What we achieved - where we will go

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FOOD QUALITY AND EXPERIMENTAL DESIGN: HARVEST TIME AND THE QUALITY OF LETTUCE

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1 INTRODUCTION

Reliable determination of *product quality* needs a broad spectrum of parameters to be assessed. The judgement of fresh vegetables depends on visual and sensory characteristics as well as on *nutritional quality*. An extended definition of nutritional quality may be divided into two terms: One term for the effects of food determined by its substance, i.e., the sum of all ingredients, beneficial and harmful compounds (including the risk of toxic pathogens), and their nutritional (or biological) aspects. The other term covers the psychological effects of well-being based on the knowledge related to the organic label indicating the *process quality*, and the ethical, environmental, social and political values (Köpke, 2003).

To assess the substance effects, animal studies or so-called holistic methods can be used, but label aspects can be investigated by human studies only. Long-term nutritional tests in humans comparing results of organic and mainstream production have so far not been satisfactorily performed due to many methodological difficulties and ethical reservations. Even if these restrictions might be overcome, direct long-term investigations are at least restricted by funding. Thus, the literature is still dominated by chemical and physiological investigations on desirable and undesirable ingredients regarded as being directly related to nutritional quality. From the scientific point of view, long-term factorial field trials are the most accurate form of comparative studies, indicating for each field experiment which cultivation method results in highest product quality under specific site conditions. With this approach, however, some problems remain unsolved. For example, which cultivars should be chosen? One (for each crop) that is adapted more or less equally to both organic and non-organic growing conditions or two cultivars each with specific adaptation to one farming system only? Furthermore, the results can only be generalized when there are a sufficient number of field trials comparing the cultivation systems under different site conditions and years. On the other hand, these trials may not be representative for long due to the limited useful life of cultivars (especially in mainstream agriculture).

Regarding lettuces, the marketable and nutritional quality depends heavily on the chosen cultivar as well as the agronomic strategies used. Most vegetables are characterized by high demand of nutrients especially nitrogen that should be sufficiently available in comparatively short vegetation periods. Readily available nitrogen (N) from fertilisers or a surplus of N can lead to an increase in nitrate content of plant tissues (Vogtmann *et al*., 1984), synthesis of non-protein N-containing compounds and a decrease in beneficial phytochemicals (Brandt *et al*., 2001) especially under conditions of limited irradiation related to nitrogen uptake. Contamination with enteric bacteria has been postulated for lettuces and other vegetables and attributed to the use of organic manures. Besides these analytical parameters that can not be directly assessed by consumers sensory attributes like tissue strength and crunchiness have been frequently assigned as to be better marked in organic produce. Therefore, the aim of our study was to assess the effect of different fertiliser types and application levels on desirable and undesirable ingredients, including the risk of transfer of enteric bacteria from organic fertilisers by the splash effect of raindrops or overhead irrigation. Furthermore, we intended to deliver high quality produce to other member working groups of the integrated EU-project QualityLowInputFood (QLIF), one of these assessing sensory quality of head lettuce.

2 METHODOLOGY

2.1 Experimental design

Head lettuce was grown in a three-factorial field experiment in two different seasons during 2004 and 2005, respectively. The field trials were located on the organic research farm ‘Wiesengut’ in North-Rhine Westphalia, Germany (50°48’north, 7°17’east).

Table 1: **Experimental design of the field experiments**

Experimental area		15 m x 37,8 m = 567 m²
Sub-plot size		3 m x 1.8 m = 5.4 m²
Total number of plots		64
Spacing		30 x 30 cm
Number of plants per subplot **Sample size per subplot**		50 10 heads
Experimental factors	Irrigation system	Overhead Tape irrigation
	Fertiliser level	85 kg N/ha 170 kg N/ha
	Fertiliser type	Fresh farmyard manure (FYM) Composted farmyard manure (CFM) Fermented nettle extract (*Urtica dioica*, UDX) Calcium ammonium nitrate (CAN)

The experiment was a three-factorial split-plot design with four replications (details: *Table 1*). The main plot was the irrigation system (overhead vs. tape irrigation), the sub-plots were fertiliser input types (fresh farmyard manure, composted, fermented nettle extract and calcium ammonium nitrate) combined with fertiliser input levels of 85 and 170 kg N/ha, respectively. Solid manures were incorporated into the soil using a mouldboard plough. In each year the first trial was planted in May and the second in July/August respectively. During the rainy summer 2004, no differentiation by the factor irrigation was given. Consequently, data were analysed as two-factorial block design with 8 replications. Data of 2005 are not yet fully analysed. Nevertheless, methodological problems can be described based on available 2004 data and our experience gained in both years.

2.2 Sampling and investigated parameters

Head lettuces were harvested at optimal maturity when marketable yield was highest. Due to the different fertiliser types and levels there was a harvest date difference of up to 17 days between treatments. Harvest was assessed for total yield and marketable yield. Morphological parameters, number of leaves apart from lettuce heart, mass of heart and leaf colour were determined as well as the histological parameters cell density (outer three leaves/plant, three heads/treatment and replication; FYM 85 kg N/ha and CAN 170 kg N/ha only) and tissue strength assessed.

The fresh and dry matter yield per plant was quantified and the contents of N total, nitrate, magnesium, phosphorus, potassium, iron and the secondary metabolites lutein, ß-carotene and polyphenols were determined. For nitrate and secondary metabolites analysis, lettuce heads were quick-frozen and shredded after removal of outer leaves. For microbial/hygienic analysis lettuce plants and washing water were assessed for total aerobic bacterial count (CFU: colony forming units), number of coliform bacteria, *E. coli*, *Enterobacteriaceae*, *Enterococcus* and *Salmonella enteritidis*. For microbiological investigations, lettuce heads were shredded under sterile conditions. A pooled sample was analysed using standard microbial detection and quantification assays. Results were statistically evaluated by ANOVA and Tukey test.

3 RESULTS AND DISCUSSION

Limits of labour and time were general restrictions to overcome. For such a large number of parameters and measurements based on single plant fresh material, a step by step harvest is indispensable. Only a limited number of plants can be processed and analyzed in one day even if numerous well-skilled laboratory technicians were brought into action. Differences in ripening and reaching of optimal marketable yield as well as all measures that can be performed based on conserved (frozen) plant material meet these limitations that were characterized by 500 man hours expense during a two weeks harvest/processing and analysis phase.

Direct comparisons based on fresh plant material derived from plants of same growth stage and development such as sensory studies, generate additional substantial methodological problems. Different manure and fertilizer types as well as fertilizer input levels that yield in different dates of ripening make direct comparisons complicated. The necessity of same harvest date might be strived for by staggered planting time, but unforeseen weather conditions can make the goal of same ripening stage of lettuce heads from different fertilizer treatments uncertain. In any case, this strategy would result in an extended experimental area caused by higher number of planting dates, but also a potentially higher variation due to heterogeneous soil conditions. Furthermore, this approach would heighten the limitations for the laboratory staff dedicated to the processing and analysis of the fresh material.

Ideally, sensory tests should be performed based on the same plant material crunchiness is estimated by measuring tissue strength with the use of a penetrometer. Thus, these parameters should be assessed at one site and not- as in our case - by different working groups at different locations and with different plant material.

Generally, all parameters that cannot be based on mixed samples and chemically analysed, but have to use comparable single leaves of different treatments (e.g. tissue strength or cell density) are facing high heterogeneity that cannot be overcome by increased sample size. About 400 man hours were necessary for determining cell number and cell size of two treatments that were considered as resulting in clear differences.

Bacteriological investigations were time-consuming, too (256 man hours). Labour expense of chemical analyses, amounting to about 2000 man hours is more likely acceptable because these parameters can be based on frozen and conserved samples and distributed over a longer time.

Confirming our hypothesis nitrate content was a function of manure and fertiliser type as well as input level. Compared to organic manures, ammonium nitrate resulted in a higher nitrate content of lettuce. Nitrate concentration in lettuce tended to increase with increasing amounts of fertiliser, independent of fertiliser type. Significant differences of nitrate contents are given by low coefficients of variation and absolutely low nitrate contents that resemble no physiologically relevant results, but confirm the postulated tendency and results of other studies.

Fertiliser type and level also affected the carotenoid content. Rapidly available nitrogen from mineral fertiliser gave higher lutein levels compared with slowly released nitrogen. Similar results were observed for ß-carotene. There were no obvious differences regarding polyphenols for the different modes of fertiliser input but findings suggest an environmental/seasonal influence on the ß-carotene and polyphenol formation in lettuce treated with organic fertilisers (Rattler *et al.*, 2005). Seasonal differences in ß-carotene and lutein levels between winter- and summer-grown kale cultivars were also reported by Mercadante and Rodriguez-Amaya (1991) and can limit results generally evident.

The bacteriological quality was only marginally or not at all influenced by the type of fertiliser. In the 2004 spring trial, no effect of fertiliser input type on bacteriological quality was observed. *Escherichia coli* and *Salmonella* e*nteritidis* were not detected in any sample. When lettuce was fertilised with mineral N-fertiliser in the summer trial, total aerobic bacterial count and the level of coliform bacteria and *Enterobacteriaceae* were significantly lower compared with lettuce treated with organic manures. Independent of the type of fertiliser, *Escherichia coli* was isolated in very low numbers only (>10<100 CFU/g). *Salmonella enteritidis* was not detected in any sample. These findings suggest that there is no negative effect of untreated manure on bacteriological quality. Differences observed in the summer season trial are probably due to the weather impact.

4 CONCLUSION

The results confirm that readily available N from mineral fertiliser can increase the nitrate content of lettuce tissue but with absolutely low amounts not physiologically relevant when lettuces are grown and harvested in summer seasons or under conditions of high irradiation. Late autumn harvest increases the risk of mildew and makes site-specific timing of planting undeniable. The level of anti-carcinogenic carotenoids are a function of the amount of available nitrogen, thus tend to increase after mineral N-fertiliser application and can result in misinterpretation of product quality as a function of agronomic practice, especially of fertilizers type and amount used.

The microbiological results suggest that fertiliser type does not, or only slightly, affect the hygienic quality of lettuce when manures are incorporated into the soil and not left on the soil surface or in the upper soil layer. Thus, an adequate agronomic practice of cultivating lettuce can ensure a high hygienic quality of the produce.

To determine or describe nutritional quality, several parameters need assessment. Especially for sensory tests it seems adequate not to derive samples necessarily from only one field experiment that has not primarily been designed to deliver head lettuces derived from different treatments that should all realize optimal ripening stage, although having experienced vegetation periods of different length and thus different environmental conditions apart from the *ceteris paribus* approach of different fertilization. For that purpose a specific experimental design of extended size and with staggered planting dates has to be realised on homogeneous soil.

