in future, it is therefore increasingly important to take into account the full range of factors shown in Figure 2 influencing quality and acceptance of foods and above all to cater to the individual con-

sumer needs. However, HOMAYR was thus right in 1987 when he wrote, "Future food technology will (however) be a holistic science covering the marginal areas. Just as BELITZ once said that food chemistry was the chemistry of side reactions, food technology will be the science of integrated inclusion of all relevant marginal areas into the production of foods that the consumer wants and needs."

Figure 2: Factors influencing the food market and food range [BUCKENHÜSKES, 2004]



However, this will only become possible when we finally understand the production of foods as an integrated, connected process, a value chain which ranges from the primary producer out on the farm, via food producers and the trade, right up to the consumer, perhaps even right up to the consumer's plate, and that accordingly needs to be consistently structured and implemented.

Catch phrases such as "from farm to fork" or "from producer to consumer" have been around for a long time, but in many situations there is a lack of realization, often attributable to a mutual lack of understanding. Quality that is not already embedded in the raw material – and this applies equally for both plants and animals – cannot be introduced subsequently in the course of the further processing to achieve a marketable finished product. And if we want the gentlest possible processes to be used in processing and at the same time demand correspondingly long shelf lives, it is unrestrictedly true that hygiene commences already in the animal housing unit or in the field. However, translating such requirements into practice starts with mutual understanding about what is actually wanted in each case and why what quality demands are made. On the other hand, it must also be understood where the boundaries lie in the present state of knowledge and technology. Yet there are similar "border issues" not only between the primary producers and the processors, but rather also between the food manufacturers and the trade, as well as between the trade and consumers.

The value chain thus also represents a unique communication chain, along which the call for a transparent food market that has been voiced for a long time now should finally be answered. Two fundamental imperatives apply for this (BUCKENHÜSKES, 2000), namely:

1. comprehensive, open, honest, easily understandable and uncoded information, and
2. that origin, production and distribution of foods, processes applied in production and the purpose of additives used become transparent and verifiable for interested consumers.

As according to HUMBOLDT´s finding it is not the facts that decide our behaviour, but instead the opinion we have of the facts, communication develops a significance which is still frequently underestimated in the food trade right up to the present day. Indeed weaknesses in communication have a tradition here, whether because communicators frequently only pass on the data that are stipulated by law, or because informing consumers is preferably left to self-appointed experts, or because in advertising traditional procedures are suggested to consumers, although highly technical processes are in fact used [BUCKENHÜSKES, 2000].

As already indicated, however, communication is necessary not only in dealings with consumers, but also within the value chain. One level of communication, which interestingly enough is still frequently neglected, is for example located at the interface between primary production and processing, as for a variety of reasons the original situation of "the producer here, the processing company there" can no longer be maintained. This applies not only with regard to the current requirement regarding traceability. Instead, the processing company must define clear demands it makes of the raw materials, which must then be observed within an also defined quality window by the producer of the said raw materials. Plant and animal breeders, crop growers and animal finishers on the one hand, and processing companies on the other, must therefore enter into more intensive dialogue in order to be able to realize the various requirements for raw materials as optimally as possible. In the medium term it will certainly also be necessary to integrate HACCP concepts into primary plant and animal production so that the hygiene challenges and the ethically imperative and politically demanded sustainability concept can be adequately satisfied [BUCKENHÜSKES, 2004].

Influences of nutritional science

At present, the fact that our foods are increasingly no longer only being considered solely as nutrient, energy and enjoyment providers, but are also more and more required to satisfy HIPPOCRATES' demand that food should be our medicine and our medicine should be our food is triggering considerable impulses for food technology.

These demands are based on fundamentally new examination methods, including models for recreating the complex operations taking place in the digestive tract, that allow the knowledge of nutritional scientists and medical nutrition specialists about the connections between health and diet and possible preventive measures derived from this to progress at headlong speed. Discussion is currently revolving above all around the significance of ballast substances, the importance of the gut-associated lymphoid tissue including the intestinal flora, and the importance of substances with an anti-oxidative effect, partly in connection with the prevention of cancer diseases and ageing processes. In efforts to translate these findings into products, above all "functional foods" are being launched on the market, but these only represent a kind of transitional station towards personalized nutrition. For the sake of completeness it should be pointed out that despite all expectations made of functional foods, there are also critical voices which query their necessity and/or effectiveness, or that point out that it will never be possible to provide consumers with optimized quality and quantity in food composition, as so far they are not even able to control the calorie component.

Food technology as such

Although the above remarks appear to draw a different picture, the actual technical and technological aspects naturally remain essential key areas of future food technology, whereby a alongside the need for holistic thinking, the multi-disciplinarity immanent in this topic and hence the need to cooperate with other sectors will become much more important than it has been in the past. This is because satisfaction of the diverse wishes of modern consumers is by no means a trivial matter. Instead, foods that satisfy all consumer requirements are like absolutely high-tech products that can only be produced by involving the full range of technical food science knowledge.

