LITERATURE SURVEY

QualityLowInputFood

Underlying Principles in Organic and "Low-Input Food" Processing – Literature Survey



Otto Schmid, Alex Beck and Ursula Kretzschmar (editors)

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Table of content

Foreword

This publication contains a literature review about processing of organic and low-input food, which describes the underlying principles, the regulatory framework, problem areas as well as consumer expectations and concepts of food processing companies. The rationale for this work is an increasing consumer demand for processed food from organic and low-input agriculture. This increasing demand for more processed organic food with characteristics like longer shelf life and convenience will be a challenge for the organic food sector in the future. Organic food processing standards prohibit until now the use of many food additives which are widely used in the processing of conventional foods. However, there are frequent discussions as to the underlying rationales and criteria used to allow some ingredients or additives but not others.

Certain consumers question if specific processing methods, especially when new processing technologies are used, are still in conformity with organic food processing standards.

There is also a great diversity of underlying principles and rationales being used to develop "minimum", "low input" and "organic" processing standards. As a result, standards used, may differ significantly between sector bodies, European countries and potential export markets overseas. There can also be conflicts between the desire to "minimal processing" in order to avoid negative effects on the nutritional and sensory quality, and food safety considerations.

It is therefore important to develop a more "consolidated" concept for organic and low input food processing. The literature review about organic and low-input food processing in this report is part of a subproject about organic food processing and this is part of a large, integrated EU funded project within the 6th Framework program in the area 5 on food safety and quality. This integrated project, the QLIF Project (Quality of Low-Input Food), aims at improving quality, ensuring safety and reducing costs along the European organic and "low input" food supply chains through research, dissemination and training activities.

The results of this survey serve to identify the relevant questions for a large consultation of experts of organic food processing in Europe with the Delphi method. In a later stage, until the end of 2005 a "Code of Conduct for organic food processing" will be elaborated. Proposals how to further develop the EU regulation 2092/91 for organic agriculture will be made and hopefully contribute to clearer decision criteria for public and private actors. The present literature overview has the main focus on the underlying concepts and principles in organic food processing and less on technological solutions to problems, limited to the main product groups (vegetables/fruit, cereals, milk and meat products). The strong emphasis given to the consumer expectations and to nutrition concepts should help to develop in a "fork to farm" approach to better respond to the demand of the consumers, which see often organic food processing in a wider scope including social and environmental concerns.

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Frick, Switzerland, August 2004

Otto Schmid, FiBL, Coordinator of the QLIF-Subproject 5.1

Dr. Urs Niggli, Director of FiBL

Executive summary

Otto Schmid and Alexander Beck

This publication contains a literature survey about the processing of organic and "low-input" food.

Chapter 1 gives an overview of the **background for this literature review** and introduces this report which is part of a large integrated EU funded project within the 6th Framework program in the area 5 on food safety and quality. This integrated project, the QLIF Project (Quality of Low-Input Food) contains a subproject about processing, which aims at outlining the regulatory framework and developing a code of practice for organic food processing. The objective of the literature review is to identify the regulatory framework and current practices in "minimum" and "organic" food processing, analysing the underlying principles as well as consumer expectations. Sources were international and national standards/ regulations, scientific as well as grey literature. The focus was less on technological issues than on the underlying principles.

Chapter 2.1 summarizes the historical **development of the standards and regulations**. In 1980 the first international standards have been developed by the International Federation of Organic Agricultural Movements (IFOAM) under the title Basic Standards. These standards were to guide national organizations in the development of their own standards. Since 1996 new editions also describe criteria for the evaluation of organic food processing, in particular with regard to the use of additives and processing aids.

Since 1985 several private label organizations and their umbrella organizations have been working on standards for processed organic food, in particular the organizations DEMETER, BIOLAND and NATURLAND (Germany) as well as BIO SUISSE (Switzerland), which even developed product specific standards.

The EU regulation 2092/91 came into force in 1991. It was completed in 1993 with a special Annex VI, listing the allowed additives and processing aids for the processing of organic food (EU regulation 207/93). Two new positive lists were established for ingredients of non-agricultural origin and for processing aids, and were several times amended later on.

The Codex Alimentarius Commission, a joint FAO/WHO Food Standards Program, started in 1991 to elaborate guidelines for the production, processing, labelling and marketing of organically produced food and in 2001 it finalized guidelines for organically produced food, including some criteria for the use of additives and processing aids in plant and animal products.

Despite the existence of the regulatory international and European framework for organic agriculture, there is an ongoing discussion among the main actors about how to define "the processing of organically produced foods". At the moment (Autumn 2004) the European Commission still has not decided upon the requirements for the processing of organic food of animal origin.

The EU Regulation 2092/91 hasn't yet further developed their criteria for the evaluation of additives and processing aids, which might be an explanation of the difficulties in finding a consensus list for animal products.

Chapter 2.2 shows, that the industrialization in Europe in the 19th and 20th century also had for consequence the emergence of a "back to nature movement" as a life-style, within agriculture, nutrition,

education and health management. This movement was at the source of a natural concept for sustainable living. The **concept of natural nutrition** has been adapted today. It takes into account that:

a) eating and drinking is one of the most intensive interactions of human beings with nature (food means to incorporate nature);

b) food should support human well-being (physical and psychological as well as social criteria according to WHO's Health definition);

c) food and beverages should be tasteful and create a regional food culture;

d) food should be diverse in order to support biodiversity of regional resources.

These elements should be considered when developing a concept for organic food processing.

Aside from the term "organic agriculture", the terms "sustainable" or "**sustainable development"** are common and generally recognized. In Chapter 2.3 a comparison of the sustainability approach and the organic agriculture movement is made. Organic agriculture and processors of organic foods focussed on developing new (innovative) production methods whereas sustainability strategies rather aimed at improving/adjusting already existing production technologies. Today it is more likely to find a convergence between sustainability strategies and organic strategies in organic agriculture and food processing. But basically the strategies emerge from different perspectives.

Systems for ecological or sustainable management have been introduced on a voluntary basis in many organic food producing companies. Some private business standards deal with some aspects of sustainability with regard to the manufacturing of food whereas the EU Regulation 2092/91 has nearly no specific requirements.

The European Common Agricultural Policy recognizes organic farming as a strategy for environmental and sustainable development. To further develop the sustainable processing of food it is important to transfer and develop sustainable processing technologies and management systems which are in accordance with the internationally recognized organic food production principles and guidelines, as outlined by IFOAM (2002) and the Codex Alimentarius (2001).

Historically organic food processing was often associated with a more human-oriented technology frequently described as "appropriate technology". The term or concept "appropriate" or "intermediate" technology has been mainly used in the seventies of the last century. Although the term seems to be almost "old-fashioned" today, this concept presents interesting elements to be considered when speaking about organic food processing and sustainability.

The analysis does show that several aspects of **appropriate technology** are in line with the aims of organic agriculture. But appropriate technology focuses much more on the social and ecological aspects of food processing than on the purely technical aspects. Regionality of production, size of the processing units, flexibility of the units, consequences for the job market, environmental optimization of the whole supply chain and ownership are main elements of appropriate technology. These could be important elements for the advanced development of organic food processing and will need further consideration. Some organic food projects already follow this approach in practice.

As shown in chapter 2.4 in several standards guidelines and publications, organic food processing is strongly associated with **"minimal processing" and "careful processing"**. The term "minimal processing" is nowadays much used in the food processing industry in general and described in literature. On the contrary the term "careful processing" is used in the realm of organic food processing especially but is not yet clearly defined. The concept of carefulness seems to fit very well with the processing of organic foods, especially if it is meant in a broader sense. Indeed, "care" is an essential value in organic food production: it encompasses care for the product, the environment and the people. With this

perspective, one can make a stronger link between careful processing and concepts of sustainability and of appropriate technology.

In Chapter 3 the **consumer perceptions of organic food quality** are the main focus. The concept of food quality also requires to be further explored, and its specific contents must be investigated thoroughly. A number of definitions have been suggested and applied. Food is the meeting point of numerous symbolic codes: personal, familial, cultural, biological, industrial and environmental, as well as ethical dimensions of social justice. Consumer concerns about food quality appear to be connected to both food production and food processing. Concerns about long-term consequences for health and for the environment are also commonly mentioned when consumers talk about food.

Food quality, as shown in Chapter 4, is a concept of crucial importance for the understanding consumer attitudes towards organic food. It is evident that expectations towards product quality are as high for organic foods as they are for conventional foods. In some cases the expectations are even higher for organic foods, and there might exist additional quality features specific to organic food. Several studies focusing on consumer expectations concerning organic foods have been published in Europe in the last years. The issues to which the studies refer often relate to the main differences between conventional and organic farming practices, as well as to the use of industrial technologies, artificial fertilizers and pesticides as opposed to less industrialized methods based on a balance between plant- and animal production. The use of food additives is a common concern with consumers, and choosing organic food might be one strategy to limit the intake of additives, as the utilization of additives is limited by the regulations for the processing of organic food.

Holistic concepts of food quality and processing involve both the product- and the process-orientated assessment of food quality. Quality assessment of the product itself includes the evaluation of the nutrient content (desirable and undesirable components) as well as complementary methods – called holistic methods – based on the understanding, that "the whole is more than the sum of its parts". The hypothesis is that nutrients in food are bound to the matrix and that holistic methods are able to show quality beyond the nutrient level (e.g. structural energy, binding form, entropy). These methods need to be validated according to ISO standards; and food derived from different farming systems and/or processing techniques has to be investigated.

Methods evaluating the process-orientated quality of food are able to assess the social, economical or ecological factors that are linked to the production of food in agriculture and food processing (e.g. Life-Cycle-Assessment). The process orientation is a basis for the definition of organic foods.

Nowadays a number of different **private standards for the processing as well as state regulations** for organic foods are in place: Council Regulation (EEC) No 2092/91 of 24 June 1991, the "National organic program" of the United States, the Codex Alimentarius "Guidelines for the production, processing, labelling and marketing of organically produced foods". Parallel to the state regulatory framework for organic agriculture, many private business standards all around the world are introduced. The basis of most of those standards is given by the "Basic Standards" of the "International Federation of Organic Agriculture Movements" (IFOAM 2002). This international standard reflects to a certain extent a broad international agreement at the private level, concerning the signification and meaning of *organic* food and of *organic* food processing. All standards consist of positive lists of methods and inputs allowed. Most of the private standards are written in a language that can be understood quite easily by a majority of operators.

It can be summarized that most standards require a certified quality management system in place to ensure the "true labelling" of organic foods. There are different approaches with regard to the quality profile of the products. In all regulations the labelling provisions of the ingredients are very important. At

the private level however some organizations have developed much more detailed standards for each product group.

The processing of organic fruits and vegetables is regulated since a number of years by the EU Reg. 2092/91. In the organic vegetable sector inhibition of the browning reactions in fresh and dried products while processing is challenging, because sulphite compounds are not allowed for organic processing. Organic acids and enzymes may solve some problems, but they are not as effective as the sulphite compounds. In addition organic acids might be problematic at the organoleptic level, which is the reason why they aren't used at a larger scale at the moment. The use of ozone might be an option, and will be studied in the QLIF Project at a later stage.

Applicable enzymes can inhibit browning reactions and enzymes have an important role in the processing of fruits and berries. They can also be used in peeling processes. The fundamental problem here is whether we can guarantee that the enzymes used aren't produced by genetically modified organisms.

The microbiological quality of organic fresh ready-to-eat salads should be as good as of corresponding conventional products. Chlorine compounds are commonly used, but they are not allowed for the processing of organic products, so that other methods should be found. Organic acids, ozone treatment and other sanitizing agents should be studied for this purpose.

The **processing of cereal based organic products** is regulated since 1993 by the EU Regulation 2092/91. Especially Article 5 and Appendix III and VI are relevant in this matter. However this standard addresses no specific requirements for organic cereal processing; but rather draws up general requirements for plant products.

It is not common to encounter product specific standardization for the processing of organic cereal based food. Most private business standards do not have product specific requirements at all. The few standards which developed requirements for cereal based foods are dealing with the following principles: raw materials from certified organic origin; requirements and recommendations for storage; minimization of the use of additives and processing aids; the use of whole flour products are recommended; biological and traditional processing methods are preferred; processing methods are selectively restricted (for example extrusion); ecological and adapted pest management systems, cleaning regimes and packaging materials are enforced.

There are a number of important questions, which are actually discussed in relation to organic cereal products. These questions are addressing aspects of the evaluation of additives and technologies as well as the definition of underlying principles for the processing of cereal based foods in relation to nutrition styles, understanding of health, meaning of traditional processes or handicraft, as well as to the concept of regionality. New developments, e.g. organic starter cultures, demonstrate the possibilities for innovations adapted to the needs of the organic food sector.

The EU-Regulation 2091/92 does not yet address **dairy products**. Nowadays the processing of animal products is regulated by a wide range of different national standards and regulations.

Milk is a highly perishable food material and one must therefore have a good knowledge and understanding of the techniques used and of the complexity of microbial interactions. The challenges imposed by the tendency to go towards longer shelf life and higher food safety of products should not be achieved at the expense of e.g. their freshness. Concerning the microbiological quality and safety of dairy products, zero risk is not a reality and this fact should also be accepted by consumers. It would be necessary to provide consumers with more accurate information on food risks and to encourage behaviour modification where needed (like right storage temperatures). In addition to the minimal processing techniques which aim at maintaining the nutritional and vital quality of the product, some novel or combination of techniques and treatments could be considered (high temperature pasteurization,

high pressure treatment, micro filtration etc.). Enzymes could offer many interesting applications in organic dairy industry if GMO –free enzymes were available. Organic dairy products and functional foods are also an interesting combination, because the best known functional foods at the moment are milk products fortified with probiotic bacteria. Moreover the CLA-content of organic milk seems to be naturally higher. So could there be "naturally" functional food products?

The EU-Regulation 2091/92 does also not yet address **meat products**. Similar to dairy products the processing of meat products is regulated by a wide range of different national standards and regulations. Some countries have very strict regulations on additives to organic meat products. Standard setting often involves a balance between maintaining the purity and integrity of the organic system and ensuring that certain quality demands are met. Especially for meat this dilemma has been clearly recognized.

Currently the most urgent challenge for the organic meat sector is to offer products with a high microbiological quality and safety without using critical additives like colouring agents or nitrite. The search for alternatives and alternative approaches to the use of nitrite in processed meat should be continued. Furthermore the discussion about security should be connected to entire life cycles of the products, including for instance appropriate storage temperatures and cooling requirements in retail shops.

In chapter 6 it is shown that the organic food market is not only one of the fast growing markets in the food sector, but also one of the most **innovative food sector**. An impressive number of new raw materials, technologies and new products have been introduced during the last 20 years in the organic food sector. This innovative sector also gave substantial impulses to the conventional food sector. The observation of recent developments in the organic food market and the briefly described examples of innovative firms shows that nutrition issues are an important source of activities for companies present in the organic food market. Environment-friendly production systems are the next most important aspect. Working together with farmers is not only a key issue for success; it is part of a social concept too. The development of technological methods which are adapted to the needs of organic food production, to healthy styles of nutrition and which relate to the "naturalness" of food by limiting the use of the additives is the next aspect to consider.

Finally some processors of organic food try to emphasize the relation from the consumers to the farmers. They want to restore its identity to the food. The following statement summaries the practical situation: "The industry's main task is to take the raw material from organic origin and transfer it to the consumers in the form of well recognized attractive products without destroying its original quality, result of the organic farmer's work."

In chapter 7 an overview is given about the **identified principles in organic food processing and controversial areas**. The literature review has shown that a broad range of ideas exist about the processing organic food. This is reflected by the quite different types of products, different processing standards and marketing concepts. Some of the principles are basic, others are shared broadly and some principles are in discussion mainly in the private sector.

Controversial areas in the presented product groups were summarized. It seems to be critical to decide if new processing technologies like enzymes or extrusion technologies, ion exchange technologies, modified atmosphere, new packaging materials, are in line with the concept of organic food. Apparently there is a lack of guiding principles and related criteria, which are needed to make a decision about such methods.

However the organic food sector is under pressure, because consumers demand that it offers the same product quality, with the same shelf life, sensorial quality and high safety level that they are used to experience with conventional products. This demand stimulates the development of new innovative concepts, which use natural substances with appropriate technological properties or less critical additives

than are used normally, or the development of technologies based on additive-free processes. Nevertheless in most cases this results higher production costs.

Sometimes aspects of consumer acceptance in relation to well know product profiles like nitrite-treated or nitrate-treated sausages might cause strong contradictions for the organic food sector.

It is very important to further investigate perceptions of consumers towards organic food processing. A majority of organic food are sold as processed products. Processing has a strong influence on the characteristic and the quality of products. The future development of organic food processing should follow much more a "fork to farm" approach, taking consumer expectations into account.

Other important aspects are the risk of contamination (e.g. microbiological contamination, not allowed substances) and the origin of the substances used in organic food products. This last question is strongly related to the whole debate about the use of GMO techniques for the production of additives and processing aids, during the production of starter cultures and enzymes and to the coexistence question in relation to the production and processing of GMO crops. Furthermore it seems to be more acceptable for the organic food sector to use ascorbic acid out of acerola cherry than to use it from a biotechnological source. The organic origin of the product is a basic principle, which has a higher recognition than the chemical structure of the substance in the organic food sector.

We compared the consumer perceptions with the identified principles for organic food processing and with actual standards. Result was that a number of principles are covered at all levels (EU Regulation., private standards and by company concepts). Other principles are not or only partly implemented. This means that several consumer perceptions are not completely fulfilled by the state regulations, private standards and company concepts.

The **conclusions** in chapter 8 show that the EU-Regulation 2092/91 covers a number of consumer perceptions such as certification system, traceability, minimal use of additives, labelling concept and the use of organic raw materials. However a number of other consumer expectations and discussed topics are not fulfilled such as careful processing, freshness, healthy nutrition or fair trade.

The open and difficult discussion in the European Union about the acceptance of additives for organic food processing at the state and private levels point to the absence of a generally acknowledged theoretical quality concept about organic food, upon which decisions would be taken. A similar situation can be observed regarding processing methods: a number of them generated a controversy. It seems to be complicated to decide whether specific methods are in line with the principles of organic food production or not.

To enable a consistent further development of the EU Regulation 2092/91 it is important to develop principles and related criteria for the evaluation of additives and processing methods. In addition some technological problems have been identified (e.g. oxidation of fruits and vegetables), were appropriate solutions have to be found and/or developed.

Obviously in the mind of consumers and of other actors in the organic food sector a range of additional principles is present, when compared with the official regulation. This gap between consumer expectations and the rules given by EU Regulation 2092/91 can cause problems. Therefore it is important to clarify the situation and to build a solid link between the regulations and consumer perceptions.

1 Introduction

Otto Schmid and Alexander Beck

The market for organic food as defined in EU-Regulation 2092/91 is rapidly expanding in Europe (Hamm et al. 2002/2004). Consumers can nowadays find a growing range of different processed organic products. Although the EU Regulation 2092/91 on organically produced food is also valid for processed products, there is a lack of concepts and definitions about the term "organic food processing".

It is not clear whether the organic product range meets the expectations of the majority of consumers. This situation could possibly lead to confusion amongst consumers about what processed organic products are and reduce consumer acceptance and confidence in organic farming products. Unclear product profiles create an uncertain basis for investing in processing activities and therefore are a danger for the market development of organic food. For example, there is a trend for convenience foods, other highly processed foods and for food which is easy to handle and has a long shelf life. To follow these trends could contradict the holistic approach on which organic agriculture is based and risks harming the integrity and authenticity of organic food.

The key question in developing strategies for organic food processing is the kind of criteria organic food processing has to fulfil. Several ideas are laid down in the EU regulation 2092/91, in the Basic Standards (IFOAM 2002) of the world-wide umbrella organization IFOAM (International Federation of Organic Agriculture Movements), in the Guidelines of the Codex Alimentarius for Organic Food (Codex Alimentarius 2003) as well as in national or private standards for organic agriculture. Ideas like "as natural as possible", "minimal/low grade processing", "without or with little additives" are combined with the term "naturalness" in the sense of purity, authenticity, genuineness, freshness, maintenance of natural properties ("whole food") of the raw material. Others argue that the consumer wouldn't be interested in a special "processing quality", that there is no need to change recipes for processing and that it is sufficient if the products consist of ingredients from organic farming.

The problem of packaging and labelling of organic products is also linked to processing of food.

The problem is that the development of these ideas is partly still at a basic stage and is not synthesized within an overall concept shared by the main stakeholders (consumers, processors, retailers, producers, researchers).

To link consumer preferences with those of the other key stakeholders, it is necessary to identify the existing views, approaches and guiding principles for organic food processing, packaging and labelling. This includes the perception of different consumer groups as well as the other stakeholders within the market. The integration of these perceptions into a clear overall concept aimed at the further development of effective communication policies and guidelines for policy makers - with regard to the improvement of EU Regulation 2092/91 and private label programs for processing of organic food - is a challenge for the future.

1.1 Integration of organic food processing in the QLIF project

The literature review about organic and low-input food processing in this report is part of a large, integrated EU funded project within the 6th Framework program in the area 5 on food safety and quality. This integrated project, the QLIF Project (Quality of Low-Input Food), aims at improving quality,

ensuring safety and reducing costs along the European organic and "low input" food supply chains through research, dissemination and training activities. It focuses on increasing value to both consumers and producers and on supporting all components of the food chain, using a "fork to farm" approach.

Within the Integrated QLIF-Project the subproject 5 deals with organic food processing.

a) Workpackage .1 Development of a European framework/code of practice for organic food processing.

b) Workpackage 5.2 Assessment of chlorine replacement strategies for fresh cut vegetables.

c) Workpackage 5.3 Processing technologies which improve the nutritional composition of dairy products.

The reasons for the importance of organic food processing outlined in the Technical Annex in WP 5.1 of that project, are described below:

Organic processing standards prohibit the use of many preservatives and other food additives which are widely used in the processing of conventional foods (Codex Alimentarius Commission 1999 & 2003; European Commission 2003). However, there are frequent discussions as to the underlying rationales and criteria used to allow some (e.g. salt, sugar, nitrate) but not other processing methods and additives, especially when new processing technologies (e.g. ozone, microbial inocula) or additives (e.g. essential oils) have to be assessed for conformity with organic processing standards (Beck 2000; Gallmann 2000). A range of other processing standards focused on "minimum processing" or "low additive input" processing are also emerging. These often have very similar underlying aims to organic processing standards (Beck 2000; Gallmann 2000; Schmid et al. 2000).