Again we have to underline that currently adequate quality valuation of organic produce is only possible by integrating results of the large number of experiments that have been performed. Single or a few parameters and experiments can be misleading. Thus, quality assessment is a synthetic product of the human brain that binds together manifold relevant aspects. Models that might support the approach how product quality can be produced and described are available.

ACKNOWLEDGEMENTS

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LIVING ON APPLES – MOLDS AND YEASTS OF ORGANICALLY GROWN APPLES

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ABSTRACT IN EXPECTATION OF PUBLICATION

The microbial flora associated with apple is largely undiscovered and may be regarded as a ”black-box” with unknown effects on food quality and human health. It has been assumed that the ecology of the microflora associated with apple is a reflection of the orchard, handling, harvesting, and storage practices: some microorganisms may be beneficial for apple quality (e.g. antagonists to spoilage molds and yeasts) and thus are desirable, whilst others are undesirable because of deleterious effects on apple quality (e.g. storage diseases, spoilage, off-flavours) and of potential health risk (e.g. mycotoxins).

In the present study we postulate that the microbial flora differs significantly between organic and conventional apples showing farming system specific characteristics. We expect to identify microorganisms with ”positive” and ”negative” functions related to organic food quality and human health.

First results will be presented at the FQH Conference and further publishing will follow.

LOUIS BOLK INSTITUUT'S 2005 MILK STUDY

A pilot study in search of parameters for quality and health

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1 BACKGROUND

At the 2004 Dutch EKO Conference, Triodos Bank director Peter Blom called for further research to reinforce the health image of organic food and production. This prompted the current exploratory research on milk from organic and conventional farms, results that were presented at the 2005 EKO Conference. Recent literature reports higher CLA and omega 3 fatty acids in organic milk (Flachowsky, 2000; Worthington, 2001; Bergamo, 2003; Rist, 2004; Browning *et al*., 2005). In the present study the aim was to explore besides fatty acid composition and taste, also parameters focussing on holistic food quality and health. Additionally an immunological test on the cow's milk was performed. The results of this pilot study could inspire towards further research.

2 STUDY DESIGN

In February 2005 raw bulk tank milk were sampled gathered from 5 paired farms: 5 organic and 5 conventional farms. Organic farms were selected with a qualitative focus, conventional farms were in the neighbourhood of each organic farm, so from same region and soil. Milk samples were taken twice. After sampling the milk was cooled and sent to different laboratories and tested blindly. Production data of each farm were recorded. By choosing paired farms it was possible to compare statistically not only the mean of the groups of organic and conventional farms, but also the paired farms.

3 FOOD QUALITY AND HEALTH CONCEPTS

Due to the choices of testing parameters it was possible to deal with more analytical as well as holistic perspectives on food quality and health. The holistic perspective on food quality and health was based on LBI's philosophical study on the intentions of organic farmers and consumers with regard to the concept of 'Naturalness' (Verhoog *et al.*, 2002). Based on the interpretation of this concept three conceptional levels were described in terms of view and habits. In *Table 1* these are described as well as a first attempt into the field of health and healthcare (Adriaansen-Tennekes *et al*., 2005).

Table 1: **Views and habits in regard to the interpretation of 'Naturalness' in agriculture, nutrition and healthcare. Starting point is the conventional view, which is here shown as level 0. Additionally three levels (1-3) are shown**

Views and habits in regard to the interpretation of 'Naturalness'	**….. In agriculture**	**….. In nutrition**	**….. In healthcare**
0. Conventional agriculture is not persé 'natural'. Is substance-oriented.	The aim is production of nutrients. Soil is a substrate that needs to be fed by substances.	Good quality serves consumers with as many positive and as few negative substances as possible. Supplementation is optional.	Health is seen as the absence of illness. Illness is a disturbance that needs to be repaired or dealt with by the elimination of threats by all means (antibiotics, surgery, radiation, etc.).
1. Naturalness as 'no-chemistry', but still substance-oriented	Fertilisation and plant protection from natural sources. No mineral fertilisers and synthetic plant protectors.	Food quality means safe foods, understood in substances, as in 0. Supplementation is optional from natural sources.	Health and illness are seen as in 0, but first 'natural means' are tried, such as phytotherapy.
2. Naturalness as 'ecosystem-view'. Systems-oriented. Processes in a natural context	Self regulation in the ecosystem is supported. Production cycles should enhance natural resistance. Nature is taken care of on the farm.	Food quality considers sustainability, fair-trade and consciousness in the use of energy. Regional fresh foods are preferred. No frozen foods.	Health is promoted and illness is tried to be besieged by stimulating natural processes that support resistance and self regulation.
3. Naturalness as 'being an integrated and structured wholeness'. Farm individuality is important.	An optimal balance between growth and ripening- (differen-tiation-) processes is strived for. Respect for animals integrity: cows keep horns etc.	Well grown and well ripened food serves consumers with a support of vitality and inner structure of body and mind. Healthy products from a healthy soil bring forth healthy animals and humans.	Health is reached by stimulating self regulation and inner balance. Illness is can be a meaningful event in a personal biography. Health considers physical, psychic and social well being (who.org).

4 PARAMETERS USED

To connect milk quality parameters with these three levels within the concept of naturalness the following selection was done:

Level 0 and 1 were taken together, since both levels are primarily substance oriented. Fatty acids were measured, considering a positive health effect in man: Conjugated Linoli Acid (CLA's) and omega-3-fatty acids in relation to the total fat content were relevant factors. Due to the budget other substances like vitamin E or beta-carotene or pesticide residues could not be measured. At this level taste can be positioned as well, as taste is usually seen as a result of ingredients.

Connected with **level 2** the immune reaction of the cow's milk is a (slight) indicator for the cow's resistance.

Connected with **level 3** biophotone illumination (delayed luminescence) and the biocrystallisations were investigated. Both parameters are hypothesised to show the level integration and inner coherence of a food product. On this level the measuring of taste can be positioned, as this is quite common and usually seen as a result of ingredients.

5 RESULTS

5.1 Healthy fatty acids

There were no differences in average fat content of organic and conventional milk. The omega 3 fatty acids were about twice as high in organic milk ($p < 0.001$). This tendency was also present in the amount of CLA ($p = 0.067$).

5.2 Flavour

On average there were no differences in taste in organic milk and conventional milk. Organic milk was more often characterised as slightly creamier, although milk samples did not show a higher fat content. The organic milk tended to smell more to grass and hay, compared to conventional milk ($p = 0.059$).

5.3 The immune cell activity

The organic cows had slightly more lymphocytes (= white blood cells) in their milk in terms of somatic cell counts, but without stimulation these did show as much activity as cells from conventional milk. However, if white blood cells are cultured with a mitogen, those of the organic cows show a higher response to the mitogen, expressed as the lymphocyte stimulation index ($p < 0.001$).

5.4 Biophotons

The higher biophoton emission figures long after the exposure to light (average of 100-200 seconds) shows that milk from organic farms can retain the light longer and therefore has a better cell order. Since all biophoton emission values were systematically higher in the second milk sampling, no significant differences were found in the average figures. If farm pairs were compared organic milk emissions were higher than conventional milk (Wilcoxon test, $p = 0.005$).

5.5 Biocrystallisations

Visual evaluation of the milk biocrystallisation pictures showed a better integration and coordination in organic milk. All organic milk pictures also showed more perradiation and longer 'side needles' (all $p < 0.001$). In parallel the computer image analysis indicated a denser needle structure in the organic milk in comparison to the conventional milk.

6 DISCUSSION AND CONCLUSIONS

In this pilot study almost all experimental parameters show a difference in quality between organic and conventional milk. Remarkably good correlations were found between the different experimental parameters. These differences are interpreted as organic milk being 'healthier' at all three levels of the naturallness concept. Adriaansen and Baars *et al*. (2005) intensively discussed the results.

It can be concluded that that based on a pair wise comparison differences between organic and conventional milk samples are significant, in favour of organic. Differences between the mean values of each group are less clear.

A problem was that the second milk sampling was done by another set of people. This may be an explanation that some methods showed a big variation between the two samplings.

FQH can learn that relatively small numbers, if well chosen, can already show significant results.

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MOTHERSMILK AND ORGANIC FOOD CONSUMPTION

KOALA study in the Netherlands

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SUMMARY IN EXPECTATION OF PUBLICATION

Several studies confirm higher levels of CLA's and omega-3-fatty acids in organic dairy produce, compared to conventional dairy. Until now little is known about the effects of consumption of such organic dairy.

In 2000 a Swiss pilot-project on mothersmilk of 15 women who had just delivered, half of them consuming organic food, showed that organic eating mothers had more CLA's and more omega-3-fatty acids in the milk, correlating with their dairy use (Rist, 2003). This inspired to further investigation.

The chance came with the running FQH-project, the Dutch KOALA-study, studying 2500 mothers and their children on allergic diseases and child development, in relation to different lifestyle factors, a project of Uni Maastricht in co-operation with Louis Bolk Instituut, TNO and other partners. Of this population about 25% of the mothers have an 'alternative lifestile', which might include an organic diet. In this study 300 samples of mothersmilk were available, as well as food consumption registration, and these were now investigated in cooperation with Rist from Switzerland and Uni Hamburg (milk-analyses).

Results were like in the 2000 study, but more differentiated, in connection to the food consumption of types of dairy and organic or biodynamic products. Results will be presented at the FQH Conference.

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THE INNER QUALITY CONCEPT

A concept for organic food quality

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1 DEMAND FOR A NEW QUALITY CONCEPT

Consumers expect organic producers to provide healthy and tasty products. But which qualities enhance health, and what is tasty? And how can all this be realised by crop or stock management?

In the conventional vision, product quality is mainly based on external, nutritive and sensory properties and is strongly directed by traders and trends. Besides tastiness and ripeness, organic consumers expect products to have properties such as 'vitality' and 'coherence', which are not easy to define and thus to explain and transfer.

In the past, experimental parameters have been proposed to estimate 'vitality' and 'coherence', but they were neither scientifically validated nor related to a validated quality concept with a relation to human health.

A quality concept which matches the expectations of the organic consumer with the organic view on agricultural production and human health was developed on the basis of two apple studies (Bloksma *et al.,* 2001, 2004) and a carrot study (Northolt *et al*., 2004). The new quality concept, Inner Quality, is based on the life processes of growth and differentiation, and their integration or balance. These life processes can be defined in plant physiological terms to link the concept to generally accepted science. Growth and differentiation (including ripening) are familiar processes for organic producers. They are aware that effective management of these processes are necessary to obtain a crop with higher resistance (against stress, pests and diseases) and a product with better taste and keeping quality and which may also be better for human health.

