Consumer issues guideline to the R&D innovation projects

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1. Why a consumer issues guideline is needed along the implementation of an R&D innovation project?

An R&D project, in general, has several starting points. The literature (Linnemann et al, 2006) differentiates process development and product development. The Food Tech Innovation Portal (Food TIP) puts the technological questions in the focus. The Technology Sheets of the Food TIP offer a lot of opportunities to the technical solutions that could serve the process development as well as the product development. The expected results of the development (cost saving, better nutrition value, new product concept, extended shelf life etc.) could be diverse, but the success of the products on the market could not be realised without consumer acceptance. Nowadays it is fundamental to take into consideration the viewpoints of the consumers from the beginning. Role of consumers will be more and more important part but not only element that can drive an innovation projects.

A product is only successful in the market if it is finally purchased by the consumer. For this reason it is essential along the total innovation chain to consider and enforce consumer requirements in line with other (technical, economic, financial, legal etc.) viewpoints.

2. What are the aims of this guideline?

The guideline focuses on the following topics:

- Giving relevant and practical information regarding consumer issues for the successful innovation process
- Giving special information and aspects to the four stages of the innovation process

Summarized, our aim is to give information, essentials, and advice about the most important consumer issues to reduce the risk and uncertainty of development.

3. What is the structure of the guideline?

This guideline is intended to provide an overview in the following chapters:

- Basic information about the factors of consumer acceptance regarding novel technologies and food products
- Total Food Quality Model and its utilization in the innovation project
- Proposals on how to integrate the outcomes/viewpoints of the different expertise
- Consumer issues that have to be taken into account through the 4 successive development stages
- Relevant research findings based on the consumer studies in HTE project

The first part of the guideline (in chapters 4 and 5) is given as a theoretical overview about the two most important consumer issues regarding the innovation: consumers' concern and food quality.

After that (Chap. 6) proposals are given how to integrate the different professional viewpoints.

In the 7th chapter the relevant tasks are summarized along the innovation process.

And finally (Chap. 8) the research findings of the HTE project's consumer acceptance studies demonstrate some practical details about consumer risk perception and consumer choice.

4. Factors of the consumer acceptance regarding novel technologies and products

Nowadays, food products are quickly alternating on the shelves of the stores to meet the rapidly changing consumer demands. There is a fierce competition among companies. In general the market is saturated and consequently successful sales necessitate a consumer-orientated approach in the innovation process. Food product development is needed to provide food of desired quality and in addition the food industry should increase the sustainability along the food supply chain. Sciences are continuously developing and recommending new

technologies in compliance with the emerging new consumer and social demands (freshness, shelf life, convenience, energy saving, waste reduction, changing age group characteristics etc.). While the consumer is delighted of the top quality foodstuffs, perception of the changing food processing technologies is not so clear-cut. As to the consumer, an unknown technology often bears risk to him (e.g. discussion on the genetically modified foodstuffs).
Food perception by the consumers is influenced by many factors (Fig.1.).