There is evidence that consumers of "low input" and organic foods have specific expectations with respect to quality parameters of processed food (Anonymous 1998 &1999). These may relate to the degree of processing, concern about specific additives, nutritional composition, integrity or whole food concepts, the degree of convenience, the level of energy use and transportation distances, but also food safety. These need to be addressed in organic and other "minimum – low input" processing code of practice as well as in standards.

The starting point of the first task in Workpackage 5.1 is to review the existing literature on organic food processing issues.

1. 2 Aims for the literature review

The objective of the literature review on the underlying principles and practices used in "minimum" and "added value" processing standards is to provide an introduction and context for the whole "Subproject 5. Processing". This will be the basis to formulate key questions for a broader Delphi Expert survey in Europe as well as for the elaboration of a Code of Practice on organic food processing, which is planned in Workpackage 5.1.

1.3 Methodological approach

Until now only few scientific publications about organic food processing have been published. Even less literature is found with regard to processing of "low input" food.

Several reports from national research projects are available. However, with regard to specific techniques of food processing or specific additives, more general literature about food processing can be found.

The main role of the partners in this Subproject 5 was to identify the most relevant research publications about these topics in English and other languages and to provide access to the information enclosed in informal or "grey" literature, mainly published in their own countries. A special emphasis was given to references related to underlying principles in standards and regulations.

In each sub-chapter an overview about the addressed issue was given, the main problem areas were identified, conclusions for the future work were made where possible and relevant key questions for a Delphi Expert Survey, which is planned to be conducted from September 2004 until March 2005 all over Europe, were formulated.

2 Underlying concepts

2.1 Development of organic agriculture and organic food processing

Otto Schmid and Alexander Beck

2.1.1 Evolution of standards and regulations

Concepts for organic agriculture have primarily developed on the side of agricultural production. The first private business standards already existed in the seventies of the last century in France, United Kingdom, Switzerland, Germany and USA.

IFOAM Basic Standards

In 1980 the first international standards have been developed by the International Federation of Organic Agricultural Movements (IFOAM), under the title Basic Standards. These standards and the aims underlying them were to guide national organizations in the development of their own standards. These aims were at that time:

a) Work as much as possible within a closed system, designed consistently with available resources.

b) Maintain the long-term fertility of soils.

c) Avoid all forms of pollution that may result from agricultural techniques.

d) Produce foodstuffs of high nutritional quality in sufficient quantity.

e) Reduce to minimum the use of fossil energy in agricultural practices.

f) Give all livestock conditions of life that are conform to their physiological needs and to ethical principles.

g) Allow agricultural producers a decent return and satisfaction from their work.

Some of these general principles are also relevant for organic food processing (see chapter 2.4 about Appropriate Technology)

Although the focus was much more directed on agriculture at that time, the first IFOAM Basic standards already contained a short section about storage conservation and processing (IFOAM 1980, IFOAM 1982):

"All chemical treatment as an aid to conservation during storage is forbidden. Irradiation and anti-sprouting treatment is forbidden.

The processing and transformation of primary products must be carried out without chemical additives or treatment. An Appendix to the present document, clarifying the methods permitted in the case of each product, will be issued later. "

In 1990 the IFOAM Basic Standards were amended with a complete new section about organic food processing, including an Appendix of allowed additives and processing aids (IFOAM 1990).

Private standards

Since 1990 several private label organizations and their umbrella organizations have been working on standards for processed organic food, in particular the organizations DEMETER, BIOLAND and

NATURLAND (Germany) as well as BIO SUISSE (Switzerland), which even developed product specific standards for processed organic food (Meier-Ploeger 1996, Schmid 2000).

EU regulation 2092/91 and EU regulation 207/93

The EU regulation 2092/91 came into force in 1991. In 1993 this regulation was completed with a special Annex VI where allowed additives and processing aids were listed (EU regulation 207/93).

For ingredients of non-agricultural origin and for processing aids two new positive lists were established, which were several times amended later on. The use of these substances is allowed unless other European or national laws or regulations forbid it. Schmidt and Haccius (1994, 1998) in their first commentary to the Annex VI mentioned already that "good practices in manufacturing" are the basis for organic food processing. Furthermore in the preamble of the EU regulation 207/93 some basic principles such as the concept of "naturalness" and the minimum use of additives are already mentioned (see later in Chapter 5.1.4). However these general principles have not been further developed.

Codex Alimentarius Guidelines for organically produced foods

The Codex Alimentarius Commission is the result of a joint FAO/WHO Food Standards Program and is the body that sets international food standards. It started in 1991 to elaborate guidelines for the production, processing, labelling and marketing of organically produced food. The Codex Committee on Food labelling, a special working group in which observer organizations such as IFOAM and the EU actively participated, has worked intensively on the development of such guidelines by following the 8 step procedure of Codex. In June 1999 the first guidelines for plant production (including processing) were published. These were amended in 2001 with a section about livestock Requirements in the Codex Guidelines are generally consistent with IFOAM Basic Standards and the EU-Regulation for organic food (2092/91, 1804/99).

2.1.2 Lack of a clear overall concept for organic food processing in regulations and standards

Although there is a regulatory international and European framework for organic agriculture, there is an ongoing discussion among the main actors about how to define "processing of organically produced foods". Studies analyzing the content of the standards and regulations for organic food have shown that sections related to the processing are still underdeveloped compared to sections related to organic agricultural production (Schmid 2000), (Meier-Ploeger1996).

Nowadays (Autumn 2004) there is a controversy in the European Union concerning the requirements of processing of organic food of animal origin. This is particularly the case when discussing which additives and processing aids should be allowed (e.g. use of nitrates/nitrites for certain types of meat products). This controversy highlights the existence of different concepts or development goals for the processing of organic food, which depend on the different actors' point of view.

Beck (2000) identified six different points of view/approaches related to the processing and packaging of organic food can be on the market:

a) Products made out of organic raw materials without specific further restrictions by regulations and/or standards.

b) Products made with a social certification (e.g. Max Havelaar)

c) Products made by companies which have an environmental management system.

d) Products made out of organic raw materials with restrictions on the processing process (technologies and additives).

e) Products made out of organic raw materials which fulfil concepts of "wholefood nutrition".

f) Products made out of organic raw materials that have functional nutrition properties.

Another explanation for the absence of a clear definition is that not enough is known about the expectations of different consumers regarding processed organic food. For some consumers it might be enough to have an idea of what organic agriculture is, without knowing about any requirements concerning the processing of this organically produced food. For some other consumers the authenticity and "naturalness" of the products are very important, or even think that food processing should also be done in an ecologically and socially responsible way (Hofer 1999). Therefore in Chapter 3 a comparison of consumer perceptions of organic food quality in Europe is made.

2.1.3 Development of criteria and lists for new additives in IFOAM Basic Standards and in Codex Alimentarius

In the last years the organic food sector has reflected upon the use of additives and processing aids and tried to define some criteria fulfilling some of the consumer expectations.

In 1996 IFOAM has elaborated a special Appendix 5 in their IFOAM Basic Standards, which gives a list of criteria and proposes a step by step procedure for the evaluation of additives and processing aids (IFOAM 2002). The IFOAM Standards Committee is now working since several years with these criteria when amending the list of additives and processing aids. A detailed description can be found in Annex II.

Taking into account the technological advances of the organic food industry, the development of research for organic farming/food and the growing awareness of different consumer groups for such food, in 2001 the Codex Alimentarius further reviewed its guidelines for organically produced food the following criteria: the allowed inputs and the lists of substances in the agricultural production as well as the processing. It was agreed to review the guidelines in such a way that decisions on future inputs need be supported by technical evaluations based on the new criteria. These criteria were revised during meetings of the Working group for Organic Food within the Codex Committee on Food Labelling in 2002 and 2003 and were finally adopted by the Codex Alimentarius Commission in July 2003 (for more details see homepage www.codexalimentarius.net). The detailed criteria are found in the Annex III.

The EU Regulation 2092/91 hasn't yet further developed their criteria for the evaluation of additives and processing aids, which might be an explanation of the difficulties in finding a consensus list for animal products.

2.1.4 Evolution of consumer perceptions about organic food processing

There have been many research studies (CMA 1996),(Fricke 1996), (Jolly 1991a) about general consumer behaviour, about the main buying motives, the socio-demographic structure of buyers of organic food and their willingness to pay more for organic products. The main differences between regular, occasional and non buyers of organic products were investigated in a number of published or still on-going studies e.g. using different interview techniques, focus group interviews, etc. (Richter 2000), (Sylvander 1998), (Thompson *et al.* 1998), (Wier 2000). However the scientific knowledge about specific consumer preferences, perceptions and expectations towards processed organic food including packaging and labelling is quite small. Expectations concerning sensory properties of "authentic" processed organic foods (taste, texture, flavour) and the wording on labels as a marketing strategy especially have not been investigated at all. Therefore interviews combined with food preference tests and semiotic studies have to be done (Barthes 1981), (Danzart 1997), (Krzanowski 1990).

Most consumer studies related to food quality show that the overall food quality perception, although highly individual-specific, can be very broad. Definitions included many different aspects such as sensory preferences, price considerations, allergy or dietary concerns related to consumer health, functional properties of food, origin of the products, special nutrition approach (e.g. wholefood, macrobiotic) and food culture based on regions, perceived microbiological safety, integrity of the company etc.. With regards to organic food especially, a most important distinction must be made between product specific characteristics directly benefiting the consumers (purchasing motives such as health/food safety concerns or product quality/taste) and the process specific characteristics, indirectly benefiting the consumers, e.g. concern for environmental effects, social impacts or animal welfare (Wier, 2000). The product's as well as the process-specific characteristics have objective and subjective meanings, which depend on the value system and motivation of the individual consumer. Product specific characteristics are particularly relevant in the case of convenience food. Some consumer groups may find that highly (industrially) processed food is in contradiction with organic farming principles, while others may not perceive a conflict. More details are found in Chapter 3.

Specific characteristics of organic processing and packaging have to be discussed in the context of sustainable nutrition and sustainable development of the society (see Chapter 2.3).

2.1.5 Health issues and processed organic food

Almost all recent consumer investigations show that health is a primary motive to buy organic products (Beck 2000), (Richter 2000), (Sylvander 1998), (CMA 1996), (Fricke 1996), (Jolly 1991a). However one can identify two opposite concepts when the topic of "health" in relation to food is discussed. On the side we have the expanding field of food supplements and functional foods. On the other one is the holistic perspective, where healthy food is considered not only to ensure the individual's health but also to contribute to the ongoing health of the society and environment within which the consumer lives.

Whilst principles of the wholefood nutrition try to define the value of foods according to statements like "let foods be as natural as possible", "without additives", "carefully processed" or "low grade of processing", the concepts and values it employs are not of any help in evaluating food processing techniques. In some European countries wholefood nutrition is linked to "nutrition ecology" whereby the relevance of the personal food choice (processed vs. unprocessed, regional vs. global, problems of transport and packaging) as regards to environmental parameters is viewed as important. This concept could reveal helpful in the definition of criteria that should be taken into account when evaluating organic food processing (Simon *et al.* 1996, Bossel *et al.* 1995).

2.1.6 Evolution of the range of processed organic products on the market and current trends

At the start, the range of products being processed was relatively small. Organic food was first found in farm-shops and markets, later on in small natural food stores and food co-operatives. Often they have been processed on farm. Packaged grain, dried fruit products and jams were followed by milk products, juices and bread. Since the 1990s, the assortment was enlarged with refrigerated milk, teas, herbs, non-dairy beverages, coffee, chocolate, frozen desserts, tofu, pasta sauce, etc. More recently also frozen prepared meals, cookies, snacks, chicken and beef products, bagged salad, candy, soft drinks are produced (Eschricht *et al.* 1996). It is difficult to determine whether the organic food industry will follow the mainstream industry.

2.1.7 Evolution of the processing technology towards a more holistic quality concept for organic food

A key issue in many standards for organic food is that quality cannot be better than the quality of the raw material. From that point of view the processing can only contribute to maintain this quality by being suitable to guarantee genuineness, authenticity and conserve natural properties of the raw materials. Consequently, innovative firms and researchers propose that further developments of organic food processing should follow a three step procedure (Gallmann *et al.* 2000):

a) Guarantee freshness (including aspects of maximum transport time, of single ingredients and distances) and authenticity (preference for fruits without flavours, avoiding split material flows). This requires the design of a broadly accepted new system development approach in food processing, involving all main stakeholders.

b) Minimal processing (reducing or replacing additives and processing aids by using ingredients with functional properties and/or optimizing processes), which is an open field for innovative firms and might be an important issue for the short/medium term further development of standards for processed organic foods.

c) Careful treatment (diminishing mechanical stress, heat load), which is an approach manufactures have already started to follow and further develop.

Up to now it is not known to what extent the organic food industry follows this concept and how many products were manufactured according to it. In order to develop effective communication strategies it is of vital interest to evaluate how much interest these approaches raise among the different consumer groups. Until now industries involved in the production of organic goods, often pioneer companies did not dispose of the necessary resources to carry on widespread consumer investigations.

2.1.8 Organic food processing and sustainability issues (environmental and social issues)

Outside the agricultural domain, it is generally acceptable to define the "ecology" of a product or firm in accordance with the Eco-Audit-regulation, ISO 14000 systems, or to another environmental impact assessment system. Some consumers might expect that processors of organic products are those who follow an environmental management system. However the EU Regulation 2092/91 and most of the private label standards do not require an environmental assessment for certification purposes. Some firms in the organic food industry have implemented environmental management systems or started Life Cycle Assessment (LCA) for products or packaging systems on their own. Until now only one study in Denmark has been undertaken to show how many organic food processors have an ISO 14000 accreditation or a similar system. This study showed that less than 10% of the organic food processing companies in Denmark had introduced or planed to introduce environmental management systems (Kristensen *et al.* 1998). A broad introduction of such systems in the organic industry, for example through regulations or standards, could raise consumer trust in the processing of organic food (see Chapter 2.3)

2.1.9 Further development of labelling systems for organic food

The current "mad cow disease"-discussion in Europe concerning the ingredients of sausages reveals high consumer sensitivity to the nature of the ingredients used for the processing. There is a need for clear principles allowing the comprehensive communication of recommended organic processing methods, additives and ingredients to be used. Indeed studies show that to some extent consumers want more relevant information e.g. on taste, use of certain additives, specific processing methods, etc.

Furthermore, it has to be discussed whether standards for the processing of organic products should be named "organic" or not. An alternative would be a labelling system based on additional information like: "without preservatives", "without GMO", "only with natural additives and flavours", "minimal processing" etc. Such a system already exists in the USA. A communication system of the sort would require definitions of the labelling allowed for each specific description of a processing.

2.2 Natural Concepts for a Sustainable Nutrition

Angelika Meier-Ploeger and Monika Roeger

2.2.1 Overview

In Europe, especially in Germany, Switzerland, Austria, Italy and Great Britain, the idea of integrity and authenticity of food developed in the middle of the 19th century. In those days nutrition was part of a new concept which focused on a natural lifestyle ("back to nature"). This movement was born because of the rapidly increasing industrial development in Europe and a separation between working place and home in industrial cities. Even in agriculture, as a result of the scientific work of Justus von Liebig (1803 – 1873) intensification (mineral fertilizer) and industrialization (meat production) took place (Rothschuh, 1983). The food industry was developed (1850) thanks to new processing techniques such as cooling systems, conservation by sterilization. The first convenience products were put on the market (soups, artificial butter, coffee replacement; Spiekermann 1995, Spiekermann, 1999).

As a response to this development, groups were founded in different parts of Europe to establish alternatives in all life areas. Concepts were created for a natural agriculture which tried to work within a closed cycle (animal - manure- compost) using different techniques and crop-systems (plant protection through e.g. intercropping). In addition, new ideas regarding economy and trade were developed (reform of the property laws, co-operatives for trade, land-settlement societies e.g. Eden and Monte Veritas; Spiekermann, Schönberger, 2001).

People sharing this lifestyle were aware of nature protection and animal husbandry issues, which even led for some to the establishment of principles for a vegetarian life (foundation of the Vegetarian Society in England). A healthy life is supported by guidelines for medical treatment (e.g. Hydrotherapy; Sebastian Kneipp), combined with guidelines for nutrition (e.g. Schroth, Rikli, Kollath).

At the same time the role of food to support health in the human metabolic system was addressed (Lavoisier 1743 – 1794); nutrients and vitamins in foods were discovered and analyzed (Prout 1785 – 1850). Some names have to be addressed here, such as Eijkman, (1896) who detected that the deficiency of "Thiamin" causes Beriberi, or E. Fischer (1902), who described the protein and amino acids requirements for human beings, and Burr & Burr (1929) who described the importance of essential fatty acids.

2.2.2 The concept of a natural and sustainable nutrition

Basically we can differentiate between two movements in nutrition from which two different nutrition guidelines emerged: „back to nature" versus "analyses of nutrients in food". While the analytical view led to the "tables of the composition of foods" (Paul, Southgate 1978) and to guidelines focusing on nutrient requirements, the "back to nature" movement stressed the importance of integrity and authenticity of foods, derived from natural agriculture systems. Thus these guidelines addressed "food classes" such as fruits, vegetables, meat etc.; they took into account the processing intensity of those foods and ranked them according to the processing steps (e.g. raw milk, pasteurized milk, sterilized milk, milk powder; Kollath 1988 a, b ; Kollath 1987). The different "food quality categories" which are based on the intensity of the processing are the basics of a whole-food nutrition.

Besides the influence of integrity and authenticity of food on human health, the concept of wholefood nutrition tends to take more and more ecological and social/ ethical criteria into account (Koerber, Männle, Leitzmann 2004).

Foods should be produced by such agriculture, and processed in such a way, that they support human life, create a regional food culture and sustain natural resources worldwide at the same time. A nutritional behaviour that respects the following guidelines will support the principles of sustainability and those of a natural food concept.

1. Consumption of foods of plant origin and reduced consumption of food derived from animals

The reason for this guideline is the fact that industrialized countries feed their animals with plant produce (e.g. soybean, wheat, corn) which can be eaten by human beings. In doing so they waste energy and increase the world wide food deficiency. Indeed an average of only 10 – 35% of the energetic value of a plant is "stored" in the animal produce (Strahm 1995).

The guideline to reduce intake of foods derived from animals (e.g. meat and meat products twice a week) takes into account that the European population in general is well provided with protein and energy and tends to develop nutrition based illnesses such as obesity, high blood pressure, diabetes and coronary heart diseases (German statistical agency 2003).

By reducing the intake of foods derived from animals, one reduces as well the potential intake of feed additives, such as antibiotics present in the meat, and the accumulation of organochloric substances in human body fat.

2. Increase consumption of seasonal and regional foods

The consumption of seasonal and regional foods raises the awareness of a regional food culture in the different countries of Europe. The Slow food Movement – as a European movement of consumers, processors, caterers and traders – supports this principle, considering it a natural concept for a sustainable nutrition. "Saving by eating" is the motto of the "arch- project". Typical regional breeds of animals, typical foods of plant origin, as well as recipes to process food on farm and in industries in a region should be encouraged by a consumer supported market (Meier-Ploeger, Klatt, Odia 2003). Globalization in the European food market destroys smaller enterprises and reduces the range of flavours and tastes which are developed in typical foods in regions of Europe and world wide (Murcott 2003).

Regional products can save energy – when distributed in an efficient way - because of a decrease in transportation and partially because of a decrease in the amount of packaging. Regional structures make it in principle possible to harvest fruits and vegetables fresh and ripe. By this, the content of desirable nutrients is increased (e.g. vitamin C); it is especially the case for secondary plant compounds (e.g. phenol substances) which seem to be important for human health (Watzel, Leitzmann 1999). The sensory characteristics of a product harvested when ripe are most often better than those of products ripened at storage (e.g. sweetness of tomatoes, apples). Regional structures make it possible to process meat from animals in a way (warm) that food additives such as phosphates can be left out e.g. for sausages.

Whole food nutrition advises to use as rarely as possible food preparation techniques that are considered to change the nutrient content of food. This underlying principle includes techniques in the industrial processing as well as in food preparation within the household. Its goal is to reduce the intake of carcinogenic substances (e.g. from grilled meat, as well as phosphate and nitrite) and minimize the loss of vitamins, minerals and secondary plant compounds. Through this, the principle might enhance human health by supporting the immune system (Leitzmann et al. 1999).

3. Consumption of organic produce

Koerber et al (2004) recommend within the natural sustainable food concept to consume organic foods. They showed that the intake of pesticide residues in plant products grown organically is negligible and much lower compared to conventional products.

Annex VI of the EEC Regulation 2092/91 states that food additives such as colouring and preservation agents are restricted (positive list; 36 agents versus approx. 350 in conventional foods) which diminishes the potential risks of allergic reactions.

EEC regulation 2092/91 also prohibits GMO contamination of food derived from organic agriculture and in the food processing. Although we do not yet have evidence that GMO contaminated food interacts with human health, people who refuse GMO-technology because of health fear or ethical reasons can be sure, that organically produced food contains the lowest possible amount, or even when proven, is free, of GMOs

Besides the relatively egocentric reasons to consume organic products, more altruistic ones are as important within the natural and sustainable food concept: that is to support a sustainable agricultural production taking care of natural resources, such as soil, water, air and biodiversity (Koerber/ Männle/ Leitzmann 2004; Simon 1998). Supporting regional structures for agricultural commodities is an aim for organic agriculture. Agriculture influences nature and creates landscape. Food derived from a region is an expression of the regional culture (preparation and including processing) (Meier-Ploeger 2003)

4. Reduced consumption of highly processed food

The first reason for this statement is to diminish the intake of food additives which might interfere with human health (Broadhead 2001). Other reasons are to minimize the loss of desirable nutrients (vitamins, minerals, secondary plant compounds), minimize calorie intake derived from the fat and refined sugar used during the processing, as well as to minimize the food risks resulting from the alteration of ingredients during the processing (e.g. fatty acids, amino acids). The most important principle for this is to ensure the "integrity" / "wholesomeness" of a food (Kollath 1988a, b). Minimizing food processing also means minimizing the additional energy used for food processing. Moreover it is meant to support regional structures in agriculture and in the food preparation branch (Woodward, 1999). Finally it allows reducing food packaging.