The purpose of this Inner Quality Concept is twofold: First, to link product properties to farm management during production. Organic growers manage the plant's life processes 'growth' and 'differentiation' to optimise quality in positive terms of taste, keeping quality and supposed healthfulness. Secondly, to verify the assumption of organic agricultural communities that healthy food needs to be ripe and coherent, with coherence defined as a high degree of organisation in the plant as a result of an optimal integration or balance of the growth and differentiation processes.

2 INTEGRATION OR BALANCE OF LIFE PROCESSES

We define ‘balance in life processes’ as: the crops have as a moderate resistance to stress and diseases and their food products are aromatic and firm. Some authors describe this as ‘maturing’ (Strube and Stolz, 2004) or ‘maximum natural development for vegetable growth, flowering and fruiting’. Biodynamic growers express this as ‘coherence’ and ‘plant-specificity’ (Koepf *et al*., 1976).

Defining optimum food quality as a balance in life processes is not a new concept. This mode of thought has long held sway among biodynamic researchers (e.g. Koepf *et al.*, 1976; Kunz, 1999) and in plant physiology (e.g. Herms and Mattson, 1992; Lerdau *et al.*, 1994). The way we use this idea, however, is new: the life processes are used to form a framework for a coherent quality concept including various quality properties.

Another new aspect of this concept is that it does not include a single optimum quality. For example, some consumers like green, firm, juicy apples, and others prefer blushed, sweet, aromatic apples. So, there is some freedom to choose a more growth-related or a more differentiation-related optimal balance between the ranges of a resistant crop.

In *Table 1* we present the Inner Quality Concept as it was developed for apple (Bloksma *et al.*, 2004). In Northolt *et al.* (2004) this is modified for a carrot crop, and the table can be generalised as basis for any crop (Bloksma *et al.* (in prep)).

3 VALIDATING THE CONCEPT: STEPS AND EXPERIMENTS

It is beyond the scope of this article to fully describe the – still ongoing - process of validation of the Inner Quality Concept. There is a risk of using circular reasoning when introducing a new overall quality concept such as the Inner Quality Concept that contains new aspects and new parameters. It is difficult to introduce an unknown aspect such as integration of growth and differentiation, to associate it with crop management measures and to measure it with experimental parameters such as luminescence and copperchloride - crystallisations, as is the case here.

A methodological foothold was achieved by simultaneously working on the theory of the new concept, and executing experiments to evaluate the concept (Streiner and Norman, 2001) (*Table 2*).

In order to find the range of and the optimal balance between growth and differentiation during cultivation, it is necessary to grow the crop under extreme conditions of growth and differentiation, and to demonstrate the consequences of one or the other for the harvested product. It is also necessary to know how the balance between the life processes can be managed during cultivation.

Experiments were designed with apples and carrot in which conditions were varied to induce the extremes of growth or differentiation in the crop (Bloksma *et al*., 2001, 2004; Northolt *et al.*, 2004). By comparing the results with our expectations, we partly completed the validation course for apple and carrot.

4 RESULTS

For the apple crop, as expected, higher fertilisation stimulated growth characteristics and caused a decline in differentiation characteristics: there was a longer period of shoot growth and there were more shoots, but there were also more fungal infections, darker and

Table 1: **The Inner Quality Concept for apple (Bloksma *et al.*, 2004)**

INNER QUALITY FOR APPLE		
CROP MANAGEMENT to regulate the growing crop *To communicate with the grower*	PROCESSES in the crop *To communicate with the grower*	PROPERTIES of the crop or the final product *To communicate with the grower, consumer and retailer*
1. Growth		
+ no limits in nutrients and water by optimal fertilising and watering + defruiting when heavy bearing + growth stimulating pruning + space (wide plant distance) - Root pruning - controlled drought stress - growth reducing pruning	• photosynthesis: primary metabolites (C-growth) • nitrogen (and other nutrients) uptake (N-growth • filling reserves with starch, protein, etc. • froming mass • maintenance of basic metabolism	• green vegetative mass, leaf size, tree vigour, fruit size, fruit weight, yield • Acid starch • amino acids, protein • firmness, juiciness, crispness • metabolic energy • many fungal diseases and sucking insects (aphid) • a high initial value in delayed luminescence • perradiation, fullness, expansion in CC-crystallisation pictures
2. Differentiation		
+ light and dry warm growing place + reducing heavy growth + binding down young twigs + hormone ethylene + beehives for pollination	• refining, ordering. • ripening : starch -> sugars; acid -> aroma • secundary metabolism • induction of pollen, seeds and flower buds	• differentiated refined forms (leaf serrations, cork). • order • calcium, firm cell walls • ethylen (= ripening hormone) • ripe colours (ellow ground on fruit, autumn leaves) • biting insects (blossom weevil, etc) and powdery mildew • yperbolic decay in delayed luminescence • structure in CC-crystallisation pictures
1+2 Integration		
+ growing phase-typical care for optimal proportion between	• interaction between growth and differentiation in a species and stage balance =	• Species- and stage-typical proportion of growth and differentiation properties (=

growth AND differentiation + balanced nutrients, regular and slow release of nutrients (compost) + appropriate varieties + diseases preventing soil (by compost?) + diversity? + human attention? + harmonious landscape? + biodynamic preparations?	'maturing' • forming secondary metabolites out of primary metabolites • self-regulating	'maturation') • tasty and red, glossy fruits = aroma + blush + shine + firmness + juciness + sweetness • high number of fertile generative organs (flower buds, seeds) • phenols, vitamin C, tannin, wax, resin • high ratio protein/total nitrogen • self-regulation, elasticity, ce;; turgor, resistance to stress and diseases • wound healing after damage • species-tpical in spectral range luminescence • coherence in CC-crystallisations

larger leaves, higher nitrogen levels in the bud, leaf and fruit, and more and stronger blossom formation for the following year. Higher levels of fertilisation resulted in larger apples which were less firm and slightly less tart, with less blush, a lower phenol content and a greater susceptibility to fruit rot. After two to three years it had become clear that the 0 kg N/ha and 40 kg N/ha regimes were too low and inadequate (the trees had a non-bearing year) and that fertilising with 160 kg N/ha was too much (more fruit rot, less tasty). For this orchard, a fertilisation regime of about 100 kg N/ha best achieved the two-fold objective of regular yield and optimal inner quality. This is what we call the optimal apple-specific balance between growth and differentiation.

***Table 2*: Validation route for the 'Inner Quality Concept'**

	completed (+) or partly (+/-)
1. Development of quality concept for organic products	
a. based on life processes (growth, differentiation and integration of both).	+
b. relating processes and properties (see *Table 1*).	+
c. making processes measurable by parameters	+
d. relating with holistic health concept by physicians and dieticians	+ / -
2. Testing face validity	
a. Life processes recognised by workers in the field (e.g. farmers).	+
b. Life processes recognised by specialists (e.g. physiologists).	+ / -
3. Testing content validity of concept	
a. Is concept consistent in itself?	+
b. Is concept consistent with current theories?	+ / -
4. Testing predictive validity of concept	
Is concept consistent with existing empirical data?	+ / -

5. Testing reliability of established parameters	
a. Good correlation between parameters for the same item? b. Same results by different observers and laboratories?	+ / - + / -
6. Responsivity to change	
Do parameters discriminate sufficiently?	+ / -
7. Development of a new parameter	
a. Parameter compared with established parameter in controlled field study.	+ / -
b. If no established parameter, the parameter is based on logical reasoning (here on physiological theories).	+ / -

Quality measurements related to the ripening processes were realised, comparing ripening at the tree with ripening during storage. Ripening during storage has conversion of starch into sugars and loss of firmness in common with ripening at the tree. Completing the ripening process while still at the tree results in increasing differentiation parameters like colour and taste, compared to ripening in storage (Bloksma *et al.*, 2001, 2004).

The design of the carrot experiment, with only three levels of fertilisation, light and ripeness, did not reveal the desired optimum levels. Series with at least five, and more extreme levels will give a better chance of finding significant results. The experiment did clearly show, however, that the best quality resulted from a combination of the lowest level of fertiliser, the highest degree of light and the latest harvest date. Carrots grown in these conditions had the best taste, lowest nitrate content and best keeping quality. All three factors shift the balance in favour of differentiation. The type of soil on which this experiment took place is highly conducive to growth: all management measures taken here should aim to reinforce the differentiation process.(Northolt *et al.*, 2004).

5 DISCUSSION AND CONCLUSIONS

The Inner Quality Concept based on life processes offers good perspectives as a tool for improving the production of high quality crops and measuring the health effects of these products in the future. Growth and differentiation are well distinguished. The integration aspect is still the weakest part of the concept and needs to be developed further.

Parameters are especially useful for the Inner Quality Concept when they express the three aspects of the concept: growth, differentiation and integration of the two. Such parameters might involve crop observations (e.g. a test of resistance to stress, diseases and pests), content analyses dealing with sugar/nitrogen ratios, physiological amino acid status and secondary metabolites (phenols), biocrystallisation pictures and spectral-range luminescence. These last two mentioned new holistic parameters have a secondary purpose: they also open scientists' eyes to new aspects resulting from life processes. In the future, they might be replaced by the cheaper content analyses.

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THE HITCHHIKER'S GUIDE TO FOOD QUALITY

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There exist two main topics in food quality research, which are of high relevance for both, small and medium enterprises (SMEs) and scientific institutes: Quality definitions (concepts, models) and laboratory methods detecting the quality's attributes. The quality of food is defined, when the measured attributes of a sample are related to human health. The sample's quality needs a relation of the data to processes or models. Laboratory methods as well as sensory analysis detect these attributes, which can then be related to the quality. Quality definitions or concepts are not applicable, if they cannot be related to measurement data. On the other hand methods need to be selected in connection to the quality concept.