Old as the topic already is, the original core theme of food technology, namely to preserve foods and maintain their quality during defined storage periods, will remain on our agenda. In order to be able to satisfy consumer demand for the lowest possible level of technical treatment, the hurdle theory formulated in 1976 by LEISTNER and RÖDEL (according to which the stability of a product is not achieved by just one single measure, but instead by the interplay of different individual principles known as hurdles), will play a special role, as the negative process-related impacts on product quality can be vigorously countered in this way.

In order to be able to produce product groups such as chilled food, minimally processed food, or sous vide products, both consistent application of the opportunities offered by this hurdle principle and consistent planning and organization along the entire production chain are necessary. This is particularly so as special and elevated demands are made of the raw materials used, the general production hygiene, processes, packaging and packaging materials, and ultimately of traceability and sustainability too. In accordance with the old saying that residues, dirt and microorganisms that don't reach the raw material in the first place don't need to be removed either, the demand for integrating HACCP concepts that are now a firm component of processor operations into the primary production is certainly understandable.

It is certainly possible to answer the question of what technical developments will play a special role in future food technology simply in keywords, and at the same time incompletely. Beyond question, topics such as bio-technology, dynamic and static high-pressure applications, other non-thermal preservation methods, ultrasonic methods and clean room technology are involved here. Essential impulses can also be expected from extrusion technology, homogenizing and emulsifying technology, coating and micro-encapsulation, membrane technology, drying, instantizing and granulation, as well as from areas such as robotronics and process automation.

The development of new or improved methods will receive essential support from the increasing understanding of internal chemical and physical structures of our foods and food systems. In particular rheological aspects, questions of water binding capacity, water structure and water activity, as well as interactions between molecules and micro-aggregates are likely to provide new insights.

Finally, important impulses for food technology are expected from the mathematical/statistical sector, making modulations and simulations as well as complicated structures and processes possible and thus clearer or understandable in the first place. Examples of this are modulations and simulations of individual process

steps of complete production lines, or the environmental assessment of material and energy flows. However, models such as neuronal networks also form the basis for understanding the perception of odour and taste and consequently also for developing chemical sensors that can be used for example in quality assurance [MÜLLER et al., 2003]. Such methods also play an increasing role not least within the framework of what is known as predictive modelling and microbiological risk assessment [WHITTING und BUCHANAN, 2001].

Ethics in food technology

Last but not least, it should be pointed out that food technology in future will have to tackle ethical issues to a far greater extent than has been the case to date. While ethical responsibility has so far addressed above all making a sufficient supply of safe foods available, questions now and in future go substantially further. Knowledge of the globally diminishing drinking water resources alone makes it clear that globalization does not offer any option either for withdrawing from the responsibility for sustainable and resource-conserving production and processing of raw materials. Yes, we must even ask ourselves whether our present-day concepts of food safety and unconditional availability are indeed ethically justifiable at all and for example can be harmonized with the reasonable demand for sustainability, or whether we should not be thinking about new points of reference here too.

One of the basic ethical demands concerning all foods and beverages is that the products produced must be safe in terms of health too. This requirement is set down, for instance, in the German Basic Law, which states in Article 1, Section 1, "Human dignity shall be inviolable. To respect and protect it shall be the duty of all state authority." By "dignity" here we understand both physical and spiritual integrity, from which all the demands of food legislation can then be derived. Even if we can also state with conviction that we have never had such safe foods as we have today, there is still no reason to be satisfied with what has been achieved. Every genuine or supposed food scandal shows that there are possibilities of improving general safety further. And the further development of measuring and analysis methods enables us to identify undesirable properties of raw materials and processes ever more reliably and with increasing accuracy, and then to develop and take measures to avoid theme. Such precautionary or even counter-measures may lie in the organizational sector. They may be of a technical nature or relate to initial and continuing training of staff.

In the context of ethical questions a quite different development can ultimately be seen, although the final consequences of this are not yet really foreseeable. This has to do with demands made of food production that are based in religion or world outlook. Although this is fundamentally nothing new, in recent years substantial momentum has been observed worldwide in the corresponding market segments. The most important of these sectors are organic products, vegetarian products, as well as Kosher and Halal-certified foods. In this connection the reaction of consumers is interesting. In the USA, it is assumed that only about one third of the Kosher products produced are really consumed by Jews. A further third is used by Muslims, whose dietary laws display great similarities. The final third is shared by vegans ("parve" products contain neither meat nor milk) and consumers who are convinced that the strictly religious regulations offer a higher degree of food safety than state specifications and controls can guarantee. And this argument is now being heard ever more frequently outside the USA too.

Concluding remarks

It appears absolutely safe to assume that in the field of food technology we can continue to expect trail-blazing technical developments that will lead to a further rise in quality, safety, production efficiency and sustainability. It appears substantially more difficult to maintain an overview and assess the complexity of the diverse "marginal areas" and realize these in economically justifiable terms. There is urgent need for action above all in communication – communication between expert colleagues, communication within the product chain from primary production through to the consumer, communication with the trade, public authorities and politicians, but above all communication with consumers too, who we ultimately want to accept and honour the fruits of our labour.

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