2.2.3 Conclusions

The industrialization in Europe in the 19th and 20th century caused a "back to nature movement" as a life-style, which includes agriculture, nutrition and health treatment. This movement was at the source of a natural concept for sustainable living. The natural concept of nutrition today takes into accounts that:

a) eating and drinking is one of the most intensive interactions of human beings with nature (food means to incorporate nature),

b) food should support human well-being (physical and psychological as well as social criteria according to WHO's Health definition),

c) food and beverages should be tasteful and create a regional food culture

d) food should be diverse in order to support biodiversity of regional resources.

Relevant questions to be discussed:

- With regards to the different processing methods, it would be interesting for the project to reflect on and investigate whether processing technologies like microwave, extrusion for cereal products, reverse osmoses for the cheese or wine production and others, are suitable for the organic food production.
- Are functional foods, in which isolated vitamins, minerals or other physiologically important food compounds are added, an opportunity for the organic market (isolated versus matrix-bound substances)?

2.3 Sustainable processing

Niels Heine Kristensen and Alexander Beck

2.3.1 Overview

The notion of sustainable development has been recognized by the EU (EU Commission 2001) and other international and national authorities (WTO 2001, UN 2004, and World Bank 2004). A broad definition of sustainable development exists and major political institutions work towards this goal. In many sectors the definition of sustainability and related policies are taken into consideration. The fact that the definition of sustainability is open constitutes a dynamic factor, facilitating the adoption of the concept by more stakeholders. In this perspective the existence of an acknowledged concept reveals very helpful to favor the greater involvement of stakeholders, including companies, sharing the common aim of sustainability.

With the EU regulation Nr. 1836/93 of year 1993, the EU established a regulatory basis for environmental management systems at the company level. The EU Eco-Management and Audit Schemes – called EMAS are now based on the EU Regulation Nr. 761/2001. In the last decade a big number of food companies have adopted such a system. (www.emas.gv.at , 2004).

While sustainability has been defined and its concepts implemented mainly by experts working within companies, the organic farming concept originated in the practice on farms and tended to be dominated by practitioners (farmers, often recruited by non-farmer groups). Organic farming principles define new (innovative) production methods whereas the concept of sustainability focuses on system routines that can be improved/adjusted within already existing production technologies and management systems. Many entrepreneurs in the organic food sector have the similar objective to integrate environmental management systems into their companies, be it certified according to EMAS or ISO standards or not.

Today it is likely to find tendencies of convergence between sustainability strategies and "organic" strategies; still they arise from different perspectives. It seems that now sustainability strategies are often initiated by the head of the company. Therefore it is important for them to be aware that combining these two different perspectives and strategies is not an easy task. This is also the reason why sustainability strategies are more often executed within big (food) companies, already having running management systems in which it is easy and logical to integrate an environmental part.

The translation of sustainability concepts into action-oriented principles includes at least the three following elements:

- environmental protection
- organizational adjustments and integration (in a change perspective)
- consideration of political processes (as priorities and decisions, allocation of resources, etc) within the company as well as the state environmental policy and social changes and expectations in the society.

Also integrated in these issues – but often not explicitly mentioned - are the concepts of 'trust', 'integrity' and 'transparency'.

2.3.2 Food processing and sustainability

The implementation of strategies for sustainability in the food sector deals with the above mentioned three elements but in different degrees of priority. The food sector was not a pioneer in implementing changes aiming at a greater sustainability. Until now the food sector has focused mostly on environmental issues that can also have a positive impact on the production and handling costs. These are:

- energy savings (storage, heat and cooling control)
- waste management
- cleaner production technologies (when re-engineering facilities)

Priority for each issue is given by the company according to the degree to which issues are in compliance with its economic condition and the legal framework within which it acts.

Also other issues of environmental interest have been recognized by some industries and companies. These are complementary to the above mentioned points and are often integrated in and reflected by the companies' marketing strategies and public profiles. They are often actively used in company external communication – also in order to strengthen company legitimacy within a broader audience. Elements of communication can be:

- packaging (renewable materials, recycling)
- industrial ecology
- life cycle assessments
- transport costs

Complementary to environment management tools, the food chain concept (from field to fork) has been supporting the development of market oriented tools as well, such as the supply food chain management. This concept of entire food chain management is expanding in the modern food business as the horizontal integration along the food chain and becomes widespread.

In the broader sense of sustainability, as defined above, also distribution chain as well as company or society structure cause environmental effects. Elements of sustainability to consider are for example:

- regional/short distribution chain
- precaution (exclusion of risks)
- greater recycling of matter in time and space within the company (closing cycles)

Management systems dealing with internal matter and energy flows especially (since they have a big environmental impact) have been developed into specific systems: in Europe the most commonly used are ISO 14000 (1999), EMAS (2000). Aside from these generic formal systems there exist also branch-specific systems and guidelines. We won't discuss them here further, although some seem to be used by or related to major companies or branches.

2.3.3 Organic food processing and sustainability

Historically organic agriculture developed as an alternative to the newly established practices in the agricultural sector. In particular the separation between nature and man occurring in the non-sustainable structures, systems, routines and attitudes, was questioned (Brundtland 1987). A radical critique of societal structures and distribution systems was formulated in the 1980ties. Since then the more radical

voices have lowered and the established food sector has acknowledged the need for sustainable principles and methods.

The response of the organic sector as well as conventional food industry to this critique was the introduction of new technologies and different environment management systems. An important element in this approach consisted in becoming a partner of organic farmers. The organic farming system comprises an ecological optimized production system (Köpke 2002).

At the processing level the use of organic raw materials is an important ecological practice; still it does not mean that the whole processing system is always completely environment-friendly. A number of other aspects are important: waste management, energy, transportation, cleaning and disinfection, transport equipment and distance, etc. (BMU 1995).

Therefore a lot of processors of organic food have established eco-management systems. Such systems constitute a basis for a steady improvement of the ecological performance of an enterprise.

Environmental management systems are addressed neither in the regulatory framework for organic food processing nor in state regulations (EU Regulation 2092/91) nor in private business standards (IFOAM 2002). Only these later refer to packaging issues. But no certifier or labeling organization requires an ecological or sustainable management system.

In the specific standards requirements of the Basic Principles, IFOAM (2002) formulates some relevant environmental principles which could be applied to food processing. But apart from using certified organic raw materials and minimizing the use of additives, only very few and weak recommendations regarding environment management are given (IFOAM Basic Standards 2002):

"Organic food is protected from pests and diseases thanks to good manufacturing practices that include proper cleaning, sanitation and hygiene, and without the use of chemical treatments or irradiation (Chapter 6).

a) The packaging of organic products has minimal negative side effects on the product quality or on the environment (Chapter 6)

b) Social justice and social rights are an integral part of organic agriculture and processing. (Chapter 8)"

Both from a policy and a market perspective it has become important to recognize the need for improving sustainability within the organic food industry. There are already concrete and creative efforts from some actors of the sector. A number of companies combine the production of organic foods with "Eco-Management" systems and uses this approach as an additional communication tool (e.g. www.zipperle.it, 2004), but these efforts are not coordinated (Kristensen & Nielsen 1997).

Both from a policy, research and market perspective the need to develop the organic food industry with regard to sustainability has become obvious. There are concrete and creative efforts from actors within the sector. However these are not coordinated – but can be considered to contribute to the development of common and more specified processing standards (Kristensen & Nielsen 1997). In major food companies, activities involving organic concepts and sustainability are often carried on in different departments. Also there seems to be little collaboration between these departments within companies, as well a little coordination of their work or even with the company's environmental policy (Kristensen & Nielsen 1997, Mac 2001). Several smaller companies have strategies and practices to deal with environmental and energy issues but without having formally written and certified protocols (Holm et al 2002).

Therefore it is important to study the experiences done already in this area and to formulate superior and specific aims and goals that will transfer the key concepts of the organic alternative and of sustainability into the organic food chain (including production, processing, distribution, etc). There is a demand from the side of nutrition ecology to gather the different elements of sustainable nutrition under one concept.

2.3.3 Future challenges

The most important question for the future is whether aspects of sustainability should be introduced in standards for organic foods. The AOEL (Association of organic food processors mainly in Germany) has formulated its position as follows (www.aoel.org 2004):

"VIII. Increased future integration of companies' environmental protection measures
The integration of additional subject areas and questions relevant to environmental protection and social responsibility into the concepts relating to organic food is being advanced through private-commercial agreements."

The AOEL Association understands the stronger orientation towards environment protection as part of the private system. But it could also be discussed whether relevant factors ensuring sustainability should be integrated in state regulations. Aim would be to adapt the EU Regulation 2091/91 so that it would reflect the expectations of consumers towards organic food production.

In practice nowadays systems for sustainable management are introduced more on a volunteer basis. Some aspects of sustainability are included in private business standards. However the EU Regulation 2092/91 gives very few specific requirements.

Some of the relevant environmental aspects in organic food processing are listed below:

a) Energy: local sources, new technologies, renewable energy

b) Packaging: systems, renewable materials, recycling

c) Water supply and waste water management

d) Transportation: food miles

e) Waste management

f) Emissions

g) Pest management

h) Use of chemicals: disinfecting, sanitizing, (Neumarkter Lammsbräu 2002)

The most common way to consider these aspects is the introduction of environment management systems. Such a system can be inspected and certified, and when in place, constitutes a good tool to steadily improve companies environmental performances.

2.3.4 Conclusions

In many organic food producing companies systems for sustainable management have been introduced on a voluntary basis. Some private business standards deal with aspects of sustainability with regard to the manufacturing of food whereas the EU Regulation 2092/91 gives nearly no specific requirements. This literature research shows a potential here.

Indeed the literature review also points out that the definition of common standards guiding the implementation of sustainable processing of organic foods can be done by systematically studying the different and specific experiences done already in this area. This can facilitate the formulation of superior and specific aims and goals that will be able to guide the inclusion of organic and sustainable aims into the organic food chain (including production, processing, distribution, etc).

The European Common Agricultural Policy recognizes organic farming as a strategy for environmental and sustainable development. To further increase the sustainability of food processing it is important to translate, implement and develop sustainable processing technologies and management systems which are in accordance with the internationally recognized organic food production principles and guidelines, as they are outlined by IFOAM (2002).

Relevant questions to be discussed:

- Is the concept of organic food related to the concept of sustainability at the level of the processing of food?
- What are the most important relevant factors for sustainability in the food sector?
- How can the company be able to benefit of environmental management systems on the market?
- Is the consumer, when buying organic food, also expecting the processing to be sustainable?
- Does the company benefit from environmental management systems on legislative compliance?
- Should the sustainability approach for processing and handling of organic food remain on a voluntary basis or should it become obligatory?

2.4 Appropriate technology

Alexander Beck

2.4.1 Overview

Historically organic food processing was often associated with a more human-oriented technology frequently described as "appropriate technology".

The term or concept "appropriate" or "intermediate" technology has been a term mainly used in the seventies of the last century. Although nowadays the term seems to be almost "old-fashioned" this concept has interesting elements to consider when speaking about organic food processing and sustainability. During that time several scientific groups have worked on this concept. (Schumacher 1975), (Boye et al. 1976), (Arbeitsgruppe Angepasste Technologie 1977).

Appropriate technology is used to solve technological problems by providing sustainable solutions which are beneficial to local communities, and which are reducing environmental pollution by using renewable sources of energy and recycling materials wherever possible (Mathes 2004).

2.4.2 What is appropriate technology?

Appropriate technology is primarily a small-scale technology. It is structured in such a way that people can manage and implement it at local level. Appropriate technology makes use of skills and technologies that are available or can easily be adopted on small scale levels. Appropriate technology can be handled by humans.

Typical aspects of appropriate technology are:

a) Decentralized.

b) Technologically sophisticated, though simple in design.

c) Environmentally friendly.

d) Socially integrated

The technology should be designed in such a way that the humans who are involved in the production processes and who are the users of this technology or products have the control over it. The whole technology should be structured like a cultural evolution in which the technology could ideally never be in opposition to the needs of environment and the human beings (Kükelhaus 1979).

In an early stage of the development a discussion arose about the possibility to implement this new technological way of thinking (Reddy 1977). Today this technological approach is in a strong contrast to the current developments. In Europe and also in the USA appropriate technology is today often seen mostly as a tool for developing countries. Nevertheless a number of applications of that technology like alternative energy systems or organic farming are in place or being implemented in a number of developed countries. Especially in the organic food sector one can find a tendency for more decentralization of processing, another typical element of appropriate technology.

In general three types of application of appropriate technology can be distinguished.

a) The "Small Technology" based on the actual stage of scientific and technological knowledge. This "Small Technology" should be implemented in a decentralized structure and should remain always under the entire control of the local community.

b) "Intermediate Technology" is also oriented towards small scale production processes but is mainly based on human labour and not so much on technical skills. The aim is to develop a human-friendly technology, which is based on local resources.

c) "Biological Technology", which should be based on a harmony of human and nature. This means a) using more environmental friendly technologies, and b) technologies which are adapted to biological needs or biological systems (Protokoll-Gruppe-Berlin 1976).

2.4.3. What is appropriate technology aiming at?

Aims of the concept of appropriate technology are:

a) Choosing open cycles

b) Adoption of the system and parts of systems to an optimized extend

c) Internalization of external costs. (e.g. « polluter pays » principle)

d) Compensation of imbalances in the distribution systems at local and worldwide levels

e) Very high quality production with a low input of material and energy

f) Creation of stabilized social structures

g) Reduction of specialization and

h) Promotion of small and transparent units through decentralization (Edelmann 1977)

The aim of appropriate technology is to create a technology with a "human face".

Appropriate technology is often discussed in the context of food security issues but in most cases again in the context of developing regions of the world (Gill 2002)

2.4.4. Appropriate technology and Organic Agriculture

A number of aspects of appropriate technology are in line with several basic principles of organic agriculture and organic food production. In the actual IFOAM Basic Standards (IFOAM 2002) we find the following "principle aims" which correspond to the concept of appropriate technology:

a) To produce sufficient quantities of high quality food, fibbers and other products.

b) To work compatibly with natural cycles and living systems through the soil, plants and animals in the entire production system.

c) To recognize the wider social and ecological impact of and within the organic production and processing system.

d) To maintain and increase long-term fertility and biological activity of soils using locally adapted cultural, biological and mechanical methods as opposed to reliance on inputs.

e) To promote the responsible use and conservation of water and all life therein.

f) To use, as far as possible, renewable resources in production and processing systems and avoid pollution and waste.

g) To foster local and regional production and distribution.

h) To utilize biodegradable, recyclable and recycled packaging materials.

i) To provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs, within a safe, secure and healthy working environment.

j) To support the establishment of an entire production, processing and distribution chain which is both socially just and ecologically responsible.

k) To recognize the importance of, and protect and learn from, indigenous knowledge and traditional farming systems (IFOAM 2002).

The two approaches of "organic agriculture" and "appropriate technology" can be seen as very similar but with a different main focus. Organic agriculture, as it is understood nowadays and laid down in different regulations/standards all over the world, is seen more and more as a production method. The requirements for processing in standards and regulations are only related to technical subjects directly oriented towards the production of the products. A broader view on social aspects in the processing company or the environmental influence of the processing units is not part of any governmental regulations for organic foods.

In practice within the organic food chains we find still quite a number of common aims and elements from the appropriate technology approach in place. Many "organic" processing companies have an environment management system in place. New cooperation models between farmers, processors and consumers are being developed especially in the organic food sector (Community Supported Agriculture/ www.attra.nat.org). Often fair trade activities are directly linked to organic food projects. But once again, all that is not part of the governmental regulations on organic agriculture. However some private standards for organic agriculture have tried to integrate such elements in their requirements.

2.4.5 How to implement appropriate technology in organic food processing

These elements can be implemented in the following way:

a) Middle and small-scale technologies oriented towards human capabilities based on the best scientific knowledge.

b) Technological methods focused on ensuring the perpetual quality of foods.

c) Optimization of the impact of the processing unit on the environment (minimization of negative influences)

d) Integration of processing activities in locally organized communities on regional level and by humans of the community on economical as technical level

e) Strong integration of all farming, processing, trading and consumption activities.

2.4.6. Conclusions

Several aspects of appropriate technology are in line with the aims of organic agriculture. But appropriate technology is focusing much more on the social and ecological aspects of food processing than on the purely technical aspects. Regionality of the production, size of the processing units, flexibility of the units, consequences for the job market, environmentally oriented optimization of the whole food chain and

ownership are main elements of appropriate technology. These could be important elements for the advanced development of organic food processing and will need further consideration. Some organic food projects already follow this approach in practice.

Relevant questions to be discussed:

- To which degree is appropriate technology applied in the organic food industry?
- Is it possible in food processing today to develop technologies more oriented towards to the needs of human and environment?
- What should such an approach include?
- What could be understood under the term "appropriate technology for food" in your field of expertise or production today?

2.5 Minimal and careful processing

Thorkild Nielsen

2.5.1 Overview

In several standards, guidelines and publications, organic food processing is strongly associated with "minimal processing" and "careful processing".

The term minimal processing is nowadays often used in the general food processing industry and described in literature.

The term "careful processing" is used more specifically within organic food processing but is not yet clearly defined.

2.5.2 Minimal Processing

The concept of minimal processing in food production covers a wide range of technologies that seek to achieve two things:

a) To use processing procedures that changes the inherent fresh-like quality parameters as little as possible or techniques which have a limited impact on the nutritional and sensory properties of the food.

b) To endow the product with a shelf life sufficient for its transport from the processing plant to the consumer. The specific technologies cover a wide range, e.g. "Clean room technologies", "High pressure treatment", "Gamma irradiation". There has been very little attention given to environmental and ethical issues. Some of the techniques also deal with different packaging methods: *sous-vide*, high frequency or radio frequency heating, heat processing in the package, etc. (Ohlsson 1996).

2.5.3 Careful processing concept in organic food standards/guidelines

The concept has been used in several standards for organic food. For example the standards of the Soil Association give the following description:"The basis of processing organic products is that its vital qualities are maintained throughout each step of the process. This is achieved by a combination of: Choosing and developing methods which are adequate to the specifics of the ingredients. Developing standards which emphasize careful processing methods, limited refining, energy saving technologies, minimal use of additives and processing aids etc." (www.soilassociation.org).

It is interesting that the guidelines for organically produced food in the Codex Alimentarius also refer to "careful processing methods". "The integrity of the organic product must be maintained throughout the processing phase. This is achieved by the use of techniques that are appropriate to the specificities of the ingredients with careful processing methods limiting refining and the use of additives and processing aids. Ionizing radiation should not be used on organic products for the purpose of pest control, food preservation, and elimination of pathogens or sanitation." (www.codexalimentarius.net/).

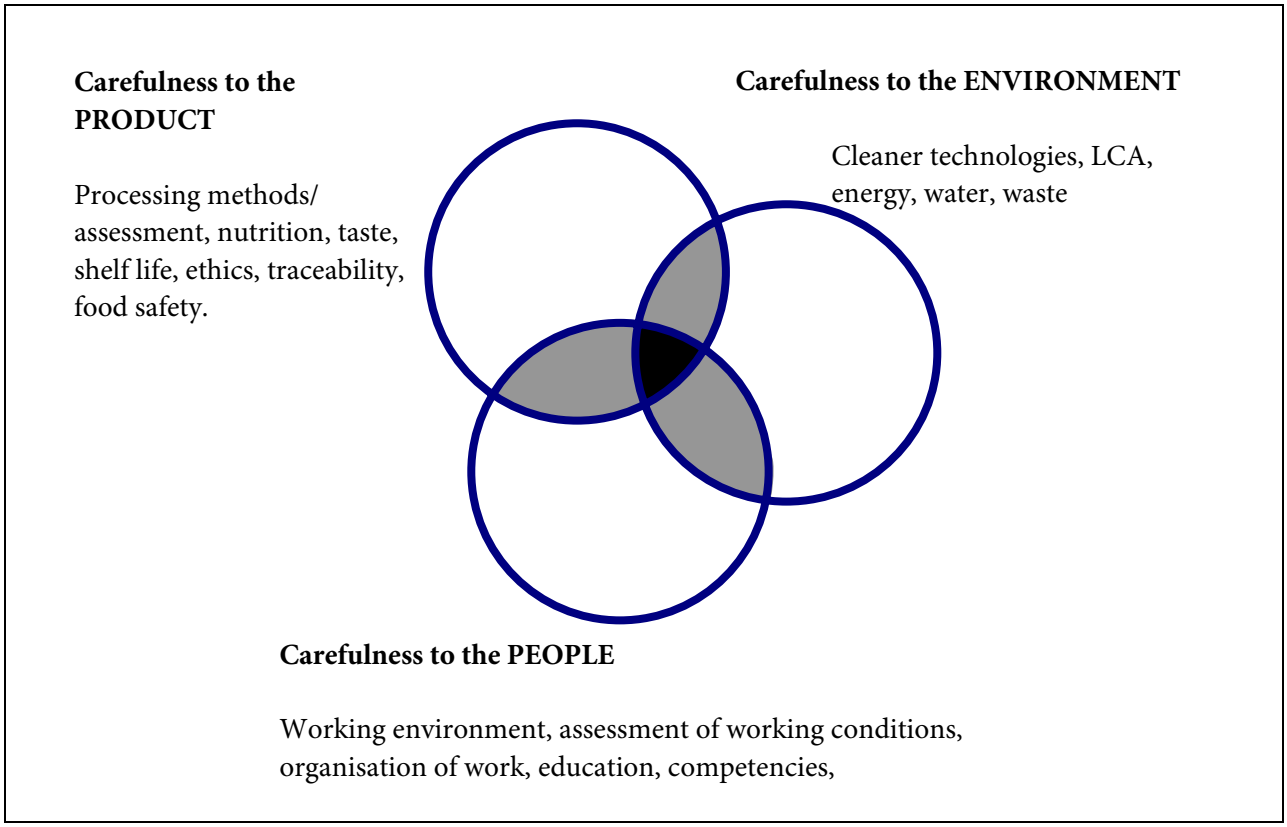
A much broader definition of careful food processing is illustrated below (Nielsen, Kristensen 1996).

2.5.4 Further development of the careful processing concept

Although there is no clear common definition of the concept of "careful processing", "care" is an essential value in organic food production encompassing care for the product, the environment and the people. In relation to the production of organic food, this is translated for example in the fact that significantly fewer additives are allowed. Such restrictions for organic food production, together with food producer, retailer and consumer interpretation of the concept of care, has resulted in the production of some organic foods (e.g., cheese, bread) which are innovative and apparently exercise more care than this is the case for the same non-organic products.