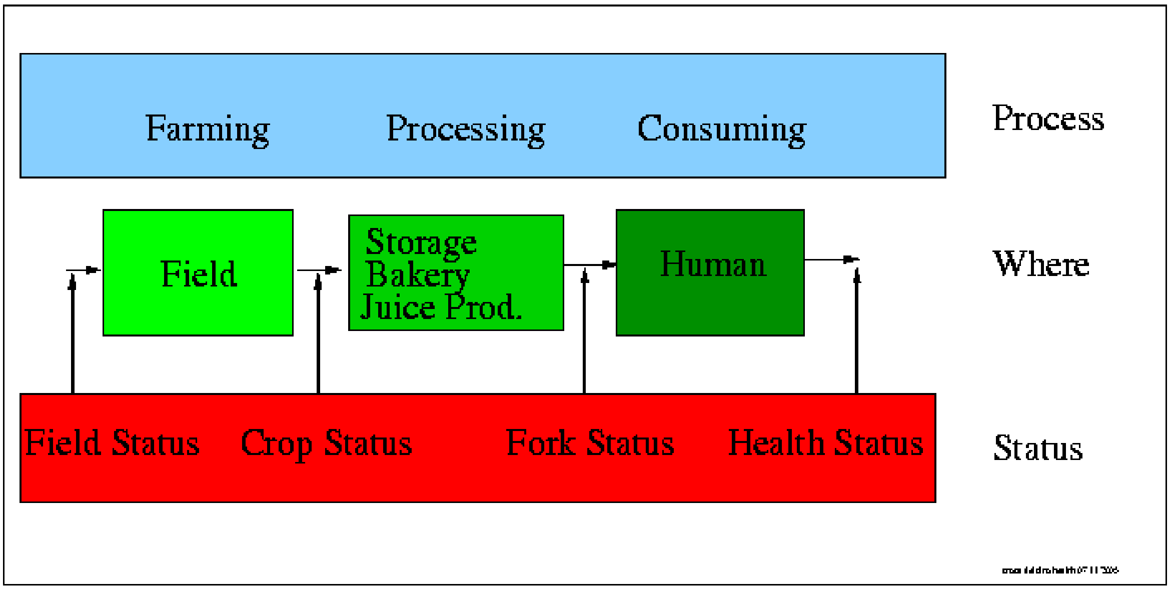

Figure 1: **Overview of the different processes between field and human and their relation to quality evaluation.**

Each status shown in *Figure 1* consists of different attributes. The different attributes can be classified according to statistical scales (*Table 1*) going from a nominal differentiation to a quantitative absolute measurement. Whereas most of the laboratory methods deliver attributes on a microscopic scale (therefore: analytical methods), the relation of these attributes to the sample quality or human health needs a macroscopic view. There is no doubt that single substances play an important role for human health. Their interactions with other compounds within the matrix (e.g. food), their orientation in the product structure as well as complex dose-response curves in intervention studies make it quite impossible to find simple relationships between the single constituent of the food and human health. Thus, every decade a new compound class is en vogue to cover THE health related compounds. Therefore methods are needed which give an answer on a macroscopic scale and take into consideration the organisation and the structure of the product. Although it is possible to follow the statistical scales top-down, the way back is impossible: The whole is more than the sum of its parts. This problem is described in scientific concepts, which are applied in various disciplines e.g. physics, (Ebeling *et al.* 1998). The concept of self-organization should be from of relevance also for food quality definitions because it can be applied for single methods (e.g. the biocrystallization) as well as multi-parameter approaches.

Table 1: **The statistical scales**

Scale	Example	Meaning of difference	Meaning of relation
Nominal	**carrot varieties**	**no meaning**	**no meaning**
Ordinal	**good, better, best**	**ranking, but the value of the difference has no meaning**	**no meaning**
Interval	**sensory analysis**	**difference value has a meaning**	**no meaning**
Relation	**carotenes**	**difference value has a meaning**	**zero value exists**

Therefore the first part of the presentation describes these different levels of quality measurements, statistical evaluation and summarises the conceptual work (N. Busscher: From concepts to roadmap). Different steps need to be gone successively towards health studies on organic food:

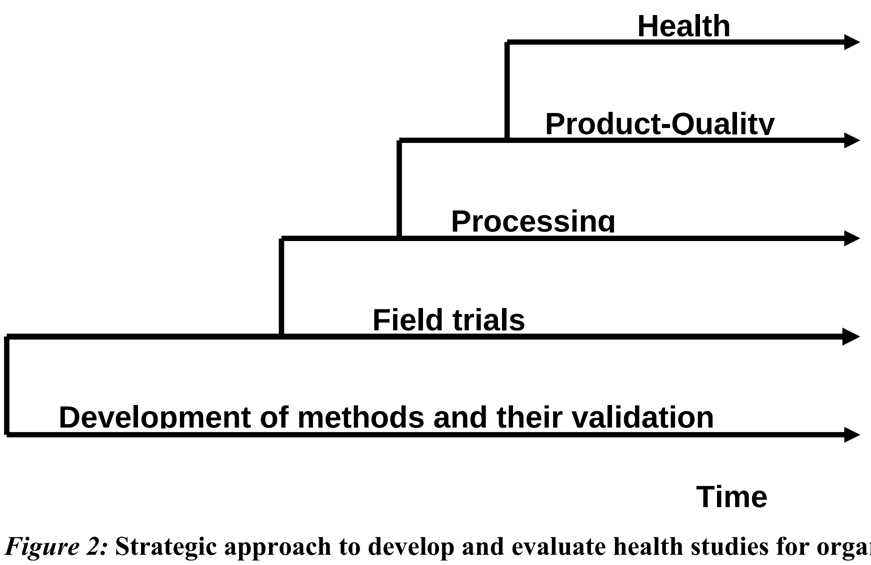

Figure 2: **Strategic approach to develop and evaluate health studies for organic products.**

Without valid methods, the results of field trials cannot be published. Without knowing the variation in the field, processing will not cover the whole range of different raw materials. Without field trials and processing investigations a product-quality range or even a product quality status (which needs to be defined, see statistical scales) cannot be established. Having these tools we just can say something about the product quality but not the food quality. Food quality can only be defined in relation to human health studies.

Our hypothesis is, that the organic movement is missing clear product quality oriented strategies and a definition which can complement the process-oriented regulations in order to meet the consumers interest. We looked over the IFOAM guidelines (IFOAM 2002) and found:

Scope: *The purpose of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people;*

Aim: *To produce sufficient quantities of high quality food, fiber and other products;*

and in ***6.3 Processing methods, General principles:*** *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.*

What means "high quality food" (and what is low quality?) and what means "vital quality" and how are both parameters measured? Do we really implement the WHO health definition in the strategic planning of health studies? From our opinion, moreover the product quality criteria and their limits have to be defined within the organic market.

In the second part of the presentation two different networks are presented (J. Kah: Status of the roadmap) as examples for possible strategic orientation within FQH. The first project contains the validation of the biocrystallization method within the FQH-"triangle" network. Validation means to proof if a laboratory method is able to answer a question from the customer or not. For validation procedures the question has to be specific to be answered and the method has to be characterised. The growing organic market needs methods which allow the characterisation of the sample. Therefore methods have to be developed which reflect the systemic approach in organic agriculture. First of all these methods shall differentiate food products grown and processed organically from those derived from other production processes. One of these methods is the biocrystallization. Here pictures with textural and structural features are produced which allow a multi-dimensional evaluation rather than single substance analysis. Reviews on comparative studies of effects of different farming systems on crop and product quality have concluded that the method has in several studies successfully discriminated the farming systems. However, the reviews also note that various methodological difficulties and insufficiencies existed, including a lack of a validated methodology, and the need for more objective means of evaluating the patterns (Soil Association, 2001; Tauscher *et al*., 2003).

In recent years initial efforts have been made to document, characterize and standardize the method, including optimization of crystallisation technique and development of computer software for image analysis of the patterns beside the visual evaluation based on selected morphological features (Kahl *et al*., 2003). The procedures are documented and the critical factors influencing the result in sample preparation and crystallization are tested. Moreover reproducibility of the method was tested between the 3 partner laboratories. For detecting the day-to-day variation of the system a standard control card was established, which later shall allow to develop a standard reference material for this method. In *Figure 3* a standard control card is shown for freeze dried wheat samples evaluated with a texture analysis program. The main part of the work was to integrate the different methodological approaches and to adapt validation procedures which are applied for analytical techniques to the biocrystallization method. Whereas visual descriptive evaluation of the pictures is working on a nominal scale, the structure oriented trained panel profiling approach as well as the texture analysis program allow differentiation of samples on the ordinal and interval scale.

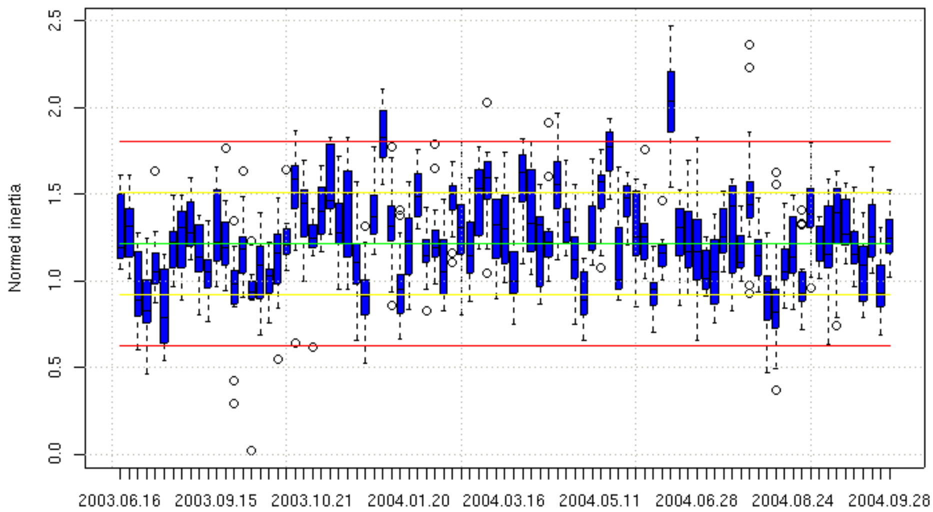

Figure 3: **The result of the texture analysis with variable inertia and ROI80 for standard wheat samples in every chamber run (here 2 chambers together) over a period of a year (biocrystallization method).**

To evaluate the pictures statistically a linear-mixed-effects model (Lindsey 1994) was developed in order to reflect the variation of the results in the different steps of laboratory procedures.

The second project is based on a data base approach, where different methods measuring defined attributes of different products are combined. This approach may meet the SME´s interest of an applicable tool in the direction towards a quality status of organic food products. Different FQH members are working in two German governmental projects since 2002 to differentiate organic from conventional products using more than 150 different method parameters including the statistical correlation and multivariate optimisation. Wheat, carrot, apples and maize samples are derived from organic and conventional production (4-6 pairs from different locations per product over a 2 year period). Although the project is not finished yet, the problems, difficulties and achievements in organizing such a project and collecting the data in a uniformed format for uni- and multivariate statistical analysis are discussed. Because the sampling cannot be validated for each single method (costs and time), we documented it in standard operation procedures according to existing regulations and norms. Furthermore the samples are coded (by a governmental institute, FAL-OEL) before they are send to each laboratory. To collect the different data we defined the format and the way to transfer the data. After collecting, the data are formally checked and later evaluated statistically. The statistical evaluation contains different steps: The test of the differentiation ability for each single method and parameter, the correlation with results achieved from other methods and a multivariate optimization of the differentiation ability of each single method as well as method combinations. The results are available via internet for all project-partners. *Figure 4* shows the front page of the product quality measurement documentation.