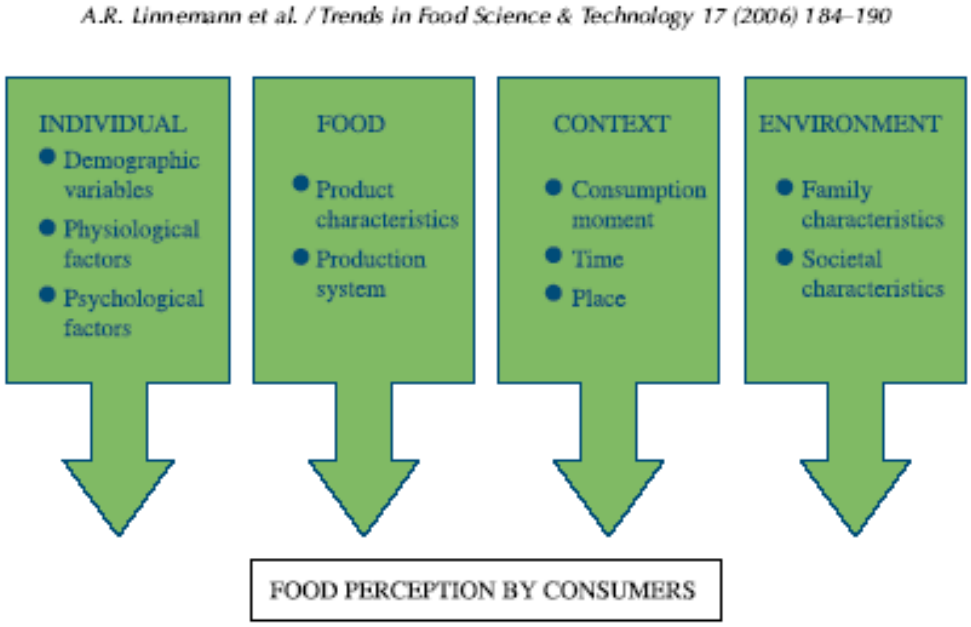

Fig. 1. Food perception by consumers (Sijtsema, Linnemann, van Gaasbeek, Dagevos, & Jongen, 2002).

Figure 1 (Sijtsema et al., 2002) shows, that the personal, social and country specific features are very important in consumer acceptance. According to the figure the personal, social and country specific features are very important in consumer acceptance. This is the reason why the differences between countries and several consumer segments are highlighted in the ITP guideline.
In accordance with several consumer investigations the European people show negative attitude to risks, especially to health risk (Hohl and Gaskell, 2008; Eurobarometer, 2006). There have been several food scandals and food related outbreaks in the last two decades all over in Europe. The consumers were hit by these crises (for example BSE crisis, EHEC outbreak, dioxin crisis, Listeria outbreak) and since then their confidence in food safety issues has become a very considerable topic. Consumers fear the unknown the most, especially new techniques and technologies (e.g. genetically modified foods, cloning animals for food) (Bánáti, 2008). Despite efforts to strengthen public confidence in food safety, some new technologies have difficulties in spreading successfully into industrial practice. However, risk of the innovation process can be reduced when also consumers' acceptance is considered. The consumer acceptance is a very crucial topic during innovation, because it seems that consumers are considerably uncertain, anxious and increasingly critical about food safety.
The topic of consumer acceptance is growing in literature; some important view-points are highlighted here (Siegrist, 2008; Ronteltap et al., 2007; Frewer et al., 2011)

Influencing factors on consumer acceptance

- *Risk-benefit perception*
    - Perceived risk (when the risk is voluntary, consumers have a larger willingness to accept risk; consumers perceive a hazard more riskier when its

consequences are largely unknown to scientific experts; familiar risks are perceived as less severe than unfamiliar ones)
    - Perceived benefit (regarding taste, price, animal welfare, health etc.; analysis of willingness to pay shows which attributes have the higher importance and utility for the consumers.)
    - Perceived naturalness
    - Moral and ethical concern (for example by biotechnology „tampering with nature", „playing God".)
- *Knowledge* (The studies showed that consumers' level of knowledge has an important role in acceptance, but only the knowledge does not lead to consumer acceptance).
- *Labelling* (The labelling provides additional information about the technology and so can increase awareness and transparency).
- *Socio-demographic factors* (Women are more concerned, less positive and likely to perceive fewer benefits of novel food technologies than men. The young consumers have a more positive perception to new technologies in general than the older age groups.)
- *Personal attitude* (neophob or neophile attitude; personal value and motivation)
- *Trust in the source of information* (the most trusted information sources are health professionals and least of all the media; European Union government is more trusted than national governments)

References include all substantial literature dealing with risk perception regarding new technologies.

5. Total Food Quality Model and its utilization in the innovation project

The user-oriented innovativeness of the food chains is more important than ever:

- Most of the attributes of the food products are intangible for the consumers e.g. the additives, quality of ingredients etc.).The food processing is developing continuously, what also results intangible product attributes (e.g. the safety of the food processed by novel technology). These intangible elements increases the consumers' doubts regarding the products made of unknown novel technologies.
- There is an increasing demand for individualized products;
- There are new technological opportunities to improve competitiveness;
- There is an increasing public interest regarding sustainable development and the consideration of ethical and environmental aspects along the food chain.