There is a need to systematize and evaluate these changes in processes and products so that they become more accessible to food producers in general. It might also be interesting to come to a broader concept and link it to the sustainability approach. This was done in a Danish research project (Nielsen, Kristensen 2000). In this project careful processing was broadened to include product, people and environment (see fig 1).

Figure 1. The broad definition of careful processing.



2.5.2 Conclusions

The concept of carefulness seems to fit very well with the processing of organic foods, especially if it is reflected in a broader sense. This would allow making a stronger link to the sustainability issue (see chapter 2.3) as well as to the concept of appropriate technology (see chapter 2.4). Nevertheless the concept lacks a clear and precise definition, which is important if it is to be used as a guide to the future organic processing standards. This seems to be its major weakness.

Relevant questions to be discussed:

- Should the term "careful processing" only be connected to the product (pressure, heat, etc.) or should it also cover broader issues like environment, ethics and people?
- Should some less careful processing techniques be avoided in organic food production? Which ones and why?

3 Comparison of consumer perceptions of organic food quality in Europe

Angelika Meier-Ploeger and Monika Roeger

3.1 The concept of food quality for consumers in Europe

Food quality is a concept of crucial importance for the understanding of consumer attitudes towards organic food. This concept also needs to be opened up, and its specific contents must be investigated thoroughly. A number of definitions have been suggested and applied. Food is the meeting point of numerous symbolic codes: personal, familial, cultural, biological, industrial and environmental, as well as ethical dimensions of social justice (Soil Association 2001, Woodward 1999, James 1993).

Evaluations of the quality of a food product often focus on different levels of property. For example, a distinction might be made between:

a) directly visible properties (e.g. shape, colour, size),

b) easily recognizable properties (fragrance, taste, consistency), and

c) properties which are less easily detected in the purchasing situation (storing quality, nutritional value) (Meltzer et al. 1992).

According to some definitions, the quality of a food product may be considered to be equal to the sum of the qualities of its parts, while others reject such an equivalence (Dewes 1994, Klett 1986), stating that the emergent properties of the whole go beyond the sum of the qualities of the parts. A holistic approach to the measurement of food quality suggested by Meier-Ploeger and Vogtmann (1991) includes social, psychological, environmental and political dimensions (Koerber, Männle, Leitzmann 2004).

It is evident that expectations of product quality are as high for organic foods as they are for conventional foods. Indeed in some cases the expectations are higher for organic foods, and there may be additional quality features related to organic food. Thus several concepts referring to "inner" food qualities that are assumed to be of importance for human health are used in connection with organic food (Meier-Ploeger, Vogtmann 1991; Woodward, Stolton and Dudley 1990). Methods of measuring the vitality of the food (picture-developing methods) (Schwenk 1991, Balzer-Graf and Balzer 1991) and its structural energy (Popp 1991) have been developed and used in research on organic food quality (Tauscher et al 2003). Concepts such as "vitality" are certainly important to some organic consumers and to some of those who prefer practising alternative nutrition – such as wholefood nutrition.

Most of the studies reviewed refer mainly to the "eating quality" of organic food. The perceived better taste of organic food is raised in several studies both in Italy, Denmark and the UK as well as Germany and United States (Soil Association 2001, Tauscher 2003). Both Italian and British studies indicate that quality aspects relating to appearance (size, uniformity etc.) are not considered very important by consumers buying organic food. Nor are deviations from "trade standards" important (Torjusen, 2004).

Some studies indicate a perception among consumers that organic food does not keep as well as conventional food.

Comparative studies disclose variations in the aspects of food quality, which consumers care about (Becker 2000). Furthermore the review of Torjusen *et al* (2004) indicates that consumer attitudes to the

quality of organic food vary between countries and different contexts. What is missing is a thorough understanding of this. In particular, consumer conceptions of food quality and the perceived relationship between food quality and health need further investigation.

Some specific issues arise repeatedly in the literature. Whether the issues themselves are formulated by consumers or reflect particular questions that researchers have focussed on is not always clear. However when they are raised, these issues – which also appear in qualitative studies – clearly resonate with many consumers.

Not surprisingly, the issues to which the studies refer often relate to the main differences between conventional and organic farming practices, associated with the use of industrial technologies, artificial fertilizers and pesticides as opposed to less industrialised methods based on a balance between plant- and animal production (Soil Association 2001).

Pesticide use is of concern to many consumers. The worries here may relate to the environment as well as to possible health effects – i.e. either personal short-term health or the health of future generations.

The use of food additives is a common concern with consumers, and choosing organic food might be one strategy to limit additives in food, as the usage of additives is limited by the regulations governing organic food processing (36 agents allowed instead of approx. 350 for conventional foods).

The issue of genetic modification in food production is widely debated in public food discourse in many countries. It is known to be a major concern of consumers, and has been found to be explicitly connected with the preference for organic food.

An important issue is often the consumer's distrust of producers' motives: some have the perception that these practices (e.g. food ingredient, food technologies) reflect an interest in profit rather than in the production of good and healthy food. Concepts such as "homemade" and "natural" appear to stand out, and express a preference of the consumer for food that has been produced with little or no use of artificial fertilizers, pesticides, food additives and technologies like genetic modification (Bugge /Wandel 1994, Bugge 1995, Holm/Kildevang; 1996, Holm 1999).

The literature review shows that consumer concerns about food quality and safety embraces broad and interconnecting realms. Health, environment, ethics, authenticity, taste and concerns about the relationship between people and nature are examples of broad themes that recur in the literature. Health and environment tend to be interwoven and a strong motive for buying organic food (Zanoli et. al. 2004, Midmore et al. 2004)). A typical rationale is that healthy soils, plants and animals are a basis for human health (Howard 1947).

In addition to issues already mentioned, many consumers favour limited transportation of food (keeping "food miles" low); limited food packaging; the use of environmentally friendly packaging; and concerns exist about energy expenditure in the food system in general as well as the use of natural resources (social and environmental criteria; Hofer, Stalder 2000; Mäder 2002).

Choosing organic food might be seen as a way of providing for personal health, the health of future generations, or for what has been called "agro-ecosystem health", which in turn provides for human health. Developing a better understanding of the way in which concerns about health relate to various levels of well-being – from avoiding illness to enhancing full physiological, spiritual and social well-being – is an important challenge.

3.2 Consumer concerns about food quality and processing in Europe

Consumer concerns about food quality appear to be connected to both food production and food processing (O'Doherty Jensen *et al.* 2001). Concerns about long-term consequences for health and for the environment are also commonly mentioned when consumers talk about food. Holm (1999) concludes that, for some consumers, this concern about modern industrial food production leads to explicit criticism, whereas it expresses itself for the majority in the more latent form of mistrust and insecurity. The implication of this for research is that in the case of the majority, consumer concerns may be far from clearly articulated. Methodologically speaking, it can be a challenging task to obtain data that document the character of these concerns.

The following case-study country analysis are summarised from a literature review entitled "European consumer's conception of organic food", which has been the work of Torjusen et al. in 2004 within the EU Project "organic HACCP".

Denmark

Consumer concerns with respect to the purchase and consumption of organic food are highlighted in a number of studies that have been designed to identify buyer motives.

With regards to the eating quality, an important parameter for consumers in their assessment is the taste: some consumers perceive some organic foods as having a better taste than their conventional counterparts. With regard to other aspects of quality, importance is attributed to effects of production on processing, the environment, animal welfare, human health/quality of life, as well as the production and sale of foods within the domestic market, as opposed to imported products. With regards to safety worry and fear are expressed about the use of chemical pesticides, medicines and growth hormones in animal production, food pathogens of significance for human health, and the possibility of GM contamination of organic products (Torjusen *et al.* 2004).

Great Britain

Some British consumers perceive organic food as tasting better, or they associate organic food with the quality of "home-made" food. Organic food is perceived by many as having benefits related to a series of interwoven values connected to health, safety and environmental soundness, such as being "pure" or "natural", free from artificial additives, fertilizers, pesticides and growth hormones, products from "not intensive production", products which have been produced without the use of genetically modified organisms, etc. A small survey conducted in the Newcastle area indicates that "natural", "not intensive" production "without chemicals", "without growth hormones" are key elements in consumers' interpretation of the term "organic farming" (Hutchins and Greenhalgh 1997).

Ethical issues related to organic food include fair trade, workers social rights, environmental impacts in the third world producer countries, equity among people involved in the food chain or who are affected by the use of natural resources. This moral dimension of consumerism is described by Gabriel and Lang (1995) as a "new wave", characterised by the connections between production and consumption, both at local and global levels. In this dimension, issues such as fair trade, workers social rights and environmental impacts in the third world producer countries are central concerns. Ethical awareness related to choice for organic food might refer to a broad spectrum of concerns, for example for the environment, animal welfare, equity among people involved in the food chain or who are affected by the use of natural resources, social rights for workers, care for the health of the people you serve food to, etc.

Issues of animal welfare (for example in terms of natural rearing and "human" slaughtering) and environmental protection are also included in the ethical concerns related to organic food. Perceptions of the environmental soundness of organic agriculture are often related to the key features of organic production methods: without the use of chemical pesticides and fertilizers (Soil Association 2001).

Concerning food products, such an ethical attitude of the consumer might be reflected by his efforts to avoid unnecessary food-miles and packaging, and in general avoid excessive use of energy in all levels of the food chain.

Also highly processed "low-caloric" foods (such as "fat-free butter") may come unfavourably out of calculations such as energy used in production / energy value for consumer. The findings of Holt (1993) that consumers of organic food tend to have a preference for less processed and unrefined foods, as well as a lower meat consumption seems to be in accordance with a guideline of "sustainable eating".

Italy

Appearance and taste are reported to be of importance for choosing organic food for Italian people. However, other studies indicate that Italian consumers do not seem to prioritise the appearance of products, thus indicating that they use other quality measurements apart from appearance when it comes to evaluating food. Health is important to the majority of the consumers, and this issue might be even more prominent than environmental issues in Italians' self-perception of their reasons for buying organic food. In general consumers buying organic foods seem to be more ethically concerned and idealistic than buyers of conventional food. The origin of the food is important, but one study indicates that consumers view the origin of the food as a proxy for quality. Animal welfare as an issue is absent of the reviewed studies. With regard to safety, worry is mainly expressed in respect to the use of chemical pesticides in agricultural production.

Hungary

As regards the quality aspects emphasised by Hungarian consumers of organic food, the few available studies from Hungary indicate that health is currently a main focus among consumers. Moreover there is reference to a general view that agriculture is not associated with environmental pollution (Frühwald, 2000, Kürthy-Baricz 1996).

Germany

In March 2004 a representative study was published by the Ministry of Consumer protection, Food and Agriculture (Ökobarometer 2004) concerning the motivation to buy organic food. The following criteria have been mentioned:

Table 1: Criteria for buying organic foods in Germany

animal welfare	53% 1)
health reasons	53%
good price for high quality	51%
Freshness	50%
good taste	50%
no antibiotics are allowed in animal feed	50%
no pesticides are allowed in organic agriculture	45%
no GMOs are allowed in organic food production	40%
minimum food processing	39%
being „natural“	35%
low price	23%
Regional	23%
Advice	19%
certified organic	15%
atmosphere in shops/ market	12%

1) percentage of consumers evaluating the criteria as „very important“

A smaller but compared to 2003 increasing amount of consumers in Germany buy only organic products (3%). 60% of the interviewed consumers say that they buy organic food "sometimes" (+1% compared to 2003) and 20% stated that they do not buy organic food yet but are open to buy. The high price for organic food is the most often named obstacle (54%), some do not trust the certification (19%) and some see a deficit in quality (appearance, freshness). Consumers in Germany do believe that organic food is very important for children's health (58%), 33% stated it as "important" and 8% as being "not important" (March 2004).

3.3 Recommendation of the study of Torjusen *et al.* (2004) for further consumer surveys

Torjusen *et al.* 2004 recommend as a result of their study:

a) To incorporate a much wider range of *substantive issues* in consumer research with regard to organic food and in reviews of the literature in this field,

b) To treat *consumer characteristics* in this field *as dependent variables* calling for explanation,

c) To undertake *more research regarding* the consumption of organic foods in *central, eastern and southern regions* of Europe.

Specific recommendations regarding the need for future research should address the following issues:

a) Consumer conceptions of the quality attributes of specific food products and product groups,

b) Consumer conceptions of quality attributes as compared with conceptions among other stakeholders,

c) Consumer conceptions of food safety as compared with those of other stakeholders,

d) Whether and to what extent consumer conceptions of food safety relate to a quality attribute of specific *products* and product groups or a property of *production and distribution systems,*

e) Reasons why some producers and some consumers maintain a preference for organic products sold/ purchased through *direct distribution channels,*

f) Dominant conceptions among each set of stakeholders in chains of organic production and distribution with regard to other groups of stakeholders in that chain,

g) The *accountability of stakeholders* in the organic food system, satisfaction with existing methods of accountability and barriers to the institutionalisation of consumer wishes with regard to accountability in the food system more generally

h) With regard to research methodology it is recommended that:

Future consumer research should employ a variety of methods of data collection and analysis, ideally planned such that *quantitative* and *qualitative* methods supplement each other.

3.4 Conclusions

Food quality is a concept of crucial importance in understanding consumer attitudes to organic food. It is evident that expectations of product quality are as high for organic foods as they are for conventional foods. Indeed in some cases the expectations are higher for organic foods, and there may be additional quality features specific to organic food. Several studies focussing on consumer expectations concerning organic foods have been published in Europe in the last 5 years. The issues to which the studies refer often relate to the main differences between conventional and organic farming practices, associated with the use of industrial technologies, artificial fertilizers and pesticides, as opposed to less industrialised methods based on a balance between plant- and animal production. The use of food additives is a common concern with consumers, and choosing organic food might be one strategy to limit additives in food, as there are limits on additives in the regulations governing organic food processing. For the market of organic produce it is of primary importance that new guidelines for organic food processing take these consumer concerns into account.

Relevant questions to be discussed:

- *The accountability of stakeholders in the organic food system, satisfaction with existing methods of accountability and barriers to the institutionalisation of consumer wishes with regard to accountability in the food system more generally*
- *Consumer conceptions of quality attributes as compared with conceptions among other stakeholders*
- *Consumer conceptions of the quality attributes of specific food products and product groups*

4 Holistic concepts for food quality and processing

Angelika Meier-Ploeger and Monika Roeger

4.1 Principles for holistic concepts of food quality

A commonly acceptable definition of food quality proves practically impossible because its meaning varies according to the values of consumers and traders/processors and the status and development in science (Woodward 1998). Food quality is composed of various partial aspects and represents *the sum of all characteristics* scored highly by partners in the market. Six criteria are used to identify important components of quality (Meier-Ploeger 2002):

a) Authentic Food which is authentic, traditional or natural and has not been synthesized or adulterated during production, processing or storage (e.g. GMO - food); "integrity" of food

b) Functional How appropriate food is for its specific purpose, e.g. food that produces, stores or cooks well

c) Biological How food interacts with the body's functioning, both positively and negatively

d) Nutritional How food contributes to a balanced diet (healthy nutrition), both positive and negative interactions

e) Sensual Food which appeals to the senses (e.g. smell, taste, texture)

f) Ethical This concept has four related but distinct meanings:

environmental, social, ethical and political aspects of food quality

Our perception of the quality of a certain food in terms of biological and nutritional quality has changed in the past and will keep on changing as we are confronted with new results from the nutrition research (e.g. dietary fibbers or importance of secondary plant components). At present, chemical analyses are widely employed to determine the content of nutritionally desirable or undesirable substances in food. Nutrients which are matrix-bound are seen as equivalent to those which are added as isolated, single substances to food (e.g. vitamins, minerals in so called functional foods or nutraceuticels). Watzl and Bub (2001) reported a difference in bioavailability between isolated carotinoids added to food and matrix-bound carotinoids, when in a mixture of different carotinoids. The same is reported by Watzke (1998) for the bioavailability of minerals.

In the current (official) view about quality of food for humans is estimated by comparison of the food nutrient content with the recommended dietary allowances (RDA). Humans are seen as an accumulation of cells and reduced to their metabolic systems. The value judgment of food is nutrient driven, and consequently so are the methods for food quality assessment.

In contrast to that development in nutritional sciences, a significant number of people like to practice so called alternatives in nutrition e.g. vegetarian, macrobiotic or whole-food nutrition (Leitzmann, Keller, Hahn 1999) in which not single nutrients but the whole diet with its many interactions is considered. Most of these alternative nutrition paths do recommend organic food, so that the principles of organic agriculture are also criteria that are taken into account when giving a value to food (Beus and Dunlap 1990). Scientists (Tauscher et al. 2003) claim that there is a paradigm shift in agriculture because organic agriculture considers "systems" (such as "plant-soil-system") and "interactions between systems" (e.g.

feeding, housing, breed of animals). This system approach requires a scientific methodology different from the mono-functional investigations (fertilization level and yield). Therefore "on farm research" as a methodology seems to be appropriate for organic agriculture.

In some dietary movements such as the "wholefood nutrition", the quality of a product is not only based on its nutrient content; the environmental and social qualities of the production are also included in the quality assessment (Koerber v., Männle and Leitzmann 2004). The methodology used to determine food quality thus includes e.g. eco-balance sheets or life cycle- assessments (UNS 1999). The "holistic" approach to food quality within the wholefood nutrition movement is process and not only product oriented: data concerning the production process and documenting the processing of foods are gathered for the assessment of quality.

Other nutrition guidelines (e.g. macrobiotic) do include the term of "balance" or "harmony" to describe the potential of food to influence human health. The WHO (World Health Organization) defines health not only by the absence of illness but as physiological, psychological and social wellbeing. Methods to determine this wellbeing in relation to foods are rare. The expression of "balance" is taken up e.g. from the Louis Bolk Institute (2003) which describes their approach to food quality as a balance in the plant between "growth" and "differentiation". Both have to be in harmony (integration). Methods to determine quality should therefore focus on parameters showing these different steps in the growth process (e.g. yield, sugar content), the structure (e.g. seeds) and the coherence (e.g. resistance to stress).

The term "holistic" is also used to describe analytical resp. in complementary methods to investigate the food itself (Meier-Ploeger 1995). Holistic in this respect means that food is not destroyed during examination and therefore can give us some ideas about the nutrient – matrix - relation (e.g. binding form, entropy). This might be important for human health (Watzke 1998; Watzl and Bub 2001).

To this category of "holistic" methods belong the following techniques: fluorescence excitation or low level luminescence (biophotons) or picture-creating methods such as copper chloride crystallization (Busscher et al. 2003).

A method which uses common analytical preparations might be called holistic too, if its results are interpreted in relation with the whole living organism and its general functioning (Meier-Ploeger, Vogtmann 1991). Microbiology tests (e.g. stress test) belong to this group as well as sensory evaluation of food with men and animals (feeding trials, fertility tests). Results of feeding experiments with animals support a wider view of nutritional food quality. Some investigations have shown that even if the proportion and amount of chemically determined feed components are equal in two types of food, the fertility and survival rate of new born animals having consumed these foods can differ (Staiger 1991). Indeed Staiger was able to show that hares, fed with conventional feed had significantly less embryos in the 2nd and 3rd generation than hares fed with feed produced according to biodynamic standards (6.3 and 6.3 per hare compared to 10.8 and 9.7). As shown above, the determination of chemical components alone is insufficient to estimate food quality in its wider perspective. Questions such as "What is life?" (Schrödinger 1945) and "How can food support the living organism?" are the central focus points of holistic methods from a natural philosophical point of view. The scientific work of pioneers in nutrition and agriculture is based on the following premises: "The living whole is more than the sum of its parts" (Dewes 1994). They conclude from this that:

a) Life is bound to forms / structures and their maintenance,

b) Life is bound to light,

c) Life is linked to communication,

d) Life is reproduction (Tauscher et al. 2003, p.159 -166).

In order to verify the validity of these premises it was and will still be necessary to develop and validate new methods for the determination of food quality. An increasing number of scientists, especially in the last two decades, have concentrated their research of food quality in areas which take up the idea of "What is life" from Schrödinger.

4.2 Holistic Concept of Food Quality and Food Processing

Following the above mentioned concepts of "holistic" food quality, the principles for food processing should include:

a) An evaluation of the processing steps according to environmental criteria (e.g. energy needs, pollution of soil, water, air and changes in biodiversity) using methods such as LCA (Life Cycle Assessment) or eco-balance sheets (process orientated determination of food quality; Andersson 1998),

b) an evaluation of the social implications of food processing including health aspects (individual and social system) as well as working conditions, meeting the needs of consumers etc. (process and product orientated evaluation; Soil Association, 2001; Tauscher et al. 2003),

c) Using complementary "holistic" methods (additional to chemical and microbial analyses) to evaluate the changes in quality using new or different food evaluation techniques (product orientated evaluation; Meier-Ploeger and Vogtmann 1991; Tauscher et al. 2003),

d) Using feeding experiments or immune system studies in animals and humans (product orientated evaluation; Williams 2002).

Processing concepts for "low input" foods should put emphasis on the guidelines for a natural and sustainable nutrition (chapter.2.2). The German report on the quality of foods issued from different production systems pointed out (Tauscher et al. 2003, p. 99 - 110) that research must pursue with process and product orientated evaluations of food quality. A deeper insight concerning processing techniques for organic foods as well as concerning regional product lines is especially needed (Hofer and Stalder 2000).

As an example, there is a discussion about the use of microwave heating as a processing technique for organic food (on industrial level). The question is whether this technique, with a frequency of 2,45 Gigahertz can be regarded as a "natural" heating. In comparison to other heating techniques, microwave heating neither preserves a higher vitamin content nor builds, so it seems until now, undesired or unhealthy by-products (Dehne 1997). Nevertheless microwave heating is not recommended for organic food processing.

4.3 Conclusions

Holistic concepts of food quality and processing include the product and process orientated assessment of food quality.

The quality assessment of the product itself includes the evaluation of the nutrient content (desirable and undesirable components) as well as complementary methods – called holistic methods – based on the understanding, that "the whole is more than the sum of its part". The hypothesis is that nutrients in food are bound to the matrix and that holistic methods are able to show quality beyond the nutrient level (e.g. structural energy, binding form, entropy). These methods need to be validated according to ISO standards and food derived from different farming systems and/or processing techniques has to be investigated.