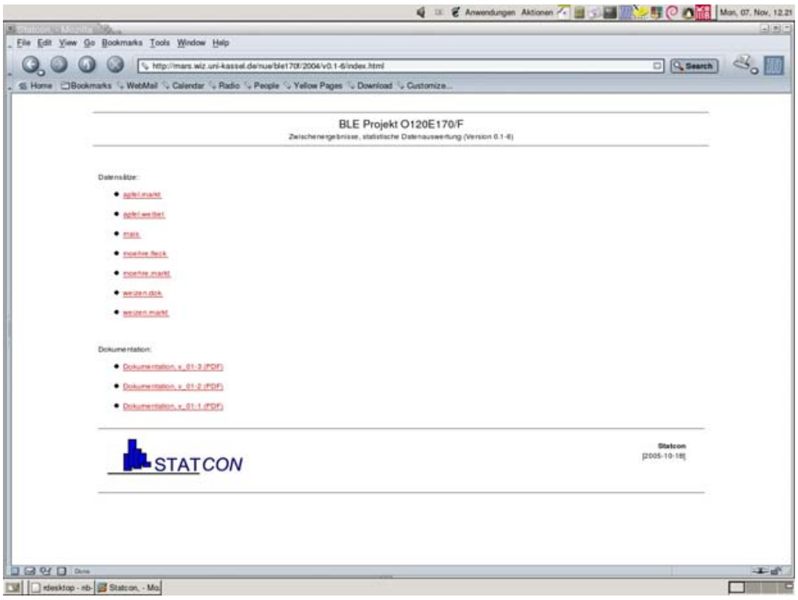

Figure 4: **Front-page of the plat-form, where the results of the different quality parameters and the statistical correlation is visible for the project-partners via Internet.**

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WHO Definition Health, www.who.int/en/

ABILITY TO RESIST DEGRADATION FROM STRESSFUL CONDITIONS AS A QUALITY INDICATOR -

A newly developed microwave heating test for biocrystallisation

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1 INTRODUCTION

In the organic quality research the ability of a crop to reach physiological ripeness at harvest is an important quality indicator, and similarly the ability to preserve crop-specific characteristics (outer morphological characteristics, colour, taste, aroma, content of nutritional compounds), during post-harvest conditions. Correspondingly there is an interest in degradation tests, i.e. methods for determining the ability of crop and food samples to preserve these characteristics during stressful conditions.

This ability is widely appreciated in the organic movement, and seen in the context of one of the basic starting points underlying organic farming, namely that '... healthy plants give healthy animals and humans'. Thus conceptually plant health may be defined as 'the ability to build up and preserve a high degree of order in the crop-specific life-processes under constant pressure from the surroundings'. This correlation between physiological ripeness, ability to resist degradation and nutritional value is generally emphasised, whereas in conventional research e.g. a poor storage ability is more seen in an economic context.

Several degradation tests, also termed self-decomposition and stress tests, are available, based on e.g. grating or juicing of the sample in combination with subsequent exposure to increased air temperature and humidity, with and without microbial inoculation. In several investigations such tests have successfully discriminated conventional and organic samples, in favour of the organic. However, results from different stress tests may vary considerably among each other, and also discrepancies are found between results from storage ability investigations (spoilage, weight loss) and results from 'in vitro' degradation tests. Furthermore, detailed documentation of experimental procedures are generally not available.

A broader application of degradation tests will clearly benefit from the following three steps: (1) detailed documentation of the experimental procedures; (2) deepening of our understanding of the plant physiological background associated with autolytic and microbial degradation processes; and (3) documentation of the closer correlation between the ability to resist degradation and nutritional properties.

2 A DEGRADATION TEST FOR BIOCRYSTALLISATION BASED ON MICROWAVE HEATING OF JUICES

Within the project 'Effects of microwave heating on the picture-developing properties of foods, as examined by means of a degradation test for biocrystallisation' a degradation test was developed by BRAD. The project was performed in cooperation between BRAD, University of Kassel (D), Louis Bolk Institute (NL) and Kristallisationslabor (CH). The labs tested out the developed experimental procedure, based on two organic carrot samples (K, L) with known differences in physiological ripeness as reflected in chemical-analytical properties. The samples, originating from two different fields, and even from two varieties, may be roughly described as 'sub-optimally ripe' (K) vs. 'optimally ripe' (L), see *Table 1*.

Table 1: **Chemical-analytical parameters of the carrot samples K and L, including content of nitrate (mg/kg), total N (g/199g), glucose (g/100g), sucrose (g/100g) and dry matter (g/100g).**

	K	L
Nitrate	130	110
Total N	0.1	0.1
Glucose	1.54	1.63
Sucrose	1.93	2.30
Dry matter	9.1	9.2

The heating procedure generates a heating of 200 ml juice contained in a 250 ml glass beaker to 80-84^{o}C. The samples were shipped around as freshly harvested, and examined at the 4 labs, applying the heating procedure 0-3x successively with intermediate cooling to 25^{o}C. At the 3 so-called Triangle labs was applied a mixing ratio between the juice and the reagent CuCl2 (95/125), whichs represents an additional 'stress factor' during evaporation due to a relatively high concentration of the reagent, thereby generating pictures with a relative minimum of ramification stems. At Kristallisationslabor was applied a mixing ratio (180/150) which in combination with the applied crystallisation techniques yielded pictures with a relative maximum of ramification stems.

The biocrystallisation pictures were evaluated visually, based on ranking of 9 selected morphological criteria relative to reference scales from 1 to 9 where high values are desired. The ranking was performed relative to reference pictures representing the scale levels 1, 4, 7 and 9.

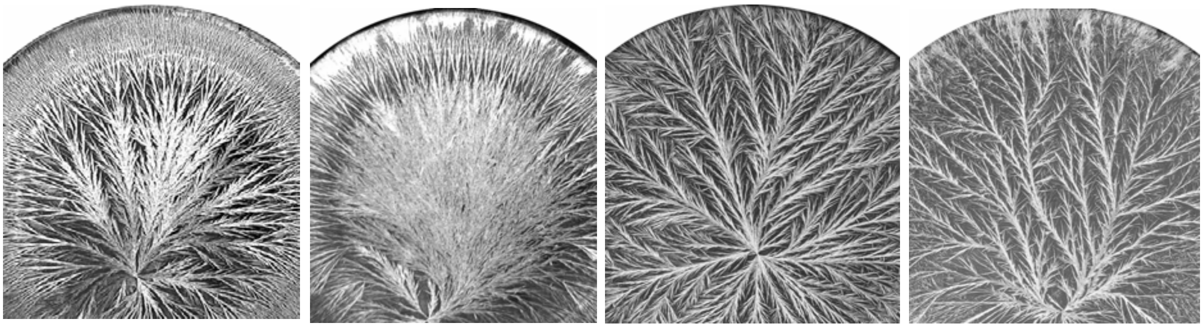

***Figure1-4:* Sections of pictures representing the treatments 0x (Fig. 1 and 3) and 2x (Fig. 2 and 4), from BRAD (Fig. 1-2) and Kristallisationslabor (Fig. 3-4).**

3 RESULTS

Figure 1-4 show sections of pictures representing the treatments 0x and 2x microwave heating for the sample K. The statistical analysis of the ranking data showed that the optimally ripe carrot sample (L) had significantly better ability to resist the loss of picture-developing properties from the microwave heating than the sub-optimally ripe (K). I.e. by means of the test the ability to discriminate the two samples was markedly improved. *Table 2* shows the key mean scores involving the two carrot samples (K,L), the 4 microwave heating treatments (0x-3x) and the 9 morphological criteria, based on ranking data from all 4 labs. Note that at Kristallisationslabor the treatments 3x was not applied.

***Table 2:* Mean ranking scores involving the two carrot samples (K,L), the 4 microwave heating treatments (0x-3x) and the 9 selected morphological criteria, based on data from 4 labs.**

	0x	**1x**	**2x**	**3x**
Means crit. 1-9 (K,L)	6.7	4.9	4.5	4.6
Means K	6.5	4.5	4.2	4.7
Means L	6.9	5.3	4.8	4.6
Means L-K	0.4	0.8	0.6	-0.1

4 CONCLUSION AND PERSPECTIVES

As can be seen from *Figure 1-4* and *Table 2* the combined microwave heating treatments have a marked degradative effect on the picture-developing properties which are observed for the untreated juice (0x). Interestingly, already the first treatment (1x) generates a serious decrease in the carrot-specific morphological characteristics, and simultaneously improves markedly the ability to discriminate the two samples, here in favour of the optimally ripe sample L. For the applied samples and procedures no additional discriminative ability is gained from treatment 2x. Finally, treatment 3x generally shows an inconsistent pattern of evaluation over the 9 criteria, and seems to be of little value for future investigations.

Since several parameters associated with physiological ripening (increase in dry matter, various vitamins, disaccharides and polyphenols; decrease in nitrate) are known to be nutritionally important, it may be hypothesised that the degradation test reflects relevant aspects of the nutritional value of the sample. More final conclusions concerning the potential and 'message' of the test may be drawn after application in connection with: (a) various crop and food quality investigations, in order to examine to which degree the present results may be generalised; (b) comparative investigations on conventional and organic samples; (c) animal and human nutritional investigations.

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QUALITY OF FOOD PROCESSING PART I: PROCESSOR'S AND FOODPROCESSING EXPERTS' UNDERSTANDING OF QUALITY CRITERIA

RESULTS OF THE DELPHI SURVEY

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1 BACKGROUND

1.1 Study design

The goal of the subproject 5 in the EU project "Quality of Low Input Food" is to develop a framework for the design of "minimum" and "low input" processing strategies, which guarantee quality and food safety. The method chosen was the Delphi method. The survey was carried out in form of a two-step Delphi survey. In the first round 250 experts in 13 countries in Europe were involved, and were asked to respond to a standardised questionnaire in October and November 2004 and the second round in March to Mai 2005. The Delphi expert survey was designed in such a way that the most important and currently discussed aspects regarding organic food processing have been taken up.

Table 1: **120 experts from 13 countries answered the first round and 83 experts from 13 countries answered the second round.**

Countries	Frequency 1st in %	Frequency 2nd in %
Switzerland	21	27
Germany	14	16
Austria	14	13
Czech Republic	11	11
Great Britain	8	6
Spain	8	6

Italy	6	6
France	6	6
Finland	4	5
Denmark	3	2
Belgium	3	1
Netherlands	1	1
Slovakia	1	0

1.2 Expert selection

Chosen as experts were processors and a number of non-processors.