User-oriented innovation is defined as a process towards the development of a new product or service in which an integrated analysis and understanding of the users' wants, needs and preference formation play a key role (Grunert et al, 2008).

The Total Quality Food Model (TQF Model) was developed by Grunert at al. (Grunert, 2005; Bronso, Fjord and Grunert, 2002) to integrate various approaches into one conceptual framework specifically for analysing quality perception of food. This model (Fig. 2) is recommended to take into consideration by the innovation projects to fulfil the consumer demands.

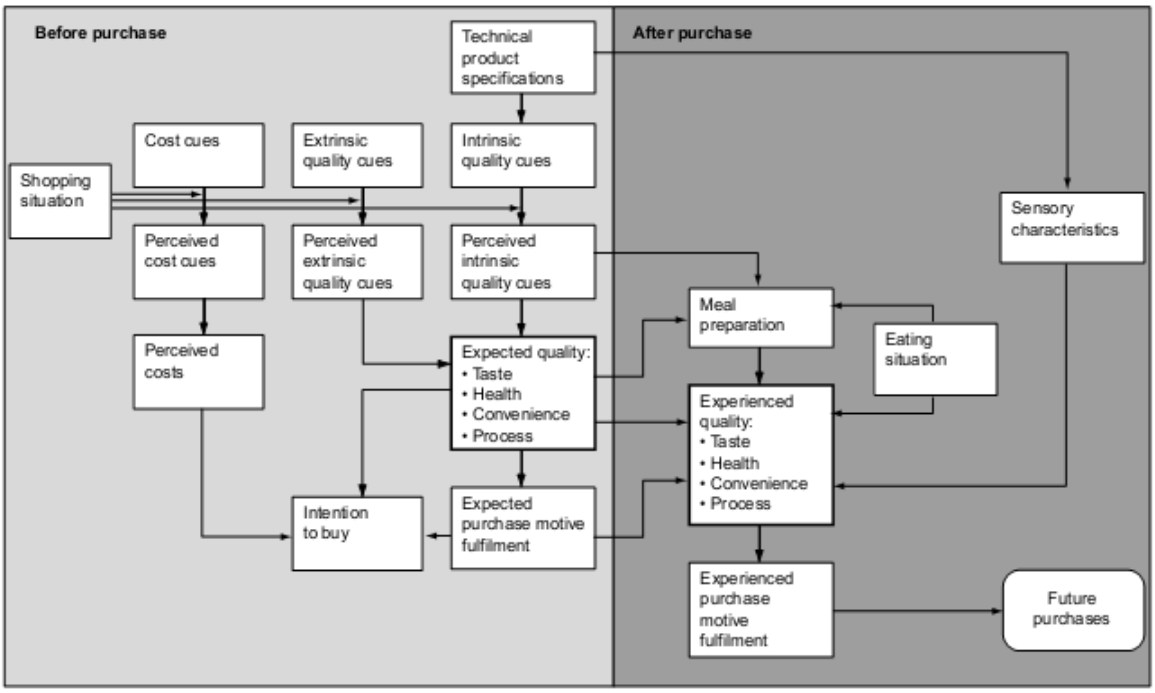

Fig.2. The Total Food Quality Model (Bronso, Fjord and Grunert, 2002)

The TQF Model analyses the consumers' quality perception along two major dimensions: horizontal and vertical dimension. The horizontal dimension is the time dimension: it distinguishes quality perception before and after purchase. The vertical dimension deals with inference-making. What motivates consumers to buy one food product rather than another?
Before the purchase consumers can form their quality expectations based on several extrinsic and intrinsic (sensory) quality cues (signals). Quality cues are connecting to the consumers' knowledge, expertises and beliefs about good quality. Extrinsic quality cues such as brand, product origin, quality labels etc. refer to the intangible credence attributes of the products (e.g. food safety, origin, production method), which can not be observed and checked by the consumers directly. Intrinsic cues refer to physical properties of the product. For example consumers use the colour and fat content of meat as an indicator of taste and tenderness. The expected quality has four major quality aspects: sensory, health, convenience and process characteristics.