Methods evaluating the process-orientated quality of food are able to assess the social, economical or ecological factors that are linked to the production of food in agriculture and food processing (e.g. Life-Cycle-Assessment). New research results state that organic production systems score higher than conventional production systems (Teuscher et. al. 2003). New or "improved" processing techniques especially for organic food - including packaging - should be assessed with these process and product oriented methods, as described above (Tauscher et al. 2003).

Relevant questions to be discussed:

- *Is there a need for novel methods assessing food quality? Is there a need for the determination of a bundle of criteria which are relevant especially for organic foods (quality matrix)?*
- *Are there special food quality criteria relevant for organic food?*

5 Guidelines for organic food processing

5.1 Overview of the underlying principles for organic food processing present in standards/guidelines on the private level and state level

Alexander Beck

5.1.1 Overview

Nowadays a number of different private standards as well as state regulations for the processing of organic foods are in place. The most important of the state regulations are the Council Regulation (EEC) No 2092/91 of 24 June 1991 and the "National organic program" of the United States referring to agricultural products and foodstuffs on the other side. The Codex Alimentarius, a common program of the UN-Organizations FAO and WHO, have published "Guidelines for the production, processing, labelling and marketing of organically produced foods" (Codex Alimentarius 2003). See also Chapter 2.1.

Parallel to the state regulatory framework for organic agriculture, many private standards all around the world are introduced. The basis of most of those standards is reflected by the "Basic Standards" of the "International Federation of Organic Agriculture Movements" (IFOAM 2002). This international standard reflects to a certain extent a broad international agreement at the private level, concerning the signification and meaning of *organic* food and of *organic* food processing. All standards consist of positive lists of methods and inputs allowed. Most of the private standards are written in a language that can be understood quite easily by a majority of operators.

As already outlined in chapter 2.1, underlying principles for organic food processing are not as clear as they are at the agricultural level. Certifiers, processors and consumers have quite different approaches. These can also be found in the available state regulations and private standards for organic food production.

There is no defined philosophy or commonly shared set of principles in place concerning the approach entitled "organic food processing", which causes two different major problems (Beck 1998):

a) A distortion of competition on the market is caused if processing standards follow different technical requirements.

b) More importantly this lack of clear principles results in uncertainties in relation to the further development of standards and products.

5.1.2 Underlying principles

The requirements laid down in EU Regulation 2091/92, the Codex Alimentarius Guidelines and the NOP USDA rules, similarly to most of the existing private standards, are based on the following principles. These are constructed as labelling regulations and they define under which conditions a food can be called "organic" or not.

- Organic raw materials
- A restricted number of accepted food additives, processing aids and conventional ingredients

- Transparent and well documented processing (traceability, separation and identification)
- Certification of the production and of the labelling

The state regulations mainly focus on guaranteeing the certified organic origin of the raw material, and establish a positive list of additives, processing aids and allowed conventional ingredients accepted for organic foods.

In the preamble of the EU Regulation No 207/93 an amendment to EU Regulation 2092/91 the following focus is given: *"Whereas Annex VI to the Regulation should take account of consumers' expect actions that processed products from organic production will be composed essentially of ingredients as they occur in nature;*
Whereas, however, other ingredients or processing aids which may be used in conventionally processed foodstuffs, and which preferably exist in nature, may be included in Annex VI to the Regulation, provided it has been shown that, without having recourse to such substances, it is impossible to produce or preserve organic foodstuffs;:" (EEC Regulation 207/93).

The British Soil Association defines following recommendations in their processing standards:

"*The following considerations should be taken into account when manufacturing organic foods and when developing new lines:*

Locally produced foods and ingredients should be used wherever possible to reduce the energy involved in transporting goods and to support local communities.

Processing should minimize so as to maintain the nutritional quality of the food.

(Soil Association 2002/2003).

From these statements we can identify a principle of „naturalness". That principle relies on the assumption that minimization of processing is meant to maintain the nutritional quality of the foods.

5.1.3 Development of product specific standards

Some private business standards have developed a more detailed approach at the "content level". Additionally to the above-mentioned aspects these standards have special requirements for each product group (BIO SUISSE 2004), (Bioland 2004). The Demeter Organization, a certification body, introduced this approach in the organic food market for the first time in 1994 (Forschungsring für Biologisch Dynamische Wirtschaftsweise e.V. 1994). Standards of this type are much more detailed and are covering additional technical aspects at the level of the product group. That means in practice that for each product group, like cereal products or meat products, a detailed standard is in place. Such standards cover the following aspects:

Let's take the cereal products flour and bread as an example (bread was one of the first organic processed food) and follow the changes in the development of private business standards. Some private standard setting organizations had started relatively early to formulate specific requirements for the processing of bread made out of organically grown cereals.

Meier-Ploeger (Meier-Ploeger A., a.t. 1988) gave in 1988 an overview about organic processing standards. At the time the following private organizations had standards for the processing of cereal products in place or at the state of draft:

a) U.N.I.T.R.A.B. (F) – (Union Nationale Interproffesionelle des Transformateurs et Distributeurs de produits issus de l`Agriculture Biologique 1982)

b) Soil Association (GB) – (Soil Association 1988)

c) V S B L O (CH) – (VSBLO, 1988) (new BIO SUISSE, Basel)

d) VIDA SANA (S) – (VIDA SANA 1988)

e) Bioland (D) – (Bioland 1988)

f) Bayrische Vollkornbäcker (D) – (Verband der bayrischen Vollwertbäcker e.V. 1987)

g) Arbeitskreis „Gutes Brot“ (D) – (Arbeitskreis Gutes Brot 1988)

h) Demeter (D) – (Demeter Bund e.V. 1988)

These former standards gave already a detailed description of a number of relevant issues related to bread processing, which take into account the needs of bakers who wanted to maintain the wholefood quality. However only very few guidelines were given for the management of the quality under such standards.

If we compare the old standards from 1987 with a modern product group specific standard for the processing of organic cereals, we find substantial differences. Let's take the actual processing standards of BIO SUISSE (BIO SUISSE 2004) as an example. The new standard has a much broader scope than the old standards of "Arbeitskreis gutes Brot". The BIO SUISSE standard includes all cereal based foods like, bread, cakes, pasta and semi-processed half products like starch and starch syrup. In total comparison to the old standards the new one covers more aspects of quality management. For example it is clearly stated that each company handling and processing organic foods must be contracted by BIO SUISSE. BIO SUISSE runs a complete quality management system in which all operators are included. The old standards from 1987 comprised practically no quality system; the standard was contract-based but still voluntary, and was not followed by an inspection.

Aspects such as the origin of raw materials, recipes, processing methods, labelling, and packaging are chiefly identical in the old and new standards. But especially the restrictions concerning the allowed substances are much more precise today than in the old standards from 1987.

Details present in the old standard concerning working conditions, environment-friendly processing methods, nutrition styles or conditions of trade cannot be found in the modern one anymore.

Within 15 years the underlying principles for the processing of organic cereal products changed, as can be reflect by the shift in the issues dealt with in the standards. Relevant issues in the new standards are:

a. Based on organic agriculture

b. Minimization of additives

c. Based on traditional and biological methods of production (raising methods)

d. True labelling (transparency /Integrity)

e. Quality management systems

5.1.3 Status of product specific standards and directions for the development

Nowadays only very few organic standard setting and label organizations in Europe (France, Germany and Switzerland) have such product specific private standards in place (Schmid 2000). In the EU Regulation 2092/91 we do not find any indication for product group related specific standards. The IFOAM Basic standards mention no product specific approach in the processing area. It's interesting to see that organizations like the Soil Association, which had in former times, product group specific standards, have given up this concept or did not develop it further.

Beck (1998) gave an overview of the main differences between the EU Reg. 2092/91 and the existing product specific standards for the processing of organic foods on the private level.

Table 2: Main differences in the processing of organic foods: Comparison of EU Reg. 2092/91 and private business standards

Area	Characteristics of EU Regulation 2092/91	Characteristics of product specific private standards
Product group specific requirements for additives and processing aids	Only restrictions for some additives and processing aids	In general product-related standards, partly orientated on specific applications
Requirements for enzymes	General allowed with the exception of GMO	Only some enzymes allowed for specific applications in some product groups*
Requirements for starter cultures	Generally allowed with the exception of GMO	Only some starter cultures allowed for specific applications in some product groups*
Requirements for natural flavours	General allowed with the exception of GMO	Not allowed or only for some products*
Regulation/standards for animal products	Only partly in place not regulated in Annex VI	Standards developed in the same way as for plant products
Percentage of conventional ingredients	95 % of certified organic ingredients 70 % of organic ingredients are required with special labelling	95 % of certified organic ingredients are required, generally like 2092/91
Processing methods	No specific requirements	Positive description of required methods and/or negative lists of processing methods not allowed
Packaging systems and materials	No specific requirements	Positive list of packaging materials

Materials from GMO origin are excluded

For the further development of the regulatory framework for the organic food processing sector, four different main approaches were identified (see also chapter 2.1.3):

a) Suppress all technical restrictions like restrictions on additives or processing aids. This position considers that the label "organic products" is only a guarantee that raw materials are certified organic. The processor has solely to ensure that organic raw materials are used for the manufacturing of the products and that the ingredients are labelled in a correct way.

b) Continue the development so that it is consistent with the existing regulations. One should require at least a list of acceptable food processing additives and processing aids, which are not chemically synthesized and not of GMO origin. Such a list should preferably be restrictive, based on the concept of proven need and be acceptable for consumers and the other stakeholders.

c) Enlarge the scope of the given regulations on organic food processing. It should include for example materials for cleaning and disinfections, materials used for food processing, packaging materials, and requirements for careful processing.

d) Add completely new approaches in the regulatory frame such as social aspects, aspects of sustainable company management or fair trade issues.

5.1.5 Conclusions

It can be summarized that most standards require a certified quality management system in place to ensure the "true labelling" of organic foods. There are different approaches with regard to the quality profile of the products. In all regulations the labelling provisions of the ingredients are very important. Some organizations however have developed on private level much more detailed standards at the product group level.

The underlying concepts for processing of organic foods are not clear. Terms like "careful", "natural" or "minimum" processing are used but should be better defined. May be a term like "appropriate" could be more suitable for organic food processing.

Relevant questions to be discussed:

- *How relevant are the 4 concepts presented in this chapter?*
- *Are product specific standards a helpful and positive tool for the further development of processing standards?*
- *How to develop clear concepts of product profiles and clear criteria for the evaluation of technologies and for the regulation of additives and processing aids.*
- *Is it possible to successfully develop the market for organic products and still respect the concept of "naturalness" as it is given in EEC 207/93?*
- *How do the terms "minimum processing" and "careful processing" fit in a modern industrial food processing concept? And how are they adapted to the needs of the consumers in the organic food market?*

5. 2 Underling principles and actual problems for the processing of organic vegetable/fruit products

Marita Leskinen and Marjo Särkkä-Tirkkonen

5.2.1 Overview

Organic food processing standards forbid many of the processing aids or additives used in conventional food processing. The number of additives allowed in organic foods is about one tenth of the number allowed in conventional foods. As stated in the EU Regulation 2092/91 the great majority of the additives in organic foods are compounds found in nature, such as citric, malic and lactic acids, pectin, agar-agar and locust beam gum. The use of GMO in organic products or in their ingredients is forbidden. Yet changes in organic processing standards resulting in the prohibition of specific processing aids have created a need to find suitable alternative treatments.

The results of the consumer research carried out in Finland during 2002-2003 (Arvola & Lähteenmäki, 2003; Arvola et al. 2003) suggest that there are potential consumers for pre-processed organic food products. According to the data consumers are most willing to accept organic pre-processed products, which are perceived natural, healthy and contain no additives, but are more convenient to use than pure raw materials. Consumers also expect freshness, and accept shorter shelf life from organic foods, but are quite unwilling to accept lower quality in organic vegetables. The food service industry values vegetables that are fresh, readily available, that have been already peeled, and possibly sliced, grated or shredded. This, combined with the insight delivered by previous consumer studies lead us to believe that minimally processed vegetables would ideally come up to the expectations of both consumers and food services.

Minimally processed vegetables are perishable products. Among the most severe quality problems in minimally processed vegetables are enzymatic browning and the deterioration of microbiological quality. Especially minimally processed potato and iceberg lettuce are susceptible to enzymatic browning.

Typical processing methods for fruits and vegetables

Fermentation and drying are two of the oldest methods of preparation and preservation of foods known to mankind. Fermentation is the result of the growth of bacteria, yeasts, moulds, or a combination of these. The changes occurring during fermentation are caused by the enzymes elaborated by these micro organisms (Pederson 1979). Normally food industry uses starter cultures (lactic acid bacteria) to ensure good quality of fermented products. Fermented foods generally have a very good safety record.

Terms such as drying or dehydration are used to describe the unit operation in which nearly all the water normally present in a foodstuff is removed by evaporation or sublimation as a result of the application of heat. The main objective of dehydration is to prolong the shelf life of foods beyond that of the fresh material. This is achieved by reducing water activity (Brennan 1994). Different drying methods use heated air, microwaves, infra red and ultra violet radiation. Also vacuum is sometimes used in drying machines. The dried product should reach very quickly a level below the critical humidity level in order to avoid the loss of microbiological and sensory quality.

Freezing is a method of food preservation in which the food temperature is reduced to such a level that a large proportion of the water present in the food product is converted into ice. Freezing methods are: freezing by contact with a cooled solid surface, freezing by contact with a cooled gas (blast freezing),

freezing by contact with a cooled liquid (immersion freezing) and two-phase freezing (cryogenic freezing) (Brennan 1994).

Pasteurization is a heat treatment method used for killing vegetative bacteria but not bacterial spores. Most enzymes are inactivated. The duration and temperature differ from product to product.

Blanching is an important heat treatment used in the preparation of most vegetables and some fruits. Its main purpose is to inactivate enzymes or destroy enzyme substrates such as peroxides. If not inactivated, enzymes may cause discoloration, softening and undesirable flavour development during subsequent processing and storage of the dried product. Blanching involves the following operations: rapidly heating the food to a predetermined temperature, holding it at that temperature for a predetermined time, and rapidly cooling it (Brennan 1994).

Regulatory situation in different countries

The official EU-standards for vegetables and fruit products are common to all countries of the European Union. Private standards however differ in some sense from each other.

In accordance with the EU-directive 2092/91 enrichment with vitamins and minerals may be used if required by law (ex. baby food).

Effect of processing on the nutritional quality

Vegetables and fruits contain many different bioactive compounds which are good for human health. Yet, processing does alter the nutritional quality and bioactive compounds of food products. It changes the concentration of bioactive compounds, and affects their activity and their utilization in the human body.

It has been found that different vegetables react in different ways to blanching-freezing operations. In many cases there were no changes in fibre content, but vitamin C was destroyed to levels approximating 20-30%. The very sensitive folic acid was destroyed up to 50%. The content of carotenoids and some phenolic compounds might even increase during the process (Puupponen-Pimiä 2003).

5.2.2 Main challenges/problem areas

The following table gives an overview of some problem areas of which some are described more in details below.

Table 3: Key issues of processing of organic vegetables/fruits

	General issues of Organic Agriculture	Principles of naturalness/ authenticity	Environmental /sustainability principles	Appropriate technology, Social dimensions
Fruit and fruit products mainly apples, ev. olives)	- classification	Reconstitution of fruit juices Use of Sulphites during drying Filter and Clarification techniques Use of additives and processing aids (e.g. enzymes) Use of antioxidants Use of ion exchange Use of agents for ripening (Ethylene, NaOH) Use of enzymes Draying technologies and surface treatment Peeling technologies and agents Use of sugar for preservation	- Food miles (longer transport distances)	Traditional processing technologies Development of consistent technology ->org. starter cultures regional adopted small processing plants and technologies

Enzymatic browning and enzymatic processing

Enzymatic browning is due to the oxidation of the natural phenolic compounds in vegetables by the endogenic enzyme polyphenol oxidase. Consequently cut surfaces of fruits and vegetables turn brown.

Enzymatic browning of vegetables intended to be served as cooked is traditionally controlled by sulphating agents. These inhibit enzymatic browning by a variety of mechanisms, maybe the most important being complexation with quinones to form the colourless sulpho-quinone adducts (Walker & Ferrar 1995). These sulphating agents are not allowed in organic products. Moreover because of the several negative side-effects associated with sulphites there is a growing demand - also in the conventional industry - for alternative methods such as organic acids, modified atmosphere packaging, ozone, etc. (Laurila et al. 1998).

Prevention of enzymatic browning of vegetables intended to be served as raw, e.g. iceberg lettuce is difficult. Effective processing aids or additives do not exist. The use of citric acid is permitted in organic production, but results of the VTT (VTT Technical Research Centre of Finland) showed that citric acid causes the deterioration of sensory qualities of the iceberg lettuce. Enzymatic browning can also be minimized by the use of optimal packaging material and modified atmosphere packaging, and by maintaining low storage temperature during the whole chain.

There is a need for natural non-toxic browning inhibitors, both in the organic and the conventional processing branch. A possible solution could be the use of bioactive plant compounds. Vegetables, and especially their side streams (that include peels, etc.), are rich in flavonoids, other polyphenolics and vitamin C, compounds having an antioxidant activity. Bioactive compounds are often present in the epidermal tissues. These compounds can be liberated from the cell wall matrix by using e.g. enzymatic disruption of cell walls and subsequent extraction. (Landbo & Meyer 2001a; Landbo & Meyer 2001b). For

this purpose potential enzymes are hydrolytic ones, such as cellulases, hemicellulases and pectinases. Preliminary experiments at the VTT in a project studying the enzymatic peeling of vegetables (carried out from 2001 until 2003) showed that hydrolytic enzymes can increase the amount of phenolic compounds. More over onion peels have been found to prevent enzymatic browning of potato to some extent. Onion peels are rich in flavonoids, especially quersetin.

In juice production enzymes are used to speed up the decomposition of pectin.

By using enzyme treatment methods one can achieve 20 -50 % better yields than without the treatment. If the juice is then pasteurized, the enzyme will be destroyed and it doesn't need to be notified in the package label. The type and amount of the enzyme used vary according to the berry or the vegetable (Leskinen et al. 2004).

Microbiological safety

Effective washing and decontamination of ready-to-eat vegetables is difficult. There is increasing concern regarding the microbiological safety of such products and the effectiveness of current methods. The most commonly used disinfectant for fresh cut vegetables is chlorine, of which the most effective form is hypochlorous acid (HOCl). In several European countries including the Netherlands and Germany the use of chlorine for ready-to-eat vegetables has been banned. In organic vegetable products the use of chlorine is banned as well. Some companies use only potable water, especially in countries where chlorine is not permitted as a wash water additive. Only a few companies use organic acids or commercial chlorine-free disinfectants.

Besides their antioxidative properties, phenolic compounds have been shown to have antimicrobial activities (Puupponen-Pimiä et al. 2001). Yet, there is a need both in the organic and the conventional production of ready-to-eat vegetables for natural antimicrobial agents. Practically it could be shown that sulphite could be replaced by a mixture of organic acids, providing that the product is packed in oxygen-free conditions immediately after dipping. Oxygen-free package is possible with peeled potato but not with for example iceberg lettuce.

Novel technologies such as the use of ozone

Ozone is a relatively unstable and very reactive compound, formed by the action of electricity on oxygen. Ozone is approved as a sanitizer when in contact with food and food equipment because it is effective against many microbes and leaves no residues after it reacts and decomposes. Ozone has begun to replace chlorine in treating drinking water, processing water for reuse, and wastewater (after treatment) before discharge. Most of the bottled water is treated with ozone, because it is effective while not affecting the taste.

Some studies have shown that high concentrations of gaseous ozone, when applied already as the potatoes are conveyed to storage, can reduce the incidence of the pathogens. Also it has been demonstrated that the use of bubbling ozone can be substituted to heat pasteurization in the processing of apple juice (Clark 2004). Ozone is not mentioned in any organic processing standards in Europe. It may solve some microbiological problems, but because it is not commonly used in conventional food processing, it is important to have a consumer's opinion. Such a substance have to be evaluated against relevant criteria for organic food processing as outlined in IFOAM Basic Standards (IFOAM 2002) and Codex Alimentarius Guidelines for organically produced food (Codex Alimentarius 2003).

Ion exchange

Ion exchange is a reversible chemical reaction wherein an ion (an atom or molecule that has lost or gained an electron and thus acquired an electrical charge) in a solution is exchanged with a similarly charged ion attached to an immobile solid particle. These solid ion exchange particles are either naturally occurring inorganic zeolites or synthetically produced organic resins. Synthetic organic resins are the predominant type used today because their characteristics can be tailored to specific applications (Remco Engineering 2004). Using ion exchange, it is possible to take away sulphate, chloride and nitrate ions and heavy metals. It is possible to recycle the rinse water without chemicals. Ion exchange is not effective for microbes. There have been requests to allow this method in organic food processing for specific cases were no better alternatives exist.

Modified atmosphere packaging

In the case of modified atmosphere (MA) packaging, the gaseous environment in the immediate vicinity of the product is altered in such a way that the packaged product can continue with its normal gas exchanges, while the package material allows further exchanges between the immediate environment of the product and the exterior. Most fresh food products under MA packaging technology are naturally respiring or contain micro-organisms which respire. Respiration consumes the oxygen present in the air and produces carbon dioxide and water vapour, sources of environmental alteration. The packaging material itself is permeable to oxygen, carbon dioxide and water vapour, thus causing further changes in the gaseous environment surrounding the product. Because the product and the packaging material react dynamically, the gaseous environment is modified from its initial condition.

As for the other packaging or storage method under controlled atmosphere (CA), a constant atmosphere is maintained regardless of the product respiration (Brody 1989). This method is generally also used for organic food.

CA/MA mechanisms can effectively retard the reproduction of micro organisms on plant tissue. The greater the concentration of carbon dioxide is, the lower the microbiological respiratory and reproduction rates. At concentrations of carbon dioxide above 25 %, the maximum inhibitory effect on microbiological growth rate is obtained. Alone, oxygen level must be reduced to levels well below 5 % to achieve a measurable effect (Brody 1989). In fresh vegetable and fruit products the concentration of carbon dioxide should be 1-20 %. If it is higher the taste of the product will change. Modified atmosphere packaging could thus not alone guarantee microbiological safety, but it helps maintaining the freshness of the products over longer time.