Table 2: **Distribution of the random sample with regard to activities of the first and the second round.**

Activities	Distribution 1st in %	Distribution 2nd in %
Food processing companies	55	46
Adviser	16	18
Research institutes	8	14
Processing standard setting/certification organisations	13	12
Consumer organisations	5	6
Government agencies	3	4

2 DEFINING ORGANIC FOOD PROCESSING

The main focus of the first part of the survey was to narrow and clarify definitions, which are often used to characterize organic food processing. When asking questions about minimum processing and freshness/fresh produce the answers did not vary very much. However exploring the definition of careful processing and authenticity the experts had a quite different understanding of these terms. On the other hand in the second round of the survey, we found out that authenticity is regarded as very important for an organic product. In the second survey we tried to find a suitable definition. The definitions with the best acceptations of the terms **careful processing, fresh product and authenticity** are as follows:

Careful processing: **“the maximum to keep the important compounds and the maximum to avoid undesired compounds or nutritional losses”.**

Fresh product: **Product with a short shelf life needs to be stored at a specific temperature or under controlled temperature conditions”.**

Authenticity: **"Production and processing steps and the origin are visible/recognizable to the consumer"**

A final definition of the terms "fresh product, careful processing and authenticity" seems not to be of such a high need, as originally expected. Based on the feedback from the experts we can conclude that instead of a final definition of the terms "careful processing" and "authenticity" a more elaborated definition of the production methods as well a good labelling would be more helpful for the producers as well for the consumers, when the intent of these two terms can be addressed indirectly.

2.1 Important aspects in organic food processing

Most interesting of part two of the survey was the finding that aspects like sensory quality, freshness, minimum use of additives and authenticity are regarded as the most important aspects for the success on the market, all aspects that are recognizable to the consumer.

2.2 Food safety

Regarding food safety issues most of the experts do not expect more problems with organic food compared to conventional food. Nevertheless there are some experts which mentioned expecting more food safety problems: higher contamination by mould spores and other spores problems; the reduced use of preservatives in food would increase the risk of contamination of the food by micro-organisms and their toxins; animal problem with parasites and higher residues of dioxin in organic eggs due to the free range production; problems because of the restrictions in cleaning and disinfection. Several times the problem was described, that organic farmers and processors need to understand that organic farming practices often mean that naturally occurring mycotoxins and toxic micro-organisms might be more likely on their farms and therefore all the operators must make sure that simple and adequate systems are in place to prevent those entering the food chain.

2.3 Regulation in organic food processing

An important question was "which aspects should be regulated" on an EU regulation level and which ones on other levels (national, private company or label level). The feedback from the experts was quite differentiated depending on the different areas. On the EU regulatory level, in first priority the minimum use of additives, followed by minimum and careful processing was mentioned. Quality/sensory aspects however were not seen to be primarily on EU level, because they are quite different in the different countries of Europe.

We can conclude, based on the feedback from the food processing specialists and processors in the Delphi Survey, that in the future revision of the EU regulation 2092/91 a much more differentiated approach is necessary:

- **EU regulation / State regulations:** regulatory framework but with more flexibility for regional variation and private sector rules.
- **Private standards:** focussing really on the special quality and regional aspects.
- **Private company level (intern quality standards):** focus on the special sensoric quality and general quality management.

The experts recommended clearly that some new instruments should be developed:

- **Common "Code of practise" of the organic food sector:** setting the overall baseline for sustainability and health aspects => IFOAM and private umbrella organisations (e.g. of organic food processors)
- **GMP (Good manufacturing practices):** elaborated by organic and other advisory/consultancy services specialised for organic agriculture and organic food processing.

***Table 3*: What to regulate on which level.**

ISSUE	**Relevant in survey**	**EU Reg. /state (all)**	EUReg/state (processors)	**Private standard**	**Private company**	**Code of Practise**	**GMP private**
Freshness	high	+	~	+	+	+	+
Minimum/careful processing	high	++	++	+	~	+	~
Minimal use of additives	high	+++	+++	~	~	~	~
Sensory quality	medium		~		++	+	+
Environ. friendly processing	high	+	~	+	~	+	+
Environ. friendly packaging	high	+	~	+	+	+	+
Social standards	medium	~	~	+	~	+	+
Regionality	medium	~	~	++	+	~	+
Seasonality	Lower	~	~	+	+	+	~
Whole food	Lower	~	~	~	~	+	+
Health aspects	lower	+	~	~	~	+	+
Authenticity	high	+	++	+	~	~	~
Restricted use sugar/salts	No	~	~	~	~	~	~

Scale: 0-15 % of experts = ~ not significant 15-30 % = + 30-45 % = ++ > 45 % = +++

With regard to the question if the EU-Regulation 2092/91 is sufficient there an interesting difference between the answers of the processors and the non-processors could be observed. 45.5 % of the food processors think EU Regulation 2092/91 is sufficient as opposed to only 33.3% of the non-processing organisations. This difference between food processors and non-processing organisations could be found several times. We need to think about how this discrepancy can be reduced. But in general it can be stated that, with the exception of having clear rules for the minimum use of additives and processing aids, no significant preferences or only tendencies regarding the possible ways to regulate or harmonise different aspects of organic food processing have been identified. A "code of practice" for the organic food sector seems however to be a good instrument which would allow not all issues to be described in detail in the EU regulation 2092/91. The organic food sector should take more self-responsibility by defining such a Code of Practise. A general Code of Practise for organic food processing will be elaborated and published as outcome of the QLIF subproject 5 until the end of 2005. (see: www.qlif.org)

In general most of the experts expect special processing methods to be used in the production of organic food but when asking more specific for the involved experts it was very difficult to select those methods that are usable/suitable or not usable/suitable for it. Regarding the use of additives, the answers given however were very clear. There is a tendency to prefer additives from certified organic origin both from processors as well as from non-processors point of view. Furthermore clear separation guidelines based on HACCP concepts (organic HACCP) in order to reduce the risk of contamination with GMO or conventional pesticides were supported, in particular by 64.8% of the experts from non-processing organisations. Processors show a nearly equal result of 45.3% pro and 39.1% contra HACCP guidelines. With regard to stricter labelling requirements the non-processing organisations prefer to have stricter guidelines. The same preference was also expressed regarding packaging.

3 PROBLEMS OF THE EXPERIMENTAL DESIGN

For the experimental design the Delphi method was chosen. In essence, it is a process allowing a group of experts to participate jointly in defining and analysing complex problems or issues where information is fragmentary or inaccessible, by contributing to successive rounds of information gathering, receiving feedback and, as a result, refining the information gathering process in the subsequent round.

In the second round of this survey we concretized the definitions and several aspects of the EU regulation 2092/91. These aspects were formulated in the fist survey in an open way. With the Delphi method in the second round only those experts were contacted, which answered the first round. This brings about the advantage that it can be verified, if the results had changed or were confirmed again. On the other hand experience has shown that a number of experts prefer to reply, when they can make clear statements. Therefore they might not have answered in the first round, where the questions were more explorative and therefore open but more time-demanding. Consequently, these very important opinions of those experts are missing.

Another problem was the unequal participation of different countries (which was strongly influenced by the capabilities of our national facilitators in the different countries), which had a strong influence on the analysis of the results. For ameliorating the analysis we identified different countries, which are in a different stage of development of the organic market. This helped to counter-balance the unequal participation of individual countries.

Another problem concerned the language. To reach also the people in the new EU member states for future research surveys have to be translated in their languages. English is not that commonly understood as expected.

4 WHAT CAN FQH LEARN FOR FURTHER INVESTIGATIONS?

The Delphi method described by Linstone and Turoff could be advanced in the following direction:

- The principle of the methodology that in the first round open questions and in the second and third round more closed questions are being asked, should be retained.

- In the second and third round we should involved all experts again, but the analysis has to be done in two categories: experts answering all rounds, experts answering only the last round.

The advantage would be, that we can see that the results are verified with the answers of the experts which answered all rounds. Additionally, we would get the opinion of all experts, when precise statements are inquired.

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QUALITY OF FOOD PROCESSING PART II – CONSUMERS UNDERSTANDING OF QUALITY CRITERIA

RESULTS OF A LITERATURE SURVEY

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ABSTRACT

The results are based on work being carried out in a subproject on processing in an EU-funded project on the "Quality of low input food". The literature survey focuses on the underlying principles in organic food processing, which are quite different depending of different types of products, different processing standards and marketing concepts. Some of the principles are basic (e.g. the use of certified organic ingredients, a certified production chain and a minimised use of additives), others are shared broadly (e.g. more careful processing methods, naturalness) and some principles are in discussion mainly in the private sector (e.g. environmental management concepts, social requirements, regional focus).

The report shows that the EU-Regulation 2092/91 covers a number of consumer perceptions such as certification system, traceability, minimal use of additives, labelling concepts and the use of organic raw materials. However other consumer expectations are not fulfilled such as careful processing, freshness, healthy nutrition or fair trade. The future development of organic food processing should follow a more "fork to farm" approach. Consumer expectations should be better taken into account. Innovative solutions/technologies are needed using natural substances with more appropriate technologies and/or less critical additives and processing aids.

1 INTRODUCTION/PROBLEM

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. Until now organic food processing standards prohibit 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 or processing methods but not others. 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.

2 METHODOLOGY

The objective of a 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.

3 RESULTS AND BRIEF DISCUSSION

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), reflecting 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. 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 processing standards for each product group.

Table 1: **Main differences in the processing of organic foods: Comparison of EU Reg. 2092/91 and private processing 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

In *Figure 1* 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 of 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.

With regard to controversial areas related to the main product groups, 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.