Experience can be evaluated after the purchase, the expectations based on quality cues can be confirmed or contradicted after the trial. Confirmation and disconfirmation of expectations is the major determinant of consumer satisfaction and of consumer intent regarding future purchases.

Especially for new products, where the formation of expectations at the point of purchase can not be based on previous own experience, the acceptance or rejection of the product is a crucial point for success. In line with this statement, in case of food products the importance of credence qualities is increasing. Mostly health-related and process-related qualities belong to this category. The introduction of a new product should have support by information about the process and product attributes. There are different communicational tools to inform consumers, such as the labelling, advertisements and prospects etc. These tools help the producers to frame consumers' confidence in products produced by novel technologies. Another method for increase of consumers' acceptance is the tasting. If the consumers get

experience about the sensory properties of the product, they can revise the expected quality of the product by the experienced quality. Sum up: forming consumer confidence and consumer experience has outstanding importance in an innovation process.

How can we use this theory (TFQ Model) in practice?
Sondergaard has suggested a new product development model that takes an understanding of consumer quality perception as its point of departure (Grunert et al, 2008) (Fig. 3.).

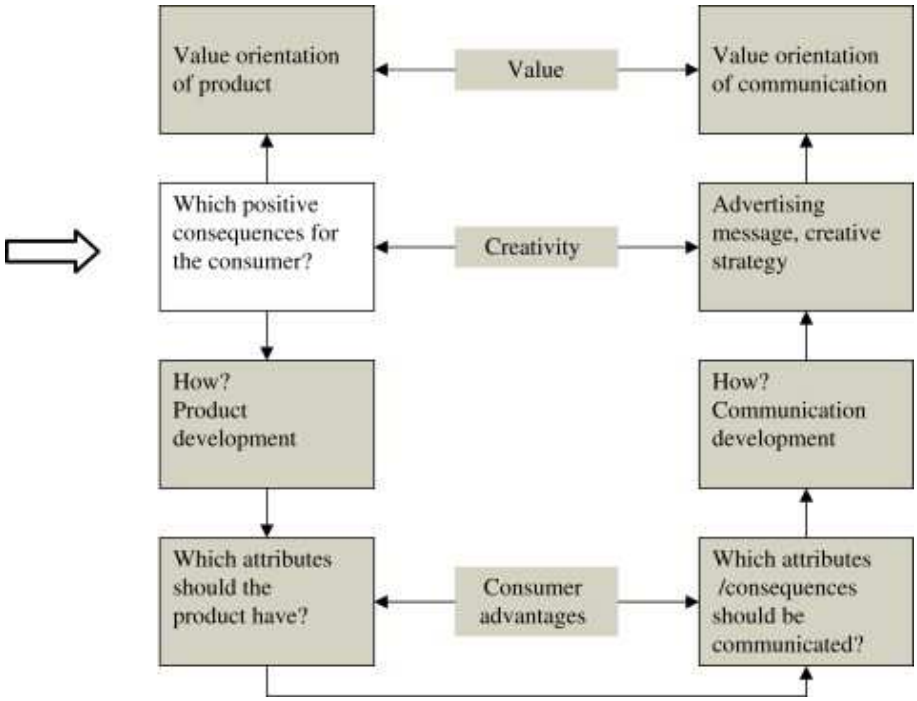

Fig. 3. Product development based on quality positioning (based on Søndergaard, 2003).

In general the physical product is developed first and the positioning of the product in the mind of the consumer follows later. In Sondergaard's new model the order is reversed. First step of development is a positioning of the product in terms of certain qualities which are desired by consumers. So motivation of purchase can be guaranteed. The positioning of product has to be translated into a physical product in the product development process. In addition to these intrinsic cues have to be complemented with appropriate extrinsic cues. The intrinsic and extrinsic cues result in the perception of quality before/during the purchase and during preparation/consumption corresponds with the planned positioning.

6. Proposals, how to integrate the outcomes/viewpoints of the different expertise
Development of a solution is not a linear activity. During the selection of an appropriate solution repeated testing cycles, review and adjustment should be made until the solution fits well to the specific needs, requirements, and facilities of the company. It is worth spending time on the discussions with people from other disciplines. Through ongoing interaction experts learn from each other and develop trust and appropriate decision making (Patist and Bates, 2008). Close cooperation among food technologists, economic, legal and marketing experts shall be successful (Linnemann et al., 2006).