Biodegradable plastic materials

Biodegradable plastic materials have been studied during the last few years. They are environmental friendly materials, because micro-organisms can decompose the plastic refuse within the composting process and leave only natural residues like water, carbon dioxide and biomass behind (BASF 2004). However there are some technical difficulties for a larger use of biodegradable plastic materials in food industry. They are also more expensive than synthetic materials. Still in the future, the use of biodegradable plastic materials will increase and will create many new possibilities for conventional and organic food packaging.

Ripening agents

It is common that many conventional fruits, including bananas, tomatoes and avocados, are harvested before ripe and then ripened prior to shipment. The most commonly used ripening agent is ethylene,

which is a naturally occurring plant hormone. It is one of the simplest compounds affecting physiological processes in plants. Effects can be initiated at internal concentrations of 0.1 to 1.0 ppm (parts per million) (Catalytic Generators 2004). Other ripening agents are for instance ethrel and calcium carbide. Currently the use of ethylene is allowed for organic bananas and there is a discussion whether ethylene should also be allowed for other fruits.

5.2.3 Conclusions

Inhibition of the browning reactions in fresh and dried products is challenging, because sulphite compounds are not allowed in organic processing. Organic acids and enzymes may solve some problems, but they are not as effective as the sulphite compounds. In addition organic acids might be problematic at the organoleptic level, reason why they aren't used at a larger scale at the moment. The use of ozone might be an option, which will be studied in the QLIF Project at a later stage.

Applicable enzymes can inhibit browning reactions and enzymes have an important role in the processing of fruits and berries. They can also be used in peeling processes. The fundamental problem here is whether we can guarantee that the enzymes used are free of genetically modified organisms.

The microbiological quality of organic fresh ready-to-eat salads should be as good as of corresponding conventional products. Chlorine compounds are commonly used, but they are not allowed for the processing of organic products, so that other methods should be found. Organic acids, ozone treatment and other sanitizing agents should be studied for this purpose.

Relevant questions to be discussed:

- Use of enzymes in processing of vegetables/fruits (degree, new possibilities, free of GMO)
- Acceptance of novel technologies (high-pressure treatments, ozone, ripening agents)
- Acceptance of hygienic treatments (organic acids, ozone treatment, UV-treatment)
- Use of flavours
- Use of functional compounds in vegetable and fruit products

5.3 Underling principles and actual problems in the processing of organic cereal products

Alexander Beck

5.3.1 Overview

The processing of cereal based organic products is regulated since 1993 by the EU Regulation 2092/91. Especially Article 5 and Appendix III and VI are relevant in this matter. However this standard addresses no specific requirements for organic cereal processing; but rather draws up general requirements for plant products.

Bread was one of the first processed organic foods. Some private standard setting organizations started already relatively early to formulate specific requirements for the processing of bread made out of organically grown cereals.

Meier-Ploeger A. (1998) gave in a literature survey an overview of organic processing standards. If we compare these old standards from 1987 with a modern product group specific standard for the processing of organic cereals, we find substantial differences. Let's take the actual processing standards of BIO SUISSE (BIO SUISSE 2004) as an example. The BIO SUISSE standard includes all cereal based foods such as bread, cakes, pasta and semi-processed half-products like starch and starch syrup. It includes aspects of the quality management as well. BIO SUISSE runs a complete quality management system in which all operators are included. The old standards from 1987 comprised practically no quality system; these standards were contract-based but still voluntary, and were not followed always by an inspection. Aspects such as the origin of raw materials, recipes, processing methods, labelling, and packaging are however similar in the old and new standards. But especially the restrictions concerning the allowed substances are much more precise today than in the old standards from 1987.

The underlying principles for modern organic food standards for the processing of cereals are:

a) Based on organic agriculture

b) Minimization of additives

c) Based on traditional and biological methods of production (raising methods)

d) True labelling (transparency /integrity)

e) Quality management systems

f) Clarification of detailed inspection requirements

5.3.2 Main challenges/problem areas

The issue of food safety is for cereal-based products not so important. The level of processing in this product group is relatively high which means that microbiological problems in particular are eliminated for most products thanks to processing technologies. But on the other hand there is a danger of over-processing, which could be in contradiction with the aims of the organic food production.

The following problem areas were identified (see table 4):

Table 4: Key issues of processing of organic cereals

	General issues of Organic Agriculture	Principles of naturalness/ authenticity	Environmental /sustainability principles	Appropriate technology, Social dimensions
For all product groups	Transparency during the whole process Separation between conventional and org.	transparency and truth full labelling	Environment management systems in firms	Fair prices
Cereals (wheat) products (Bread, breakfast cereals, starch and syrup, noodles)	- coexistence of org. and GMO crops	Use of additives in industrial processing Use of enzymes Production security Hydro-thermical processing methods Use of functional compounds or semi Convenience products Ion exchange technologies Over processing of bakery products Preservation of bread, cakes and noodle (convenience) Use of salt (salt quality)	- Food miles (longer transport distances)	Traditional processing technologies - Development of consistent technology ->org. starter cultures - regional adopted small processing plants and technologies

In the next chapters some examples of the above mentioned problems are described.

Coexistence of organic and GMO crops

One of the most important challenges is how the organic food sector can ensure the exclusion of GMOs or minimization of the contamination of its products. As we know and as demonstrated in several tests (Wenk et al. 2001) if we work in parallel production lines (conventional and organic) there is a risk of contamination especially with GMO crops. A number of problems are raised through the import of GMO in Europe. If GMO crops like corn, barley or rape are planted in Europe, the problems of contamination will increase tremendously (Bock et al. 2002). Therefore new separation technologies, such as management tools and better technical skills, have to be developed to prevent from or minimize the risk of contamination.

Use of additives and technologies like ion exchange technologies in industrial processing of organic cereals

During the last years a tremendous differentiation of organic products based on cereals has taken place. Today nearly all the conventional foods and intermediates present on the market are available in the organic food product range as well. As a result, there is a growing demand from the side of the industries to introduce new additives and to use new technologies for the processing of organic foods. The glucose industry for example is using ion exchange technologies for the production of organic starch syrups. The reason of it is that their costumers ask for an organic starch syrup having exactly the same purification level as the conventional glucose syrup they are used to. (Beck 2000). Different companies and certifiers

demand such technologies be considered as in compliance with the aims of the organic food sector. Yet in a context of increasing demand for organic starch, the industry takes the opportunity to extend their product lines and improve their general environmental impact by introducing organic products. (Kröner 2002).

Use of half-finished products

A similar situation can be found when looking at the sector of intermediate products for bakeries. Bakeries are facing a growing demand for organic products that are exactly comparable with the conventional ones. Yet organically produced raw materials are different, e.g. the protein content of organic compared to conventional wheat is lower, so that the "conventional" specifications cannot always be fulfilled (Cavan 2003).

Therefore more and more half-finished products are used in "organic" bakeries. The EU Regulation 2092/91 allows most the additives and processing aids normally used in preparations for dough making. Today there is broad range of products in the market: from preparations for dough making to frozen organic peaces. The whole range of convenience products for bakeries is now available in the organic food quality. This development leads to a need for different additives and processing aids. The reasons are: prolonging shelf-live, improving the baking profile, enhancing humidity, protecting products from retro-gradation and improving taste and colour.

The described development should be considered in contradiction with the aim of minimizing the use of additives in organic food. And it can also be seen as contradictory to the aims of freshness and knowledge based traditional bread production.

The use of organic half-finished products having technological functionalities might be broadly accepted, when certified organically produced technological ingredients like malted barley, oil or acerola cherry powders (as substitutes for ascorbic acid) are seen as tools for modern and intelligent recipes.

Extrusion techniques

Regarding cereal based foods for breakfast preparations; there is an ongoing discussion about the use of extrusion technologies in organic cereal based foods. The treatment of cereals with high pressure especially is discussed intensively and partly seen as an over-processing. Such treatments especially, in combination with the application of high temperatures and pressure (depending from the type extrusion technique) lead to completely new types of products. Extrusion results in a new type of destruction and the re-formation of starches and proteins in the cereal products. These typical changes caused by the extrusion process and the applied pressure and temperature are subject to discussion among companies and certifiers (BIO SUISSE 2004). Such techniques are strongly restricted under private standards for organic food processing (Demeter 2003).

Use of enzymes

Enzymes especially are important aids for different purposes in the processing of cereals (Klinger 1995), (Ludewig 2003). Enzymes are substances that don't have to be declared on labels. Most of the standards allow the use of enzymes with the exception of enzymes produced by GM organisms. Consequently a growing number of isolated functional substances are used in organic bakery products without the consumers being informed. One could consider this to be in contradiction with the aims of "naturalness" and "transparency" (Beck 1999), which are laid down in different national and private standards (IFOAM

2002) (EU Reg. 2092/91) (EU Reg. 207/93). Different organizations have therefore been asking for much more differentiated requirements and limits to the use of enzymes in the organic food processing (Beck. 1999). Under product group specific private standards for organic food, the number and type of enzymes allowed for each application is limited (BIO SUISSE 2004).

Use of functional compounds

It is very modern to use functional compounds in all types of cereal based products. For example the fortification of cereal based products with dietary fibres is a major issue for the reduction of heart disease risks (Kahlon 2003). There is an ongoing discussion whether the underlying health concepts of such products are in compliance with organic foods. However nowadays most of the certifiers accept these fortification substances, like dietary fibres or vitamins of natural origin as ingredients, if they are from certified organic origin.

Whether organic food should be fortified with isolated conventional vitamins or amino acids is debated as well. The EU Regulation 2092/91 is very clear about it and accepts such a fortification only if it is legally required.

Cereal products have originally a high content of dietary fibres and the organic movement struggled for a long time in order to introduce some whole cereal products on the market. It is thus rather astonishing today to find organic cereal products produced out of white flour and fortified with dietary fibres.

Nevertheless there is a contradiction between the underlying concept of organic food production and related understanding of human nutrition and the fortification of foods with nutrients for health purposes.

Development of consistent modern technology

An interesting synergy between new and old traditional technologies can be found in the organic cereal industry. On the one hand cereal processing is strongly based on old food technologies, e.g. the production of bread without additives, and on the basis of biological dough preparation techniques. On the other hand, modern ovens and energy supply systems, technologies for dough making and portion equipment and new "organic" starter cultures are utilized as well (Beck 2003); (Beck 1998).

There is a need for further development of technologies adapted for the processing of organically produced raw materials. It could be demonstrated for example that the problem of nitrogen deficit in organic wheat (Biernoth, Keill, Steinhart 1993) could be solved in the bakeries by using technologies which are adapted to the specific characteristics of certified organic raw materials. New technologies were also developed and established in processing units for other purposes like the hydrothermal treatment of cereals.

However the organic food industry tends to copy all typical products of the conventional food market. As a result there is a steadily growing demand among them for being allowed to use all types of conventional technologies, additives and processing aids. Clearly if the organic food industry is to provide for the same product profiles as the conventional cereal branch and on a more comparable price level, they will have to use the same cost-saving technologies and additives as actually utilized in the conventional branch. Therefore we need to develop clearer quality profiles for organic foods and clear criteria for the evaluation of new technologies as well as for the regulation of additives and processing aids.

Small regional processing plants and technologies

Regionality is a very important concept especially in the context of organic cereal processing. For the basic products like flour, flakes, breads and pasta small-scale processing technologies are available. Because of a good storage ability and the fact that cereals can grow nearly everywhere in Europe, the development of regional organic cereal products, that is produced, processed and supplied regionally, is feasible ; and this development is strongly desirable. A lot of processors are working in close cooperation with farmers from their regions and using this relationship as an important tool for their consumer related communication. Some cereal processors add information about the farm on which the cereals were grown on the packaging of their products in order to create a direct link from the consumers to the farmers (www.erdmannhauser.de, 2004). A number of creative regional concepts are carried out by the organic cereal industry. Furthermore and thanks to the availability of small-scale processing facilities, a growing number of farmers produce their own bread and pasta for the direct supply of their costumers. New supply systems such as subscriptions or box schemes strongly support the development of regional cereal based products.

However the international market for organic cereals is growing fast. Certified organic cereals are shipped around the world just like conventional ones. This is in direct contradiction to a regional approach. Organic agriculture can only benefit the environment where it takes place (Gerber 2004). The concept of "good for the soil, good for animals, good for the environment, and good for humans" can in a mid- and long-term perspective only be implemented within a more regionalized market.

5.3.3 Conclusions

Organic cereal processing is based on the EU regulation 2092/91. An additional product specific standardization of the processing of organic cereal based food is a not widely shared approach. Most of the private standards do not have product specific requirements at all. The few standards which developed requirements for cereal based foods are dealing with the following principles:

a) Raw materials from certified organic origin

b) Requirements and recommendations for storage

c) Minimization of the use of additives and processing aids

d) Use of whole flour products are recommended

e) Biological and traditional processing methods are preferred

f) Processing methods are selectively restricted (for example extrusion)

g) Ecological and adapted pest management systems, cleaning regimes and packaging materials are enforced.

There are a number of important questions, which are actually discussed in relation to organic cereal products. These questions are addressing aspects of the evaluation of additives and technologies as well as the definition of underlying principles for the processing of cereal based foods in relation to nutrition styles, understanding of health, meaning of traditional processes or handicraft, as well as to the concept of regionality. New developments, e.g. organic starter cultures, demonstrate the possibilities for innovations adapted to the needs of the organic food sector.

Relevant questions to be discussed:

- *How can the coexistence with GMO crops be achieved in mixed operations at the storage and processing level?*
- *How to combine the need of the cereal-processing sector for half-finished products with the aim of freshness and traditional technologies?*
- *Is there a need to separately evaluate enzymes for organic cereal production?*
- *What does "transparency" mean for cereal products in relation to enzymes and to other intermediate products during the processing? How can transparency be ensured?*
- *How to combine the concepts of functional food and organic food in a clear and understandable way?*
- *What do the concepts of regionality and handicraft processing mean to the organic cereal sector?*
- *Should the use of ion exchange and adsorbents resins be allowed for the processing of organic cereal products?*
- *Should the use of extrusion technologies (having a strong impact because of the high pressure and heat applied to the raw material) be allowed?*

5.4 Underlying principles and actual problems for the processing of organic milk products

Marita Leskinen and Marjo Särkkä-Tirkkonen

5.3.1 Overview

Milk is a highly perishable food material and one must therefore have a good knowledge and understanding of the techniques used and of the complexity of microbial interactions. Some typical characteristics of the dairy industry are as follows (Walstra et al. 1999):

a) Milk as raw material is liquid and homogenous -> transport and storage are relatively simple and greatly facilitates the application of continuous processes.

b) Milk properties vary according the source, season and storage conditions and the processes have to be adapted to these variations, such as the fluctuation of fat content.

c) Milk is highly perishable and the same holds true for many intermediates between raw milk and final product. This requires strict control of hygiene and storage conditions.

d) Raw milk may contain pathogenic bacteria like *Listeria monocytogenes* or *Campylobacter* and this requires strict control of hygiene and stabilization processes.

e) The processing capacity of a dairy can often not be fully used during most of the year. This is because raw milk generally is delivered to the dairy throughout the year, but in varying quantities. Yet milk must be processed within at most a few days. Storage of raw milk cannot exceed 72 h, storage of thermized milk, 300'000 CFU.

f) Milk contains several components and it can be separated into fractions in various ways; moreover several physical transformations and fermentations can be applied.

g) Besides the milk, fairly small amounts of raw material are needed for the manufacture of most milk products, but the consumption of water and energy may be high.

h) One and the same unit operation often can be applied in the manufacture of a range of products.

All together the relative amount of the initial raw material itself is very high in industrial milk processing compared to any other industrial food processing. The quality and composition of the raw material (milk) thus determines greatly the quality of the end product.

Typical processing methods

The general unit operations applied in milk processing are:

Transfer of momentum:

- pumping, flow

Heat transfer:

- heating and cooling

Mixing

- stirring, atomization, homogenization, recombination

Phase separation:

- skimming, separating milk powder from drying air, part of the churning process

Molecular separation:

- evaporation, drying, membrane processes, crystallization (of water, lactose, milk fat)

Physical transformation:

- gel formation (as due to renneting or acidification of milk), butter making, making of ice cream, etc.

Microbial and enzymatic transformation:

- production of fermented products, cheese ripening

Stabilization:

- pasteurization, sterilization, cooling, freezing

- most stabilization processes are aimed at ensuring food safety

In the dairy industry, milk is commonly heated for a wide variety of purposes. The result greatly depends on the intensity of the treatment: combination of the temperature and duration of the heating. Heating causes changes, some of which are irreversible and others reversible. Examples are renneting of cheese milk, growth of starter organisms, and efficiency of water evaporation or centrifugal separation. Heat treatment may also cause undesirable changes like browning, cooked flavour, loss of nutritional quality, inactivation of bacterial inhibitors and impairment of rennetability (Walstra et al. 1999).

Regulatory situation in different countries

At the moment the EU regulation2092/91 doesn't commit on the organic milk processing methods to be used. Basic processes such as homogenization, pasteurization and sterilization are thus allowed without any restriction, which leads to inconsistent practices in Europe. For example in Finland the established practice is to neither homogenize nor sterilize organic milk products. In other countries both processes are allowed for organic milk.

In Finland and Sweden (KRAV) the enrichment with vitamins and minerals may be used if required by law (e.g. baby food). Further more Sweden (where KRAV is the main certifier) has approved the addition of Vitamin D in the specific case of fat free milk, whereas in Finland and in Switzerland it is not allowed to add vitamin D in organic milk. Also the UK Soil Association prohibits the addition of minerals or vitamins in liquid milk but this standard is under review at the moment.

Only few additives are allowed in organic milk products. For example the use of nitrate and copper is totally banned. The demand of consumers for organic low-fat and fat free milk products poses a problem. Problematic are also the modification of the milk structure and stabilizing processes. For example in Finland and in Switzerland it is not allowed to use chemically modified starches in organic milk products.

5.3.2. Main challenges/problem areas

Table 5 gives an overview of some problem areas of which some are described more in details below.

Table 5: Key issues of processing of organic milk

	General issues of Organic Agriculture	Principles of naturalness/ authenticity	Environmental /sustainability principles	Appropriate technology, Social dimensions
Milk products	Way of distribution of the milk Collection systems	Use of additives (e.g. thickener, colorants, etc.) Use of functional compounds (e.g. yoghurts with LCD) Supplementation and preparation of baby food (Vitamins) Sensorial quality (esp. cheese and yoghurts) Separation/isolation processing techniques Intensity of processing technology (heat, pressure, temperature) Maintenance of consistency for yoghurts Use of starter cultures which produce preservatives Surface treatments (use of colours or preservatives) Reduction of cheese quality problems in industrial processing (e.g. use of specific additives like Lysozym) Transparency of food labelling (Processing methods) Use of sugar	- Food miles (longer transport distances)	Traditional processing technologies Development of consistent technology ->org. starter cultures regional adopted small processing plants and technologies Processing of goats and cheeps milk Concept of freshness

Use of additives and processing aids

Consumer studies show that an increasing number of consumers prefer minimally processed foods, prepared without chemical preservatives (see chapter 3). Natural compounds, such as essential oils, chitosan, nisin or lysozyme, are investigated to evaluate their potential for the replacement of chemical preservatives, so as to obtain products with the "green label". Their application is mainly hampered due the interaction of the natural compounds with food ingredients, and due to their effect on the organoleptic properties of the foods they are introduced in. (Devlieghere et al. 2004). Another approach could be the total replacement and suppression of additives by applying appropriate process technologies and using functional ingredients.

Biopreservation techniques of milk products

Biopreservation of milk products extends storage life, and/or enhances the safety of food products through the action of natural or controlled microflora, mainly lactic acid bacteria and/or their antibacterial products, such as lactic acid, bacteriocins and others (Hugas 1998). Antagonistic cultures that are only added to inhibit pathogens and/or prolong the shelf life, while changing the sensory

properties of the food as little as possible, are termed protective cultures. The use of lactic acid bacteria as a protective culture shows to be very promising. For example the addition of a protective starter culture like Lactobacillus or Lactococcus strains to cheese was demonstrated to have positive effects on the microbiological safety of the product (Luukkonen 2002).

The following aspects have to be considered when using the new preservation techniques in organic milk processing. Indeed natural antimicrobial compounds like lactoperoxidase, lysozyme, saponins, flavonoids and chitosan have also some disadvantages:

a) are often expensive,
b) interact with food ingredients,
c) have a low water solubility,
d) change organoleptic properties,
e) are bacteriocins, like lactic acid bacteria,
f) have narrow activity spectrum,
g) have spontaneous loss of bacteriocinogenicity,
h) can be inactivated through proteolytic enzymes,
i) are competing with bacteriocin resistant bacteria.
j) their diffusion in solid matrixes is limited,
k) there aren't many GMO free enzymes available,

Protective cultures like lactic acid bacteria:

a) are sometimes difficult to apply,
b) remain heat unstable,
c) their effectiveness is not always proven in food products.

Use of starter cultures

The most important starter cultures in the processing of milk are lactic acid bacteria (LAB). Usually used as direct starter concentrates, they are produced on a very complex synthetic matrix and protected by different cryoprotective substances. The presence of LAB in organic dairy products is a very sensitive area: eating living micro-organisms is related to specific emotions on the consumer's side. Organic LAB should be grown on natural media such as milk (rather high rate of carry over), should not contain cryoprotective agents and must be GMO free. A new trend towards the validation of geographical origin of starter cultures was observed. Some specific starter cultures that are compatible with organic food standards requirements have been developed recently by the Swiss Milk Research Station (ALP 2004).

5.3.3 Conclusions

The challenges imposed by the tendency to go towards longer shelf life and better food safety of products should not be achieved at the expense of e.g. their freshness. Concerning the microbiological quality and safety of dairy products, zero risk is not a reality and this fact should also be accepted by consumers. It would be necessary to provide consumers with a more accurate perception of food safety risks and to

encourage behaviour modification where needed (like right storage temperatures). In addition to the minimal processing techniques which aim at maintaining the nutritional and vital quality of the product , some novel or combination techniques and treatments could be considered (high temperature pasteurization, high pressure treatment, micro filtration etc.).

Enzymes could offer many interesting applications in organic dairy industry if GMO –free enzymes were available. Organic dairy products and functional foods are also an interesting combination, because the best known functional foods at the moment are milk products fortified with probiotic bacteria. Moreover the CLA-content of organic milk seems to be naturally higher. So could there be "naturally" functional food products?