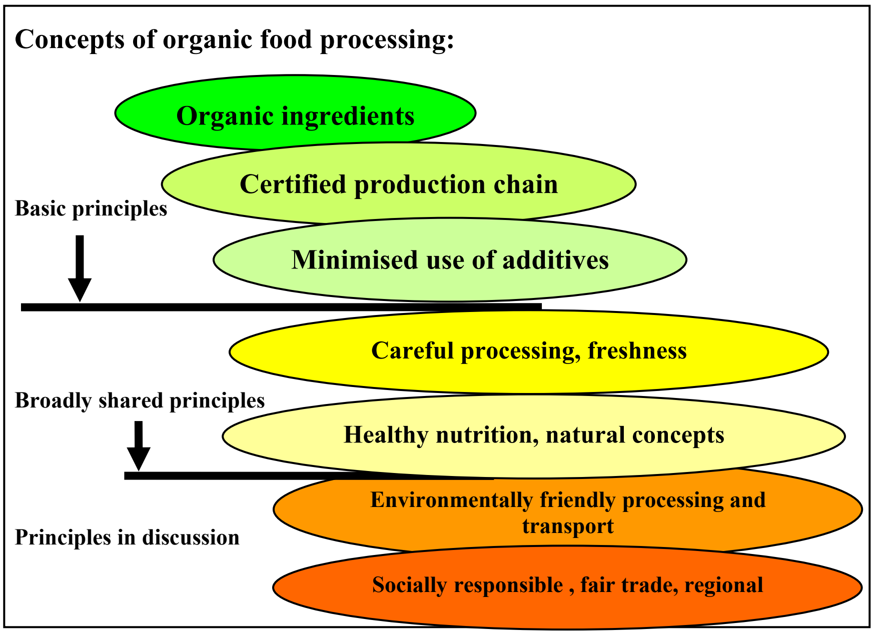

Figure 1: **Overview of principles for organic food processing**

Apparently there is a lack of guiding principles and related criteria, which are needed to make a decision about such methods. An interesting guiding principle can be summarised with the term “care” “or carefulness”, which is also proposed as overarching principle for the new IFOAM Basic Standards, which can very well be used for processing of organic food.

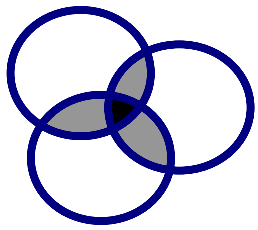

Figure 2: **The broad definition of careful processing**

However, organic food sector is under pressure, since 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. Nevertheless, the given narrow regulatory framework can also stimulate 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 might results in higher production costs. Therefore it is important that the benefits for the consumer can be communicated. But what are the perceptions of consumers towards organic food processing? *Table 2* shows a comparison of perceptions of consumer of organic food 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.

Table 2: **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 (and IFOAM BS)**	**Covered on company level**
Limitation of chemicals	Organic ingredients	Covered	Covered	Covered
	Minimized use of additives	Covered	Covered	Covered

Main topics of consumer perceptions	**Corresponding identified principles for organic food processing**	**Covered by EU-Regulation 2092/91**	**Covered by private standards (and IFOAM BS)**	**Covered on company level**
	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	No	Partly	Partly
Better Taste	Organic ingredients	Covered	Covered	Covered
	Careful processing	No	Partly	Partly
	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	Party	Partly

4 CONCLUSIONS

To enable a consistent further development of the EU Regulation 2092/91 and other standards for organic food and farming, 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 as well as other international standards like IFOAM Basic Standards or Codex Alimentarius can cause problems. Therefore it is important to clarify the situation and to build a solid link between the regulations and consumer perceptions. The principle of “carefulness” / “careful processing” might be helpful for the communication between manufactories and retailers with consumers.

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CAMPYLOBACTER AND POULTRY

Enhanced biodiversity; a risk to food safety?

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1 BACKGROUND

1.1 Organic farming, the environment and food safety

Organic farming is well documented and widely accepted as having a beneficial impact on the environment (Hole *et al.*, 2005; Fuller *et al.*, 2005). However, it has been suggested that this benefit might increase the risk to food safety. There is a school of thought that as the biodiversity and biomass of wild animals and birds increase, the risk of these creatures introducing and transmitting food borne pathogens to farm animals, and then into the human food chain, is increased.

Campylobacter has been suggested as a particular risk for organic and free-range poultry systems. This is because wild animals and birds are known to be potential carriers of this pathogen. It has been suggested that, through contact with faecal matter from these animals and birds, the pathogen could be transmitted to poultry flocks (Bates *et al.*, 2005) and create a risk to subsequent carcase meat and therefore food safety.

2 CAMPYLOBACTOR AND ORGANIC POULTRY

2.1 Approaches

Preliminary trials based at a highly biodiverse UK organic farm that produced organically certified poultry (table chicken) were used to explore this issue. The presence of campylobacter through the production cycle, in the birds themselves and their environment, and around the range was investigated. In addition to this the general farm environment was investigated for the presence of campylobacter. This included various areas, parts or 'sites' on the farm that could potentially transmit the campylobacter pathogen to the poultry. These were generally areas of the farm with different activities and levels of biodiversity, with particular attention to 'areas' close to or relevant to the poultry enterprise. Broadly, these areas covered poultry sites, biodiversity 'hotspots', other livestock, and aspects of poultry management, including vehicles used to service the poultry system and stock-people team. This was undertaken to investigate whether and if so how, where and when campylobacter enters the system. The study was also undertaken to investigate whether Campylobacter can be associated with the systems increased biodiversity.

A range of appropriate samples was taken from the various areas, locations and activities around the farm. These included both faecal and owl pellet samples and environmental swabs. All samples were sent for testing using Royal Mail guaranteed next day delivery to ensure samples were as fresh and viable as possible, to a certified laboratory for analysis.

2.2 Results

Campylobactor positive results were found within the poultry production system within 2 and 5 weeks (see Table 1) and at a number of locations around the farm (See *Table 2*).

***Table 1*: Campylobacter test results from poultry in an organic production system**

Age of birds (weeks)	Results from cohort 1	Result from cohort 2
1	-	-
2	-	+
3	-	+
4	-	+
5	+	+
6	+	+
7	+	+
8	+	-
9	+	+
10	+	+

The distribution of positive results does not suggest that it is associated with being organic or with the increase in biodiversity found on organic farms. The samples, which were found to be campylobacter positive, are from species that are present on conventional broiler farms as well as organic farms, including rats and sparrows, and have been found to be transmission vectors for conventional broilers (Bates *et al*., 2004, Chuma *et al*., 2000, and Hänninen, 2004).

2.3 Discussion & Conclusions

The study suggests no real effect of the increase in biodiversity on organic farms. The samples, which were campylobacter positive, are from species that are present on conventional broiler farms, such as rats and sparrows, and have been found to be transmission vectors for conventional broilers (Chuma et al., 2000). The study does suggest however, some possible issues with management that may be acting as a route of transmission of campylobacter between different flocks on this specific farm. The study identified a possible role for livestock in the transmission of campylobacter between different flocks, and suggested that efforts should be made to keep these enterprises as separate as possible.

***Table 2*: Campylobacter test results from environmental samples**

Details	Result	Details	Result
Sample type Faeces.			
Wild bird faeces	-	Rabbit faeces	-
Rabbit faeces	-	Wild bird faeces	-
Badger faeces	-	Wild bird faeces	-
Wild bird faeces	-	Rook and Seagull faeces	+
Badger faeces	-	Rabbit faeces	-
Rat / mammal faeces	-	Dog faeces	+
Fox faeces	-	Rook and Seagull faeces	-
Wild bird faeces	-	Rook faeces	+
Rat faeces By box	-	Wild bird faeces	-
Rat faeces Drier sample	+	Wild bird faeces	-
Sparrow faeces	-	Wild bird faeces	+
Fox faeces	-	Rabbit faeces	-
Rabbit faeces	-	Pig faeces	+
Badger faeces	+	Cattle faeces	+
Sparrow faeces	-	Sheep faeces	-
Sparrow faeces	+	Sheep faeces	-
Wild bird faeces	-	Pig faeces	+
Wild bird faeces	-	Sheep faeces	+
Rat faeces	-	Sheep faeces	-
Rabbit faeces	-	Chicken faeces from module holding area	+
Sample Type: Swab			
Stock dove nest box	-	Feeder	-
Barn Floor	-	Feed shot	-
Barn Walls	-	Boots of stockpeople	+
Nest material	-	Previous field shed site	-
Owl pellet and droppings	-	New site for clean shed	-

Nest boxes	-	Bikes and tyres	+
Sparrow faeces	+	Tyres and forks	+
Fence	-	Tyres and forks	-
Wild bird faeces	+	Tyres from truck	+
Sample Type: Other			
Owl pellet	-	Mixed sample from compost strips	-

Issues have also been raised about the difficultly when sampling for biodiversity, of identifying samples with viable campylobacter pathogen within it. Although the fragility of the campylobacter pathogen in relation to oxygen and cold, would seem to be an inhibiting factor positive thing in terms of the transmission from wild animals to poultry flocks, the sheer volume of poultry on the farm and means that this fragility is overcome. Further work is needed to explore the complex relationship between campylobacter and presence and it transmission into organic poultry flocks.

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DOES "THE" ORGANIC CONSUMER EXIST?

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INTRODUCTION

Alnatura is a trader and retailer of organic products, seated in Bickenbach, Germany, which runs 21 organic super markets and sells its product range of about 600 organic products under the own brand name "Alnatura" to trade partners, who operate over 2.000 outlets (drugstores, food stores) in Germany and Austria as well as in several eastern European countries.

1 CONSUMER ORIENTATION

Alnatura prides itself on being a very consumer oriented trader, i. e. on observing and reacting to consumer trends and wishes quickly and in an open-minded way, not being weary of the ever changing demands and preferences of consumption patterns today.

2 CONSUMER GROUPS

Young families with small children are customers in Alnatura shops or of Alnatura products.

But young urban professionals – singles or couples – as well as older persons (empty nesters) frequent Alnatura shops, too. The customers belong to health oriented and also to lifestyle oriented consumer groups.

Sociologists observe a process of "social fragmentation". Families with one or two or in rare cases more than two children still form the largest group of households. But a whole other range of household sizes and compositions exists as well, many of the singles – older or younger. Families with more than two generations under one roof are practically "extinct" in western societies.

Small households, usually with sufficient income, a high degree of mobility – often in connection with varied professional careers –, an increasing level of education and the growing desire as well as competence, to find out, what is good for oneself and to care for oneself represent the "typical" customers of organic products and shops. The trends and wishes of this group undergo rapid changes, they are quite heterogenous, and the only trait which is "typical" is, that there are very few "typical" characteristics!

2.1 Information and transparency

Modern, well-educated consumers are well informed; they use the wealth of information, which the internet provides, quite ably. They know a lot about topics, in which they are interested. They expect to get an answer to their questions quickly from a trader or processor, who offers organic products. But they do not wish to be lectured. Information must be presented in a credible way, it must underline the authentic self-presentation of the operation.

2.2 Taste

Organic consumers expect the products to taste excellent. The mere fact that a product is organic, is not accepted as an excuse for a taste and presentation of an organic food product, which is not up to standard.

2.3 Health, Wellness and Quality

Organic products are "good for you". They are expected to be healthy. They must not contain any bad thing in the world – calories, sugar which attacks the teeth, pesticide residues, other contaminants, genetically modified substances etc. The rational, well educated and informed consumer turns "archaic", once s/he learns that organic products might not be straight from paradise.