7. Key questions regarding consumer issues during the innovation projects – support for the decision making and the optimization process

The innovation process is a chain of professional decisions. As a result of them the possible technical solution becomes more and more outlined. In the successive stages of the innovation process more and more detailed and particular knowledge is needed while support of the optimization process comes into the foreground. Efficient decision making and successful optimization can be reached only possessing adequate information. The relevant information decreases uncertainty and risk, helping to obtain a solution fitting well to the requirements.
A successful development can be realized only through well posed and answered questions. As all development situations are individual, this section would only present examples without completeness for the right question rising and encourage to further independent actions. Fig 4 gives an outline of the main steps regarding consumer issues related to the stages the of innovation process.

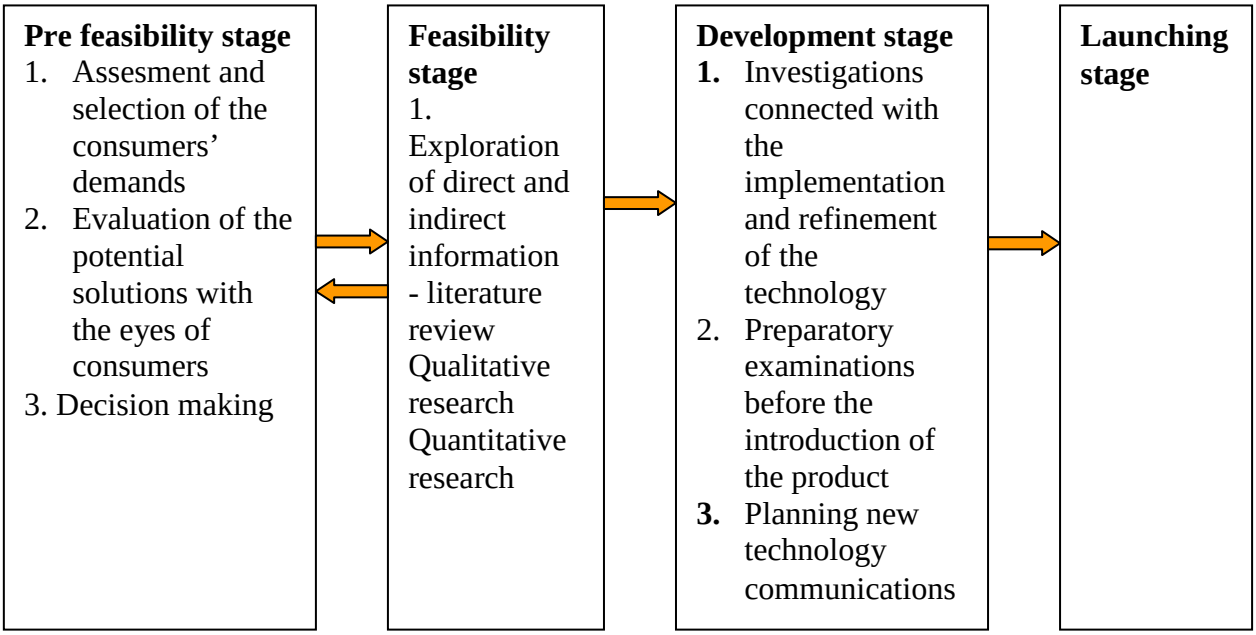

Fig. 4. Outline of consumer issues during the stages of innovation

Pre-feasibility stage:

1st step: Assessment and selection of the consumers' demands

Level of consumers satisfaction related to the existing products, what kind of demands have emerged on the consumers part and how could they be fitted to the international trends (health, environmental awareness, convenience viewpoints etc.)?

Are there any risks connected with meeting consumers demands (e.g. whether exists solvent demand, is there a consumer group to could buy the product? Are the advantages and higher added value of the new product obvious for the consumers? Which are the target groups? Is there any chance of enlargement of the target groups and/or increase of consumer's demands? Are there any weaknesses along the supply chain affecting product quality (e.g. raw material supply)?