Possible structure of a regulatory system for organic milk:

The following structure for a specific organic milk standard is recommended:

a) milking and storage
b) collection / transportation
c) separation of organic milk in the plant
d) allowed processes
e) minimal processing
f) starter cultures
g) probiotics
h) enzymes
i) by-products
j) cleaning / hygiene

Relevant questions to be discussed:

- *About the bioactive compounds in milk: is there a need for the organic food sector to copy the products of the conventional industry?*
- *About CLA enrichment and consumer acceptance according to the sensory quality: is there a need for flavours in milk products?*
- *Shall the organic food industry rather use natural compounds or rather totally give up the use of additives by applying appropriate processing technologies?*
- *About the acceptable processing techniques: could some novel processing techniques be considered?*

5.5 Underlying principles and actual problems for the processing of organic meat products

Thorkild Nielsen

5.4.1. Overview

The EU-Regulation 2091/92 does not yet address meat products. The standards for organic agriculture will be completed by establishing the list of permitted additives and processing techniques for processed animal products and improving the standards relating to animal welfare before the end of 2004. Nowadays the processing of animal products is regulated by a wide range of different national standards and regulations. Some countries have very strict regulations on additives for organic meat products. In this chapter we will give a short presentation of the main principles of organic meat processing.

5.4.2 Problem areas

Table 6 gives an overview of some problem areas of which some are described more in details below.

Table 6: Key issues of processing of organic meat

	General issues of Organic Agriculture	**Principles of naturalness/ authenticity**	**Environmental /sustainability principles**	**Appropriate technology, Social dimensions**
Meat products (mainly pork)	- Transport of animals (animal ethology) - Animal welfare - ethical questions	Use of additives (nitrates, nitrites with ascorbates) – safety and/or visual quality issue Exploitation of the whole animal Use of salt (salt quality)	- Food miles (longer transport distances)	Development of consistent technology ->org. starter cultures - regional adopted processing plants and technologies

Animal welfare, slaughtering and meat quality

Most of the literature dealing with animal welfare focuses on the primary production. Nevertheless, several ethological audits documenting pig welfare during collection at the farm, transport and within the slaughter-house suggest such issues should be integrated in the EU standards (Gade, P.B. 2002). Transportation, storage, use of anaesthesia and antibiotics can cause stress, and stress before slaughtering may cause undesirable effects on the end quality of meat such as pale, soft, exudative (PSE) meat and dark firm dry (DFD) meat (Russel 2003). One publication deals with the concept of farm-based food processing using home-produced raw materials (Kuhnert & Wirthgen 1996). This is one way to minimize the transportation from farm to slaughter-house, to gain quality improvement of the meat and to achieve higher animal welfare.

Use of additives (e.g. sodium nitrite and sodium nitrate)

Special emphasis is given to the nitrate discussion, and especially to the discussion of the ability of nitrate to preserve and to colour meat. When nitrite oxide binds to meat proteins it constitutes a reservoir of relatively stable radicals, which seem to protect the product during storage by acting as antioxidants, a protection that is important for the oxidative stability and general quality of such meat products. In the absence of antioxidants, oxidation and rancidity becomes a problem for meat during heat-treatment and storage. However, nitrite has been identified as being potentially carcinogenic (Tricker, AR & Preussmann 1991). Consequently it is important to develop alternatives to the nitrite-curing of meat. (Russell 2003)

Normally processed organic meat products are grey because no nitrite is added and are expected to be more vulnerable to oxidation and rancidity. Notably, lipid oxidation products can be a problem because they are potentially toxic especially on long-term intake.

Colours are one of the most important factors when consumers evaluate the quality of meat and choose between different meat products in retail trade. Additionally the pigment behind the red colour protects the meat against rancidity resulting in more stable products. These two aspects are obviously of considerable importance for the profitability of organic meat production. Accordingly, there is a great interest in finding natural methods to make organic meat products "red". (Albert; Gareis; Kroeckel 2003; Luecke 2003 and others).

Several publications focus specifically on the risks of contamination of organic meat by *Clostridium botulinum*, *Salmonella*, staphylococci etc. (Albert; Gareis; Kroeckel, 2003; Mueller, Moll and Hildebrandt 1994).

Among the more promising alternative preservative methods are the use of *Lactobacillus* cultures to reduce the pH of the product to a safe level (Christiansen 1975), atocopherol in conjunction with ascorbate and low levels of nitrite (Ranieri 1979), sorbic acid or sorbate with and without low levels of nitrite, or the use of sulphur dioxide (Tompkin 1980) as well as irradiation (Slater 1977). Other, more traditional methods such as wood-smoking and salt-only curing have also been suggested: (Soil Association 2004).

Consumer attitudes towards organic meat

The quality of the organic meat is discussed in several publications. In two publications from 1994 about the organic meat production in Germany and Denmark the sensory quality was considered to be unsatisfactory (Mueller, Moll and Hildebrandt 1994 and Lustrup and Kaare 1994).

In the German case study, assessment of sensory, composition and microbiological quality of 100 retail samples of organic raw sausage was conducted. Sensory quality was generally unsatisfactory; this varied between manufacturers (all samples from approx. 1/3 of manufacturers showed signs of spoilage). The high susceptibility to spoilage can be explained by the relatively high *aw* (water activity) and pH of the sausages. The microflora was mostly dominated by typical lactobacilli; many samples contained high counts of Enterobacteriaceae and *Pseudomonas* spp. No samples contained *Escherichia coli*, *Bacillus cereus*, or Salmonellae. It is concluded that the samples studied were generally not of acceptable quality. The problems are mainly due to incorrect processing methods for this type of product (Mueller, Moll and Hildebrandt 1994).

In the Danish report the focus was set on the fat content of the organic sausages, salt as an alternative to nitrite, process management and smoking. The report was intended to be used as a guide for producers of organic sausages. (Lustrup 1994)

5.4.3 Conclusions

Standard setting often involves a balance between maintaining the purity and integrity of the organic system and ensuring that certain quality demands are met. Especially for meat this dilemma has been clearly recognized.

Currently the most urgent challenge for the organic meat sector is to offer products with a high microbiological quality and safety without using critical additives like colouring agents or nitrite.

The search for alternatives and alternative approaches to the use of nitrite in processed meat should be continued. Furthermore the discussion about security should be connected to entire life cycles of the products, including for instance appropriate storage temperatures and cooling requirements in retail shops.

Relevant questions to be discussed:

- *How do consumer accept the use of additives in organic meat?*
- *Is the colouring of the sausages a necessity in order to sell the products?*
- *What is the consequence of shortening the shelf life of the organic products?*
- *How important is it to "duplicate" the conventional assortment for the organic products?*
- *Are short transportation of living animals (farm-slaughtering) an important sales argument?*

6 Applications and examples from the organic food processing industry

Alexander Beck

6.1 Overview

The organic food market is not only one of the fast growing markets in the food sector, but also one of the most innovative. An impressive number of new raw materials, technologies and new products have been introduced during the last 20 years in the organic food sector. This innovative sector also gave substantial impulses to the conventional food sector in Europe.

A number of companies have over 40 years experience with organic food processing. The very first start of these activities is estimated to have taken place approximately 80 years ago. For example the Japanese thinker George Ohsawa and the Gevaert family founded the firm "Lima" in St. Martens Latem, Belgium, in 1957. Ohsawa considered a balanced nutrition to be one of humans' fundamental needs, and placed a high importance on it. He developed a "nutrition school/school", macrobiotics, which was able to fulfil those needs. Lima therefore concentrated its activities on the cultivation and preparation of organic food (www.limafood.com).

Interestingly already in the seventies, a number of companies in different European countries were founded for the purpose of processing organic food. Many of these pioneer companies were successful and are nowadays medium size actors of the market. On the other hand a growing number of middle size companies from the conventional food sector are nowadays producing organic products. In Germany 3414 companies were processors of organic foods in December 2003 (Bundesanstalt Landwirtschaft und Ernährung, BLE 2004).

6.2. Award for innovative organic food processors

For the purpose of this literature review it is interesting to have a look at practical applications at the company level.

In the year 2003 the German Ministry of Consumer Affairs and agriculture granted an award for „organic food processing" for the first time (Gottwald 2004).

The "award" was conceived so as to cope with the holistic concept of organic food. This new award thus focused on 5 dimensions, which should reflect the most important issues for companies working in the organic food sector.

1. Technology and methods

Processing methods, recipes and technologies, which aim at protecting or improving the product quality or which are adapted to the needs of organic products in particular.

2. Raw materials and primary production

Activities which help organic agriculture to introduce main raw materials successfully in the market. Or cooperation between farmers and processors which results in new, profitable and useful organic agriculture methods, raw materials and foods.

3. Marketing

Companies which successfully introduced high quality food, through creative product designs and advertising programs. And companies which worked out new innovative contract systems between farmers, processors and traders or new logistics concepts.

4. Environmental performance of the production and processing plant

This includes the use of sustainable energy, the reduction of energy use, environmental friendly processing technologies, environment-friendly packaging systems and the minimization of waste and emissions.

5 Cultural and social contributions

Social activities, which are realized inside as well as outside the company. This includes "fair trade" concepts or activities which are related to the cultural activities of the companies (external and internal).

The design of the award demonstrates clearly that the processing of organic food should be done within a holistic approach, which includes besides aspects such as technology or innovation in marketing, also cultural, social and environmental ones. A condition for reaching the main award was to demonstrate that an extraordinarily result was achieved in two dimensions at least.

The first winner of this award was chosen because of the overall concept of sustainable management of his company and the close cooperation with its suppliers, the farmers. This company produces a lot of the energy thanks to the use of renewable resources and alternative concepts. Furthermore the company has developed different technologies: for example a special technique for filtration, which reduces the waste to a minimum. Silicon dioxide is totally replaced by cellulose fibres. The "waste" can be composted or used as animal feed. The company presents each year a very detailed and deeply documented sustainability report. (www.lammsbraeu.de)

The second winner of the award has developed completely new techniques for rapeseed oil. This company started with a young and ambitious project directly out of the university. The rape seeds are peeled before the pressing. The whole industrial plant is independent from external energy and is even producing electricity for the public grid, by using the oil of the rape hull to fuel a block heat and the power plant. The end product, that is the rape oil, is of the highest quality and of much better taste and composition than the available cold pressed rape oils on the market! No further refining is needed. (www.teutoburger-oelmuehle.de)

The third winner was chosen mainly because of his pioneer activities in the market for organic meat products. This was the result of the excellent new style of cooperation between farmers, butchers and trade partners in combination with consequent organic food processing methods. For example, all sausages and meat products are free of nitrate. The innovative system of distribution was seen as an important factor of success. (www.chiemgauer-naturfleisch.de).

The first company was influenced mainly by the macrobiotic approach to nutrition. They brought that new style of nutrition in direct relation with organic agriculture. The nutrition style was strongly orientated towards traditional specific Asian foods, which are also used in the macrobiotic nutrition. As for the second company, the most important points were their responsibility towards the environment and their regional approach. Furthermore this company is also a very good example of an ambitious new technological approach exactly adapted to the needs of the organic food sector.

The third example makes clear that the social style of cooperation is a key issue to develop the market, by giving fruits such as new concepts or even sometimes new products. The close cooperation between processors and farmers, based on new economical concepts, was the fundament of their success.

6.3. Examples of novel technologies in the organic food industry

Many novel technologies were developed by companies specifically for the organic market. Indeed important innovative findings, resulting from the discussion in the organic sector were carried out by the organic food industry.

Table 7: Some selected examples for innovative solutions in organic food processing

Problems	Solutions
Naturalness of foods	Methods for cold pressed oil and the protection of the oils against oxidation. (Use of peeled seeds, the "oxygard" method and others.)
Use of flavours	Development of new tasty varieties of fruit yoghurts without added isolated flavours by new innovative blends and e.g. by the fresh production of the fruit preparation directly in the dairy plant.
Whole cereal bread bakery products with a good volume	Use of new methods of production, addition of acerola cherry powder (instead of synthetic ascorbic acid) or oxygen (O_2) application.
Problems of using ion exchange resins in starch syrup.	Develop purification systems based on accepted processing aids
Homogenization of milk	Reduce the level of homogenization to the possible minimum by avoiding unforeseen homogenization effects and by reducing of the application of pressure to the minimum as it is needed for pasteurized milk.
Oxidation of potato's after peeling	Use of organic acids as antioxidants and optimization of handling and packaging.
Quality of meat products	Development of new processing technologies based on meat from "older" pigs and presents a new type of product on the market with new ripening technologies.
Problems with conventional starter cultures	Development of starter cultures which are multiplied on substrates from organically produced compounds
Pest management in storage and processing facilities	Concepts for ecological pest management in combination with new physical and biological control methods / elimination techniques.

Another interesting approach can be observed on the market. Some companies put or have put products with raw material coming from organic agriculture on the market without any organic labelling. They do so because they want to support organic agriculture or because they want to present healthy foods to their consumers. They do not label their products because they are of the opinion that in their special markets, the consumers will react negatively to such a labelling. They believe that if organic raw materials are used some consumers will recognize the products because of their good quality, and will prefer such products

in the future. It seems that this concept is sometimes working. The aim of those companies is to contribute to the development of organic agriculture and to a healthy nutrition.

Other companies try to emphasize strongly the relationship between consumers and farmers. On the label of their cereal products, each single farm on which the grain used for the product was produced is mentioned. One of these companies has introduced a system, in which the consumer has to pay a percentage of the costs of organic plant breeding activities. In other product groups such as meat products it is today the normal procedure for small companies to declare exactly from which animal and which farm the meat comes from.

The economic structure of the market for organic foods is reasonable. For small and middle class companies especially, which have a more flexible production system the market for organic foods remains very interesting! Therefore many of those companies in whole Europe try to develop organic production lines with the goal of reaching an appropriate share of this market, which promises attractive margins for the processors. Some of these companies were so successful that they completely converted to organic food production. The biggest organic food processor is the company "Hipp", originally from Bavaria in Germany, but nowadays located in different European countries.

6.4 Conclusions

The observation of recent developments in the organic food market and the briefly described examples lead to the following conclusions:

The issues about nutrition are an important source of activities for companies acting in the organic food market. Environment-friendly production systems are the next most important aspect. Working together with farmers is not only a key issue for success; it is a part of a social concept too.

Developing technological methods which are adapted to the needs of organic food production, to healthy styles of nutrition and which relate to the "naturalness" of food by limiting the use of the additives are the next aspects to consider.

Finally some processors of organic food try to emphasize the relation from the consumers to the farmers. They want to restore its identity to the food.

The following statement summaries the practical situation: "The industry's main task is to take the raw material from organic origin and transfer it to the consumers in the form of well recognized attractive products without destroying its original quality, result of the organic farmer's work."

Relevant questions to be discussed:

- *What are the key responsibilities of organic food processors?*
- *What is the most critical problem in relation to the processing of organic food?*
- *How could the processors contribute to the maintenance of a consistent growth rate in the organic market?*
- *What do customers understand under the concept of regionality?*
- *How realistic is the approach of regionality at the level of industrial processing?*

7 Overview and discussion of the findings

Alexander Beck, Otto Schmid and Ursula Kretzschmar

The aim of this literature review is to give an overview of the development of the organic food processing, the regulatory situation and its underlying principles, current practices and challenges (or "hot topics") in general and within different product groups.

We identified actual problems for the organic food processing sector occurring in each discussed product group.

7.1. Main principles and concepts

The study has shown that quite a lot of different approaches are related with the processing of organic food. The food processing industry has to respond to the needs of different market stakeholders: agricultural producers, costumers, environment and society.

There is a general lack of clarity concerning the exact meaning and content of the term "organic food processing". If we consider the EU Regulation 2092/91 at the level of states, organic food processing appears to be defined by the following requirements:

a) Organic certified raw materials

b) A restricted number of accepted food additives, processing aids and conventional ingredients

c) Transparent and well documented processing (trace ability, separation and identification)

d) Certification of the production chain

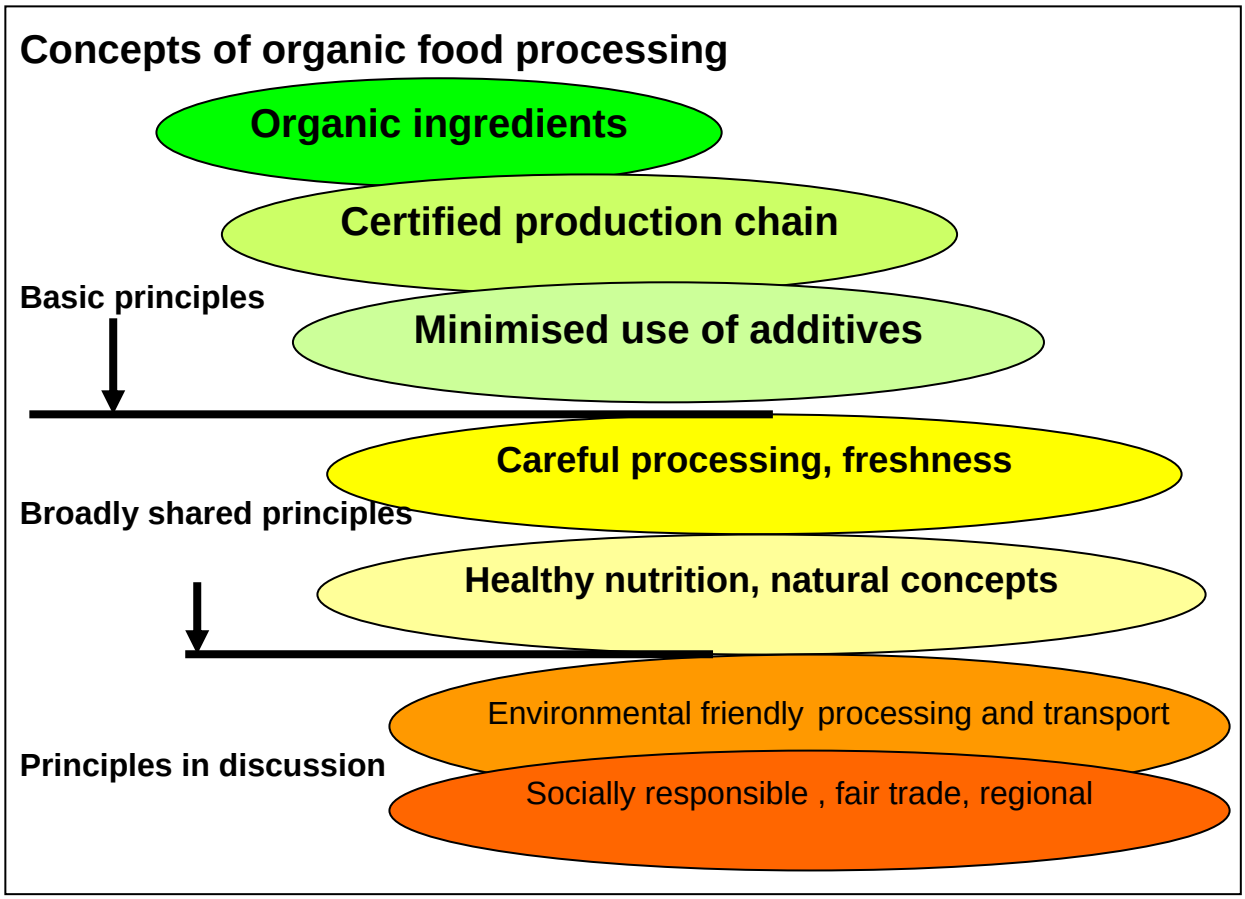
But if we consider private standards occurring at different levels, consumer expectations and the various approaches of the organic food industry, there appear to be many more aspects to consider when discussing about the underlying concepts covered by the term "organic food processing".

Graphic 2 summarizes the main findings in this report about these underlying principles.

The first basic principle, according to which ingredients of processed foods have to be of certified organic origin, in addition to the second principle, which requires a minimum of additives be used, constitute the fundament of the EU Regulations for organic labelling of food.

The use of terms *careful processing* and *freshness* is present in private standards and used by companies. These principles are shared by many actors of the private sector. The wholefood approach ("Healthy nutrition", "natural concepts of nutrition") can also be found in the private sector, but its importance is decreasing. We have to recognize that pleasure and taste aspects are becoming more and more important also in the organic food sector. Furthermore one can now find organic functional dairy products labelled with their functional proprieties on the market.

Graphic 2: Overview of principles for organic food processing



It seems to be important to raise the issue of environment-friendly production systems. At the level of the farm organic farming is seen by the consumers today as being synonym to environment-friendly farming. As regards the processing sector many activities are undertaken by some companies in that area. However at the level of label definition very few requirements for environment-friendly practices can be found. Issues such as food miles consumption are discussed and standards for packaging materials are also being developed. But until now, no label organization has requested their contractors to have e.g. a certified environment management system in place.

Considering issues such as social responsibility, fair trade and regionality, in this area the private sector is relatively active. Some interesting projects of cooperation with farmers, regionality and social responsibility are in place. However some labelling organizations have formulated social standards only in relation to underdeveloped countries. It can be concluded that only a part of the presented principles are really broadly shared by all actors of the organic sector.

After analyzing the problematic or controversial areas in the presented product groups the following can be concluded:

It seems to be critical to decide if new processing technologies like enzymes or extrusion technologies, ion exchange technologies, modified atmosphere, new packaging materials, are in line with the concept of organic food. Apparently there is a lack of guiding principles and related criteria, which are needed to make a decision about such methods.

However the organic food sector is under pressure, because consumers demand that it offers the same product quality, with the same shelf life, sensorial quality and high safety level that they are used to experience with conventional products. This demand stimulates the development of new innovative concepts, which use natural substances with appropriate technological properties or less critical additives than are used normally, or the development of technologies based on additive free processes. Nevertheless in most cases this results higher production costs.

Sometimes aspects of consumer acceptance in relation to well know product profiles like nitrite-treated or nitrate-treated sausages might cause strong contradictions for the organic food sector.

Other important aspects are the risk of contamination (e.g. microbiological contamination, not allowed substances) and the origin of the substances used in organic food products. This last question is strongly related to the whole debate about the use of GMO techniques for the production of additives and processing aids, during the production of starter cultures and enzymes and to the coexistence question in relation to the production and processing of GMO crops. Furthermore it seems to be more acceptable for the organic food sector to use ascorbic acid out of acerola cherry than to use it from a biotechnological source. The organic origin of the product is a basic principle, which has a higher recognition in the organic food sector than the chemical structure of the substance.