2nd step: Evaluation of the potential solutions with the eyes of consumers

To what extent are the related technologies known and accepted by the consumers as solutions to their demands?

Are there relevant practical and research experiences in this field?

What kind of data, figures and other information are available on the target group's expected reactions concerning acceptance of the technologies coming into question in relevant countries for given products?

Which are the benefits and disadvantages of the possible solutions from the consumers' points of view? How could we influence consumers' perception in case of both advantages and disadvantages? Are there any relevant successful practical or research experiences?

Consumer acceptance of the technologies should be investigated also in the case when only the technology itself is modernized (e.g. implementation of a cost saving new procedure) without any change in product quality. It is important for the new technology not to be deemed by the consumer as risk increase.

3rd step: Decision making

Based upon analyses carried out in various special fields, in the pre-feasibility stage decisions are made on the demands to be met, the target groups and the technical solutions.

Feasibility stage:

In this stage as much direct and indirect information should be explored on the selected target group as possible. The available secondary (literary) and primer (practical) information shall be collected and analysed on the following topics:

- quality and risk perception of the concrete target group
- orientation habits of the concrete target group and possibilities of attitude forming

Analysing these figures the necessary further target group examinations can be planned. The target group examinations can be qualitative (e.g. in-depth face-to-face interviews) and quantitative (e.g. questionnaire assessments). Although this kind of analysis is not very cheap, it is a highly efficient tool in the reduction of the innovation risk. Exclusively own investigations can answer the question, whether the innovation could be as successful as expected (product, technology, target group).

The feasibility stage can produce the following results:

- points ahead towards the development stage,
- refers back to the pre-feasibility stage,
- abandoning the planned innovation.

Development stage:

1st step: Investigations connected with the implementation and refinement of the technology

A series of expert sensory tests are needed for the implementation of the new technology. As far as possible, also consumers of the given target group should be involved into this work.

2nd step: Preparatory examinations before the introduction of the product

Food analytical examinations have to be performed related to the correctness of claims to be shown on the label. For example, if we want to say that our product manufactured by the new technology can better preserve vitamin contents or has a more natural taste and so on, these claims shall be confirmed by examinations, too.

In the pilot stage target group investigations are needed, if possible. The results are used by both the marketing (activities planning) and the quality assurance (optimization of sensory properties, label planning etc.) organization. It is practical to commission expert organizations (e.g. marketing firms) with planning, execution and evaluation of these examinations. The marketing and quality assurance department of the company should build up tight connections with the researchers to specify objectives and questions to be answered. In order to plan product introduction, generally more target group examinations are necessary.
In general these examinations are qualitative with well elaborated methodology (e.g. advertisement tests, association tests).

3rd step: Planning new technology communications
When an entirely new, never before applied technology is introduced, its communication shall be planned as well. Balanced, clear and concise information is very important. Commencing a consumers information campaign (e.g. in gastronomic and feminine papers) is recommended as early as possible before entering the market. It is also suggested to refer to the technology on the packaging. Up-to-date communication solutions (green number, company website etc.) should also be invoked. It may also be expedient to notify and persuade previously the consumers' organizations as well as to cooperate with different governmental players (authorities, ministries etc.). Good practice of the communication of new technologies has not been evolved yet. However, communication practices connected with the introduction of ESL (Extended Shelf Life) milk could be seen as a starting point.

Launching stage:
Adequate exploitation of instruments designed in the development stage. As the preferred sensory attributes play an important part in the acceptance of the products, tasting is a good occasion for the development of people's buying will. Based on consumer and other feedbacks the necessary smaller amendments and modifications shall be done.

8. Relevant research findings based on the consumer studies in HTE project

One of the major barriers of the successful process innovation is very often the lack of consumer acceptance itself. It is the reason that consumer acceptance studies are current topics in the scientific literature. The utilization of scientific results is a very important task, but is not simple at all. The food industry experts are interested in experience of universal validity and the researchers are revealing new information about a specific area which has been statistically verified. This is a practical guideline for practitioners based on the up-to-date HTE results regarding consumer attitude and acceptance.