7.2 Comparison with consumer perceptions

We have to recognize that only very little information is available about consumer expectations towards organic food processing. Nevertheless a set of important information describing consumer perceptions of organic foods in several European countries is available in chapter 3.

The use of pesticides is a major concern for many consumers. Worries expressed relate to the environment as well as to possible health effects – i.e. either personal, short-term health or the health of future generations.

The use of food additives is a common concern among consumers, and choosing organic food might be one strategy to limit their consumption of additives. Therefore regulations/standards for organic food processing restrict the use of such substances.The issue of genetic modification in food production is widely debated in the public arena of many countries. It is a major consumer concern and is also strongly connected with the preference for organic food.

An important issue is often the consumer's distrust of producers' motives: some have the perception that these practices (e.g. food technologies) reflect an interest in profit rather than in the production of good and healthy food. Concepts such as "homemade" and "natural" appear to stand out, and express a preference of the consumer for food that has been produced with little or no use of artificial fertilizers, pesticides, food additives and technologies like genetic modification. The literature review shows that consumer concerns about food quality and safety embraces broad and interconnecting realms. Health, environment, ethics, authenticity, taste and concerns about the relationship between people and nature are examples of broad themes that recur in the literature. Health and environment tend to be interwoven and a strong motive for buying organic food. A typical rationale is that healthy soils, plants and animals are a basis for human health.

In addition to already mentioned aspects, many consumers of organic food expect:

a) a reduced limited transportation of food (keeping "food miles" low);

b) the use of environment-friendly food packaging systems

c) concern about renewable resources

Table 8 summarizes the findings from chapter 3.

Table 8: Main consumer perceptions with regard to organic food:

a)	Limitation of chemicals and residues (fewer pesticides, fewer additives, no genetic engineering), food safety
b)	Trust in the operators
c)	Traditional technologies (health responsible technologies)
d)	Better Taste
e)	Healthy food
f)	Environment (production,. packaging, transport, energy use)
g)	Animal welfare

In which way do these consumer expectations correspond with the underlying principles of organic food processing?

In table 9 the main perceptions of the consumers of organic food are compared with the main guiding principles outlined in the preceding chapters. In the last three columns we give an indication whether the principles and the related consumer concerns are covered by the EU-Regulation 2092/91, by private business standards or by company concepts.

Table 9: Comparison of consumer perceptions and identified principles for organic food processing.

Main topics of consumer perceptions	**Corresponding identified principles for organic food processing**	**Covered by EU-Regulation 2092/91**	**Covered by private standards**	**Covered on company level**
Limitation of chemicals	Organic ingredients	Covered	Covered	Covered
	Minimized use of additives	Covered	Covered	Covered
	Environment-friendly processing	No	Partly	Partly
Trust for the operator	Certification	Covered	Covered	Covered
	Socially responsible, regional	No	Partly	Partly
Traditional technologies	Careful processing	No	Partly	Partly
	Minimized use of additives	Covered	Covered	Covered
Better Taste	Organic ingredients	Covered	Covered	Covered
	Careful processing	No	Partly	Partly
Healthy food	Healthy nutrition	No	Partly	Partly
	Minimized use of additives	Covered	Covered	Covered
	Organic ingredients	Covered	Covered	Covered
Environment	Organic ingredients	Covered	Covered	Covered
	Packaging, Transport	No	Partly	Partly
	Environment-friendly processing	No	Partly	Party
Animal welfare	Organic ingredients	Covered	Covered	Covered
	Appropriate processing (slaughtering)	No	Partly	Partly

The table 9 shows that a number of principles are covered at all levels (EU Regulation., private standards and by company concepts). Other principles are not or only partly implemented. This means that several consumer perceptions are not completely fulfilled by the state regulations, private standards and company concepts.

It is very important to further investigate perceptions of consumers towards organic food processing. A majority of organic food are sold as processed products. Processing has a strong influence on the characteristic and the quality of products. The future development of organic food processing should follow much more a "fork to farm" approach, taking stronger consumer expectations into account.

8 Conclusions

Alexander Beck and Otto Schmid

The literature review has shown that a broad range of ideas exist about organic food processing. This is reflected in quite different types of products, different processing standards and marketing concepts.

The EU-Regulation 2092/91 covers a number of consumer perceptions such as certification system, traceability, minimal use of additives, labelling concept and the use of organic raw materials. However a number of other consumer expectations and discussed topics are not fulfilled such as careful processing, freshness, healthy nutrition or fair trade.

The open and difficult discussion in the European Union about the acceptance of additives for organic food processing on state and private level indicates that there is no overall theoretical quality concept about organic food as a basis for decisions available. A similar situation can be observed in relation to processing methods. There are a number of controversial discussed methods were it seems to be complicated to decide if specific methods are in line with the principles of organic food production or not. One example is the ongoing discussion about the application of ion exchange resins for processing of organic foods. More and more processing methods are already used which seem to be not in compliance with the principles of organic agriculture!?

To enable a consistent further development of the EU Regulation 2092/91 it is important to develop principles and related criteria for the evaluation of additives and processing methods.

On the other hand some technological problems have been identified (e.g. oxidation of fruits and vegetables), were appropriate solutions have to be found and/or developed.

Obviously in the mind of consumers and of other actors in the organic food sector a range of additional principles are present as stated before. The lack between the consumer expectations and the rules which are implemented by EU Regulation 2092/91 can cause problems. Therefore it is important to clarify this situation and to develop a clearer link between the given regulation 2092/91 and the perception of the consumers.

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Annex 1: Underlying principles in the preamble of COMMISSION REGULATION (ECC) No 207/93 of 29 January 1993

Defining the content of Annex VI to Regulation (EEC) No 2092/91 on organic production of agricultural product and indications referring thereto on agricultural products and foodstuffs and laying down detailed rules for implementing the provision of Article 5 (4) thereto

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community,

Having regard to Council Regulation (ECC) No 2092/91 of 24 June 1991 on organic production of agricultural products and foodstuffs ([1]) and in particular Article 5 (7) (8) and thereof,

Whereas for the purposes of Article 5 (3) (b) and (c) and (4) of Council Regulation (EEC) No 2092/91 (hereinafter referred to as "the Regulation"), exhaustive lists have to be established in Sections A, B and C of Annex VI thereto;

Whereas for the purposes of the three sections of Annex VI to the Regulation, certain definitions have to be developed in order to ensure coherence with other related Community regulatory provisions;

Whereas any ingredients or processing aids to be mentioned in Annex VI to the Regulation should be used only in accordance with legislative requirements concerning the preparation of foodstuffs and according to good practise of in the manufacturing of foodstuffs;

Whereas Annex VI to the Regulation should take account consumers` except actions that processed products form organic production will be composed essentially of ingredients as they occur in nature;

Whereas, however, other ingredients of processing aids which may be used in conventionally processed foodstuffs, and which preferably exist in nature, may be included in Annex VI to the Regulation, provided it has been shown that, without having recourse to such substances, it is impossible to produce or preserve organic foodstuffs;

Whereas, with regard to enzymes derived from micro-organisms, it has to be further examined whether such products obtained from micro-organisms genetically modified within the meaning of Council Directive 90/220/EEC ([2]), can be used in foodstuffs whose labelling refers to organic production methods; whereas this question will be examined in detail when such enzymes are approved for use in foodstuffs according to the relevant Community legislation;

Whereas the said Annex VI will have to be reviewed regularly in the light of experience gained and of developments with in the availability on the Community market of certain organically produced ingredients of agricultural origin;

Whereas detailed rules for the implementation of the derogation pursuant to Article 5 (4) of the Regulation are necessary to ensure coherent implementation of this derogation in the Member States, as long as products covered by this derogation have not been included in Section C of Annex VI to the Regulation (EEC) No 2092!91,

HAS ADOPTED THIS REGULATION:

Article 1

The content of Annex VI to Regulation (EEC) No 2092/91 is defined in the Annex to the present Regulation.

Article 2

No amendments to Sections A and B of Annex VI shall be adopted unless at least the following requirements are satisfied:

1) for food additives covered by Section A, point 1 of Annex VI: without prejudice to the requirements for acceptance of additives provided for in Council Directive 89/107/EEC ([3]) only substances shall be included for which it has been shown, that without having recourse to such substances, it is impossible to produce or preserve such foodstuffs;
2) for processing aids covered by Part B of Annex VI: only substances are included which are accepted in general food processing and for which are accepted in general food processing and for which it has been shown that, without having recourse to such substances, it is impossible to produce such foodstuff.

Article 3

1) As long as an ingredient of agricultural origin has not been included in Section C of Annex VI to the Regulation, that ingredient may be used according to the derogation provided for in Article 5 (4) of that Regulation on the following conditions:

(a) that the operator has notified to the competent authority of the Member State all the requisite evidence showing that the ingredient concerned satisfies Article 5 (4); and
(b) that the competent authority of the Member State has authorized the use for a maximum period of three months, which may be reduced if it appears that supplies of the ingredient concerned are available in the Community.

2) Where an authorization as referred to in paragraph 1 has been granted, the Member State shall immediately notify to the other Member State and to the Commission the following information:

(a) the date of the authorization;
(b) the name of the ingredient of agricultural origin concerned
(c) the quantities that are required and the justification for those quantities;
(d) the reasons for, and expected period of, the shortage.

3) If the information submitted by any Member State to the Commission and to the Member State which granted the authorization shows that supplies are available during the period of the shortage, the Member State shall consider withdrawing the authorization or reducing its period of validity, and shall inform the Commission and the other Member States of the measures it has taken, within 10 days of the date of receipt of the information.
4) At the request of a Member State or at the Commission`s initiative, the matter shall be submitted for examination to the Committee referred to in Article 14 of the Regulation. It may be decided, in accordance with the procedure laid down in Article 14, that the authorization shall be withdrawn or its period of validity amended, or, where appropriate, that the ingredient concerned be included in Section C of Annex VI.

Article 4

This Regulation shall enter into force 15 days from the date of publication in the *Official Journal of the European Communities.*

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 29 January 1993.

For the Commission

René STEICHEN

Member of the Commission

Source:

A consolidated version of the regulation 2092/91, including Annex 6 with the list of additives and processing aids, can be downloaded from the Internet Site of the European Commission:

www.europa.eu.int/eur-lex/en/consleg/ main/1991/en_1991R2092_index.html

Annex 2: IFOAM Basic Standards for Organic Production and Processing

Part 6. Processing and Handling

Approved by the IFOAM General Assembly, Victoria, Canada, August 2002

6.1. General
General Principle

Organic processing and handling provides consumers with nutritious, high quality supplies of organic products and organic farmers with a market without compromise to the organic integrity of their products.

Recommendations

Handlers and processors should handle and process organic products separately in both time and place from non-organic products. Handlers and processors should identify and avoid pollution and potential contamination sources.

Standards shall require that:
6.1.1.

Handlers and processors shall not co-mingle organic products with non-organic products.

6.1.2.

All organic products shall be clearly identified as such, and stored and transported in a way that prevents contact with conventional product through the entire process.

6.1.3.

The handler and processor shall take all necessary measures to prevent organic products from being contaminated by pollutants and contaminants, including the cleaning, decontamination, or if necessary disinfection of facilities and equipment.

6.2. Ingredients

General Principle

Organic processed products are only made from organic ingredients.

Recommendations

Processors should use organic ingredients whenever possible.

Enzymes, fermentation organisms, dairy cultures, and other microbiological products should be organically produced and multiplied from a medium composed of organic ingredients, and substances that appear in Appendix 4.

Standards shall require that:
6.2.1.

All ingredients used in an organic processed product shall be organically produced except for those additives and processing aids that appear in Appendix 4 and non-organically produced ingredients that are in compliance with the labeling provisions.

In cases where an ingredient of organic origin is unavailable in sufficient quality or quantity, the standard-setting organization may authorize use of non organic raw materials subject to periodic review and re-evaluation. These materials shall not be genetically engineered.

6.2.2.

Water and salt may be used as ingredients in the production of organic products and are not included in the percentage calculations of organic ingredients.

6.2.3.

Minerals (including trace elements), vitamins and similar isolated ingredients shall not be used unless their use is legally required or where severe dietary or nutritional deficiency can be demonstrated.

6.2.4.

Preparations of micro-organisms and enzymes commonly used in food processing may be used, with the exception of genetically engineered micro-organisms and their products.

Processors shall use micro-organisms grown on substrates that consist entirely of organic ingredients and substances on Appendix 4, if available, This includes cultures that are prepared or multiplied in-house.

6.3. Processing Methods

General Principle

Organic food is processed by biological, mechanical and physical methods in a way that maintains the vital quality of each ingredient and the finished product.

Recommendations

Organic products should be processed in a way that maintains nutritional value.

Processors should choose methods that limit the number and quantity of non-organic additives and processing aids.

Standards shall require that:
6.3.1.

Techniques used to process organic food shall be biological, physical, and mechanical in nature. Any additives, processing aids, or other substances that chemically react with or modify organic foods shall comply with the requirements of Appendix 4.

6.3.2.

Extraction shall only take place with water, ethanol, plant and animal oils, vinegar, carbon dioxide, nitrogen. These shall be of a quality appropriate for their purpose.

6.3.3.

Irradiation is not permitted.

6.3.4.

Filtration techniques that chemically react with or modify organic food on a molecular basis shall be restricted. Filtration equipment shall not contain asbestos, or utilize techniques or substances that may negatively affect the product.

6.3.5.

The following conditions of storage are permitted (See Appendix 4):

- controlled atmosphere
- temperature control
- drying
- humidity regulation

6.3.6.

Ethylene gas is permitted for ripening.

6.4. Pest and Disease Control

General Principle

Organic food is protected from pests and diseases by the use of good manufacturing practices that include proper cleaning, sanitation and hygiene, without the use of chemical treatment or irradiation.

Recommendation

Recommended treatments are physical barriers, sound, ultra-sound, light and UV-light, traps (including pheromone traps and static bait traps), temperature control, controlled atmosphere and diatomaceous earth

Standards shall require that:
6.4.1.

A handler or processor is required to manage pests and shall use the following methods according to these priorities:

preventative methods such as disruption, elimination of habitat and access to facilities, substances (other than pesticides) used in traps

6.4.2.

Prohibited pest control practices include, but are not limited to, the following substances and methods:

- pesticides not contained in Appendix 2
- fumigation with ethylene oxide, methyl bromide, aluminum phosphide or other

- substance not contained in Appendix 4
- ionizing radiation

6.4.3.

The direct use or application of a prohibited method or material renders that product no longer organic. The operator shall take necessary precautions to prevent contamination, including the removal of organic product from the storage or processing facility, and measures to decontaminate the equipment or facilities. Application of prohibited substances to equipment or facilities shall not contaminate organic product handled or processed therein. Application of prohibited substances to equipment or facilities shall not compromise the organic integrity of product handled or processed therein.

6.5. Packaging

General Principle

Organic product packaging has minimal adverse impacts on the product or on the environment.

Recommendations

Processors of organic food should avoid unnecessary packaging materials.

Organic food should be packaged in reusable, recycled, recyclable, and biodegradable packaging whenever possible mechanical, physical and biological methods, substances according to the Appendices of the IBS.

Standards shall require that:
6.5.1.

Packaging material shall not contaminate organic food.

6.5.2.

Packaging materials, and storage containers, or bins that contain a synthetic fungicide, preservative, or fumigant are prohibited.

6.5.3.

Organic produce shall not be packaged in reused bags or containers that have been in contact with any substance likely to compromise the organic integrity of product or ingredient placed in those containers.

Appendix 5, IFOAM Basic Standards 2002: Criteria for the Evaluation of Additives and Processing Aids for Organic Food Products

Introduction

Additives, processing aids, flavouring agents and colours should be evaluated according to Appendix 5. The following aspects and criteria should be used for evaluation of additives and processing aids in organic food products.

1. Necessity

Additives and processing aids may only be allowed in organic food products if each additive or processing aid is essential to the production and:

- the authenticity of the product is respected
- the product cannot be produced or preserved without them

2. Criteria for the Approval of Additives and Processing Aids

Where:

- There are no other acceptable technologies available to process or preserve the organic product.
- The use of additives or processing aids which minimise physical or mechanical damage to the foodstuff as a substitute for other technologies which if used would result in such damage
- The hygiene of the product cannot be guaranteed as effectively by other methods (such as a reduction in distribution time or improvement of storage facilities)
- There are no natural food sources available of acceptable quality and quantity which can replace the use of additives or processing aids
- Additives or processing aids do not compromise the authenticity of the product
- The additives or processing aids do not confuse the customer by giving the impression that the final product is of higher quality than is justified by the quality of the raw material. This refers primarily, but not exclusively, to colouring and flavouring agents
- Additives and processing aids should not detract from the overall quality of the product

3. Step by Step Procedure for the use of Additives and Processing Aids

1. Instead of using additives or processing aids, the preferred first choice is:
- Foods grown under organic conditions which are used as a whole product or are processed in accordance with the IFOAM Basic Standards - e.g. flour used as a thickening agent or vegetable oil as a releasing agent
- Foods or raw materials of plant and animal origin which are produced only by mechanical or simple physical procedures - e.g. salt.

2. The second choice is:
- substance isolated from food and produced physically or by enzymes - e.g. starch, tartrates, pectin

- Purified products of raw materials of non agricultural origin and micro-organisms - e.g. acerola fruit extract, enzymes and micro-organism preparations such as starter cultures.

3. In organic food products the following categories of additives and processing aids are not allowed:
- "Nature identical" substances
- Synthetic substances primarily judged as being unnatural or as a "new construction" of food compounds such as acetylated crosslinked starches
- Additives or processing aids produced by means of genetic engineering
- Synthetic colouring and synthetic preservatives

Carriers and preservatives used in the preparation of additives and processing aids shall also be taken into consideration.

Source: www.ifoam.org

Annex 3: Codex Alimentarius Guidelines for the Production, Processing, Marketing and Labelling of Organically Produced Foods

The Codex Committee on Food Labelling developed the *Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods* in view of the growing production and international trade in organically produced foods with a view to facilitating trade and preventing misleading claims. The *Guidelines* are intended to facilitate the harmonization of requirements for organic products at the international level, and may also provide assistance to governments wishing to establish national regulations in this area.

SECTION 5: REQUIREMENTS FOR INCLUSION OF SUBSTANCES IN ANNEX 2 AND CRITERIA FOR THE DEVELOPMENT OF LISTS OF SUBSTANCES BY COUNTRIES

5.1 At least the following criteria should be used for the purposes of amending the permitted substance lists referred to in Section 4. In using this criteria to evaluate new substances for use in organic production, countries should take into account all applicable statutory and regulatory provisions. Any new substances must meet the following general criteria:

a) they are consistent with principles of organic production (see Foreword,

b) paragraph 7);

c) use of the substance is necessary/essential for its intended use;

d) use of the substance does not result in, or contribute to, harmful effects on the environment;

e) they have the lowest negative impact on human or animal health and quality of life; and

f) approved alternatives are not available in sufficient quantity and/or quality.

The above criteria are intended to be evaluated as a whole in order to protect the integrity of organic production. In addition, the following criteria should be applied in the evaluation process:

Criteria for additives and processing aids:

- if they are used as additives or processing aids in the preparation or preservation of the food; these substances are found in nature and may have undergone mechanical/physical processes (e.g. extraction, precipitation), biological/enzymatic processes and microbial processes (e.g. fermentation), or, if these substances mentioned above are not available from such methods and technologies in sufficient quantities, then those substances that have been chemically synthesized may be considered for inclusion in exceptional circumstances;
- they are essential to prepare such product because there are no other available technologies;
- the consumer will not be deceived concerning the nature, substance and quality of the food.

In the evaluation process of substances for inclusion on lists all stakeholders should have the opportunity to be involved.

5.2 Countries should develop a list of substances which satisfy the requirements of these guidelines. Substances included in the list developed by a country but not included in Annex 2 of these guidelines may be a part of the equivalence judgement and decision referred to in section 7.4 of these guidelines. In developing national lists, countries may reduce the list of substances indicated in the lists included in

Annex 2. Countries may include in their own lists substances other than those listed in Annex 2 only if: the criteria in 5.1 are used as a basis for these additions;they are notified in accordance with 5.3 and 5.4 below.

5.3 When a country proposes inclusion of a substance in Annex 2 it should submit the following information:

a) a detailed description of the product and the conditions of its envisaged use;

b) any information to demonstrate that the requirements under Section 5.1 are satisfied.

5.4 Because of the primary purpose of providing a list of substances, the lists in Annex 2 are open and subject to the inclusion of additional substances or the removal of existing ones on an ongoing basis. The procedure for requesting amendments to the lists is se out under Section 8 of these Guidelines.

Source: www.codexalimentarius.net

QualityLowInputFood

The Integrated Project *QualityLowInputFood* aims to improve quality, ensure safety and reduce cost along the European organic and "low input" food supply chains through research, dissemination and training activities. It focuses on increasing value to both consumers and producers and on supporting all components of the food chain, using a fork to farm approach.

The project started in March 2004. It is funded by the European Union under the Sixth Framework Programme for European Research & Technological Development (2002-2006), Thematic Area Food Quality. The project involves 31 research institutions, companies and universities throughout Europe and beyond.

The objectives of the project are

- To improve the match between producers' aims and consumer expectations regarding quality and nutritional value of organic and other "low input" food.
- To increase the cost-efficiency all along the organic and other "low input" food chain, while improving or maintaining its quality.
- To contribute to minimising food safety risks all along the food chain (including the stages of production, processing, distribution and consumer food handling).
- To contribute to reducing environmental impacts and fossil energy use in organic and "low input" farming.

Contact

Food from low input and organic production systems: Ensuring the safety and improving quality along the whole chain (QLIF)
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This publication contains a literature survey about the processing of organic and low-input food.

The survey gives an overview of the development of standards and regulations for processed organic food, describes the concept of natural nutrition, the appropriate technology approach, minimal and careful processing. It highlights some consumer perceptions of organic food quality. For four different product groups (organic fruit and vegetables, cereals, milk and meat products) the main challenges in organic food processing are described. The main principles in organic food processing are identified.

The literature review was carried out as part of the European funded project Quality of Low-Input Food. This project aims at improving quality, ensuring safety and reducing costs along the European organic and "low input" food supply chains through research, dissemination and training activities.

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