What kind of free associations do the consumers have regarding some new and traditional technologies' names? The experiments were carried out in four countries (Spain, Germany, Sweden and the Czech Republic) representing the several regions of EU.

A general summary for the industrial specialists is given in the following:

- Consumer acceptance of foods is a very complex phenomenon. Among others it depends on possible benefits and risks related to the food. The consumers can perceive the new technologies as a risk factor. Different names of technologies induce different associations. Overall, nanotechnology, infrared heating, electric pulse and microwaves were found negatively, whereas hydrostatic high pressure, pasteurization and boiling have more positive than negative associations and evaluation. There were some

differences among the analysed countries, but these differences are not statistically verified or notable.

- According to the consumer's associations the analysed technologies can be grouped into three sections: familiar technologies (boiling, pasteurization, high pressure processing (HPP)), unfamiliar technologies (nanotechnology, info communication technology) and risky technologies (infrared heating, electric pulses, microwave heating). Electric pulses technology is not well known in public and is linked to negative terms like electricity or irradiation. In contrast to electric pulses (EP), the HHP is considered to be more positive than EP.
- The consumers could not associate technologies and food categories correctly. The consumers have not got adequate information about these technologies. There was an exception: milk and pasteurization are fitted to each other in all countries. Also it is revealed, that the consumers have not heard about information and communication technology (ICT) and nanotechnology in food processing.
- In respect to the evaluation of the analysed technologies the following conclusions could be drawn: the consumers perceived the highest difference among the technologies according to knowledge. The lowest scores were given for nanotechnology in all countries, this was the least known technology. Highest scores were given to boiling and pasteurization. In Spain ICT was known, it was known to some degree in Sweden, and it was unknown in Germany.
- The consumer is unaware of certain technologies and there is a very enduring prejudice against microwave heating. For example, the German consumers know microwaving very well, but it is perceived to be unnatural and unhealthy.
- Biotechnology is perceived to be a more natural and healthy technology. This evaluation might come from the prefix „-bio". This shows the importance of a well chosen technology name. 'Bio' seems to be a powerful word for consumers implicating healthy, but expensive food products.

The next step of our researches in the HTE project was the examination of the effects of labelling and providing information on the sensory perception of a food product (milk) treated by different technologies. At first, consumers evaluated the same milk sample. Secondly, the consumers tasted seven milk samples (the same samples as previously) labelled with various technologies' names. Thereafter half of the participants were given written information and the other half of the consumers was given audio-visual information about the technologies and the consumers tasted the same labelled samples again. The description of information was as objective as possible, but one main advantage and one main disadvantage were also included for each technology. The consumers were asked to fill out a short questionnaire regarding their attitude toward new food products (Food Neophobia Scale).
The relevant results are the following:

- The labelling of milk glasses with the name of a new technology had a negative impact on sensory acceptance. (Although the differences were not significant in all cases, the acceptance values decreased for all samples) Country -specific analysis revealed that in Sweden and in the Czech Republic there were not so many significant differences and in tendency the acceptance values were higher than in Spain and Germany. This difference could be explained by attitude towards new foods: Swedish and Czech consumers were the most neophilic.
- Based on the third sensory testing, the information providing had a generally positive impact on sensory perception, but it was not significant in all countries. It is a very practical finding that written information seems to have higher impact on sensory

acceptance than audio-visual information. It is in line with consumers' demands regarding food labelling. It seems that the written information is more authentic.

- After information providing consumers' acceptance of pasteurization, electric pulse, high hydrostatic pressure and microwave heating increased significantly. The acceptance of nanotechnology decreased after information providing, supposedly because the description of nanotechnology was not attractive for the consumers. „The impact of the nano-practicles in the nature has not been well known yet" and this disadvantage was evaluated risky by the consumers.
- This study did not support the earlier research finding that women have a more negative attitude towards innovative food technologies than men. This study did not show a significant difference between the age groups, either.
- The main conclusions of this study are: The given neutral and concise information could increase the consumer acceptance. Maybe the information itself has more impact than the information channel (audiovisual or written). More information about technologies could be a key driver for better acceptance of the food products processed by innovative technologies.

The third analysed issue was the willingness to pay for a certain product labelled with new technology names. The consumers generally have mistrust and disapproval regarding the new technologies processed products. The main obstacle, which should be overcome by food producers that how can be reached the first buying? What level of willingness to pay do the consumers have?

The objectives of our 'willingness to pay' study was:

- to investigate consumer willingness to pay and buy a food product processed with innovative technologies
- to model or predict consumer attitude toward innovative processing technologies
- to describe characteristics of consumers' who are willing to buy food processed by innovative technologies.

In order to investigate these questions a choice based conjoint study was carried out to simulate a food choice situation with 602 consumers in four different European countries. Milk was chosen as model product, and we investigated the impact of three attributes (technology, price and additional information about environmental impact) on the willingness to pay. The chosen technologies were: hydrostatic high pressure (HHP), electric pulses (EP), nanotechnology (NT), microwave (MW) and pasteurization (PST). Before the product choice short information about the technologies was provided to the consumers. In this study we have used the Food Technology Neophobia Scale (developed by Cox and Evans et al., 2008, justification of reliability by Evans et al., 2010) and a shortened version of ECOSCALE (developed by Bearden et al., 1998) in order to reveal consumers' attitude regarding novelties and environmental responsibility, too.

The important findings for industrial experts are the following:

- German consumers had overall the highest mean values on the neophobia scale, they were significantly more negative toward novelties, than Czech, Spanish and Swedish consumers. 20.7% of German consumers were grouped into the „high neophobic" group. It means, that in Germany it is the most difficult to change consumption habits. Fortunately, the costumers aren't uniform. For example 78% of German respondents were „medium neophobic" and 1.3% was „low neophobic".
- Spanish consumers seemed to have the highest environmental responsibility, significantly higher, than Czech, German or Swedish consumers. If the eco-friendliness attribute arises among the arguments supporting the innovative technology, the environmental responsibility of the consumers is very important.

- In line with results of the Food Technology Neophobia Scale, the milk labelled EP, NT and MW technologies were evaluated most frequently with „non-option" answer by German consumers. In general the German consumers chose the products made of the well known pasteurization with pleasure. For Czech consumers the low price was important. The Spanish answers were diverse regarding technology, but they prominently preferred the environment-friendly technologies. The additional information (environmental-friendly) has a positive impact on the utility of this attribute in all countries. Altogether PST and HHP technologies had positive contributions to the choice situation, while NT, EP and MW technologies had negative utilities. A price below average had significantly positive influence on milk choice in all countries, whereas prices above had significantly negative influence.
- We found significant differences between the examined countries: in Czech Republic, the price attribute is very clear and nearly twice as important as technology or even trice important as environmental impact. For German consumers „technology" seemed to be much more important than price and trice important as environmental impact. In Spain the most important for choice decision was the technology and environmental impact was similarly important. In Sweden there were two important attributes, namely price and technology. In Sweden the environmental impact had the lowest relevance.
- The gender had significant influence on the milk choice and this influence appeared in all countries. Female consumers had higher importance and utility of 'technology' and „environmental impact".
- Although the environmental responsibility measured by the shortened ECOSCALE was very different among the four countries. Significant difference weren't revealed between ECOSCALE value and the results of choice based conjoint study. It was expected that consumers with higher environmental responsibility (measured by ECOSCALE) will prefer the environmentally friendly technologies more than the other respondents. But this could not be confirmed in our study: the higher environmental responsibility did not lead to higher importance and utilities of environmentally friendly technologies.
- Similarly, we did not find statistical connection between neophobia scale and the results of conjoint study. Our negative results in these field show that the prediction of consumer behaviour is a very complex issue. At the moment we have not got proper methods for the prediction of consumer acceptance, therefore product studies are very important.
- The innovative technologies have the potential to be bought by European consumers, but it seems to depend on consumers' attitude towards novel technologies and in some respect to their environmental responsibility. Consumers are willing to pay more for the environmentally friendly product, if the technology is known and safe. The reduction of consumers' fear is an important factor, but this can be influenced by proper information which can increase the acceptance.

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