Environmental concerns or the explicit intentions to support organic farmers or farming are losing their motivation power for organic products. Social aspects, especially the expectation of fair trade practices are gaining importance. But these more altruistic motivators follow the egoistic drivers with a large distance.

2.4 Lifestyle

For a large portion of consumers, organic products are associated with a modern lifestyle. If products are presented in the "right" environment, this connotation is enhanced. An ever smaller group of consumers expects organic shops and products to be small, simple, rough and pure. People, who do not consume organic products, tend to associate the products as well as their consumers with the "old", alternative and slightly ideological image of the past.

2.5 Price

Food – at least in Germany – may not cost much. The share of income, devoted to buying food, is decreasing continually. In Germany, it has reached an average of about 11 % - in the 1960's the share was still around 30 %. Organic consumers know that these products are slightly more expensive than "normal" products. They are quite sure of this, because only a very small group of less than 5 % of the consumers buy mostly or only organic products. By far the largest share of consumers buy food in several other shops as well, among them discounters like Aldi, Lidl, Penny etc. They buy organic products as part of the food they consume, something they especially like, a treat or a necessity that they do not find in other shops, or not in the desired quality. A "reasonable" price is definitely an argument for buying organic products or for buying them more often.

2.6 Variety and Innovation

Like all modern consumers in western societies, where all the goods are available everywhere and at all times, organic consumers expect an attractive variety of organic foods of fresh quality. And they enjoy finding innovations, i. e. new products and ideas, which they try out and either integrate into there shopping lists or not.

3 CONCLUSION

"The" typical organic consumer does not exist; he or she is a modern, well educated consumer, who wishes excellent products at reasonable prices and who is more critical with organic than with "normal" foods, easily disappointed when the product quality or its presentation are seen as below standard.

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APPROACHES FOR ORGANIC PRODUCTS

Implications of recent consumer study results

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5 INTRODUCTION

In recent years, several studies have analysed the differences between consumer groups with regard to the quantities of organic produce such groups consume (Richter *et al*., 2000; Richter *et al.*, 2004a; Zanoli, 2004). Most have used a two- or three-category segmentation – non-buyers, occasional buyers and regular buyers of organic food. The main goal of these studies has been to explore the behaviour and attitudes of the target group of occasional buyers, in order to derive appropriate marketing concepts for organic food which match the requirements of this group. Furthermore, barriers have been identified which hamper greater consumption of organic food by occasional buyers. The results indicate a similarity of non-buyers and occasional buyers with regard to their attitudes concerning organic food consumption. While regular organic food buyers express a preference for organic farming in general when buying ‘organic’, occasional buyers are looking for ‘safe and clean’ or special-quality food when they decide to buy organic produce (Richter, 2004).

Consequently occasional buyers often buy selected organic food items according to perceived added value in terms of quality or food safety. They clearly take a more critical view of organic food and the organic farming concept in general than regular buyers do. They are therefore only willing to pay higher prices for certain organic products (such as eggs, carrots, lemons), in certain situations (e.g. in periods of conventional food scandals), in certain phases of their lifecycle (in pregnancy, with babies or after a serious illness), when organic food is provided in extraordinary quality, or when the sale of organic food is connected to a special price offer (Richter, 2004). Two years ago, a German women’s lifestyle magazine addressed this group of switching consumers with an article headlined: *‘We show you which organic food items are really worth buying’*. The main barrier preventing this group from expanding its consumption of organic food is the higher price, which, in their perception, is not justified sufficiently by added quality attributes.

To tackle this issue, the present paper discusses quality-related marketing approaches which meet the requirements of the occasional buyers group.

6 OCCASIONAL ORGANIC BUYERS AND QUALITY EXPECTATIONS

Organic products are mostly considered a premium segment within the food market because of their extra values arising in the course of production and processing. Marketing experts in the organic sector therefore believed over the last decades that organic consumption could easily be increased when consumers are better informed about these added values and traders of organic products explain better the advantages of organic food. However, at least in Switzerland, results of qualitative consumer research in rural and urban areas carried out within the now completed EU project OMIaRD (www.irs.aber.ac.uk) indicate clearly that better informed consumers in rural regions are less interested in organic food than worse informed consumers in urban regions who have many (false) preconceptions about organic and conventional agriculture. A typical response by a rural consumer is as follows: ‘In my village I know three conventional and two organic farmers. I see how they keep their animals and I see how they cultivate their arable land. But honestly I don’t see significant differences. In fact I see more differences between the two organic farmers than between the two cultivation systems. So why should I pay more for organic products?’ Some urban consumers who prefer organic food show that they are thoroughly uninformed about organic farming when they answer: ‘I prefer organic food because cows are not kept next to highways’, ‘tomatoes are not grown in glass houses’ or ‘organic farms are smaller than conventional ones’.

Furthermore, consumer research activities in Switzerland focussing on the organic dairy sector (Richter *et al.*, 2004a) as well as initial results of consumer research within the European QLIF project (www.qlif.org) have shown that most consumers define premium in the food segment by product quality attributes such as excellent taste, product texture or appealing product designs rather than extraordinary process quality. In some cases, interviewed consumers perceive organic food as being less tasty (e.g. tomatoes, fruit yoghurts), having worse texture (e.g. yoghurts), being packed in poor plastic foil (meat, cheese, fruits, vegetables) or processed by using poor raw material compounds (e.g. organic white meal bread). Of course these characteristics are more typical of many sorts of average conventional food. However when quality oriented occasional organic buyers think about organic and premium food they expect extraordinary product quality characteristics, otherwise they will not accept the organic price premium. In the eyes of quality-oriented occasional buyers, reference products with higher quality standards are often regional food products or emotionally charged brands, regardless of the production and processing methods behind them. Consumer research has furthermore showed that many occasional organic consumers will only accept higher prices for organic food when the whole set of relevant product quality attributes promises to be excellent, including appearance, taste, packaging and design (Richter *et al.*, 2004a). The reason behind this attitude is that such consumers buy premium products mostly in order to recompense themselves in premium food attributes, and therefore expect characteristics similar to those of delicatessen food.

This means that in periods without a scandal in the conventional food sector, it will not suffice for communication and assortment policy to focus only on the inherent added values of the organic system to generate an additional willingness to pay among most occasional buyers. A review of recent successful organic food offerings which resulted in a clear growth of turnover or organic market share provides some indication of the necessary differences to ordinary organic food offers:

Two years ago in Germany, a ‘Bioland’ marketing initiative (www.ei-q.com) launched an organic brand named ‘EI-Q’ for organic eggs. The originality of the brand name (EI-Q is pronounced in German as IQ), the original slogan (‘from families to families’), the excellent packaging design and high production standards are the reasons why more consumers bought these eggs than eggs bearing another organic trademark in retail outlets, despite the price per egg being 15 cents higher than that of the competing organic trademark. Furthermore, the total volume of organic eggs sold grew on average by 24%, and the market share of organic eggs in outlets which provide EI-Q rose from 6.9% to 10.5% on average.

In Switzerland, the Migros Ostschweiz cooperative launched the Bio Weidebeef® brand (www.bioweidebeef.ch) several years ago. This brand achieved a market share in total beef sales of 20% (compared to other organic meat trademarks in Swiss retailers which mostly do not reach more than 5%). The three main success factors in this case are the combination of special beef quality compared with other Swiss beef brands, the emotionally charged images of alpine pastured cattle, and the fact that Bio Weidebeef® is sold over the butcher’s counter and not in the self service area of the supermarkets.

In a further development in Switzerland, one year ago the COOP retail chain developed a sub-brand of the ‘naturaplan’ trademark dedicated to regional specialities (www.coop.ch/naturaplan). Previously, regional specialities had not been distinguished in the assortment and were labelled just as ‘naturaplan’. The new regional sub-brand also reached new consumer groups who have a stronger preference for specialities rather than organic food – with positive consequences for the development of sales.

The Austrian consultancy ‘Shop consult by Umdasch’ has analysed groups of young mothers of babies in order to develop an assortment and communication concept for organic baby products (unpublished study). The analysis showed clearly that many of the mothers who are indifferent to organic food do prefer organic baby products when emotional pictures of babies are used in communication, rather than mothers ‘just’ being informed about product advantages without any emotional aspect.

Last but not least, an opposite example of how to lose organic market shares when conventional premium brands compete with organic alternatives: One year ago, the Migros supermarket chain in Switzerland released a conventional dairy brand named ‘Heidi’. This scarcely competes with Migros’ existing organic trademark. The ‘Heidi’ brand is based on conventional milk from Swiss mountain areas and designed in the style of the ‘Heidi’ tale known worldwide. A study by Richter *et al.* (2004b) found that occasional, but even many regular organic milk buyers tend to prefer this brand over organic milk. This is explained by the emotional values underlying the conventional brand, while the organic trademark is quite boring.

The results of these consumer and case studies lead to thesis 1:

Thesis 1: *Occasional organic buyers would develop a stronger preference for organic food and would accept higher prices if:*
a) all relevant product quality attributes achieve premium standards,
b) communication policy focuses more strongly on product quality issues rather than production process issues,
c) organic food is communicated with a more emotional emphasis rather than using rational arguments, and
d) organic food is linked more strongly to a regional origin/specification.

7 VISIBILITY OF QUALITY DIFFERENCES

A further problem arises from the lack, in consumers' eyes, of transparency of quality differences between competing conventional and organic products. In a situation in which food quality is becoming more complex, consumers are tending to reduce their involvement in the food purchase decision-making process. Consequently the price, design and shape of products are becoming more important as easy choice criteria when consumers have less information about the differences in product and process quality (including environmental or social issues) behind food items. As a result, consumers tend to buy cheaper and more appealing products. When, as in Germany, product and process quality are assessed by independent institutes (Warentest foundation, Oekotest) and positive test results are declared on the products, in many cases the companies behind the products tested have stated that consumers are guided clearly by these signals as key quality attributes and therefore do tend to buy positively assessed food, and also accept higher prices for such products. This leads to thesis 2:

Thesis 2: *Occasional organic buyers would develop a stronger preference for organic food and would accept higher prices if:*
Additional product and process quality values are made more visible for instance by independent product tests, by public quality awards and customer-oriented product declarations.

Recent experiences indicate that consumers are willing to pay more for (organic) food when quality standards behind products and producer initiatives are transparent and visible. For instance, a German dairy provides organic milk at consumer prices which are normal in the market. As researchers calculated that farmers would need 5 cents extra per kg produced milk to cover their total milk production costs, the dairy decided to provide a label which consumers can choose voluntarily when they buy milk from the dairy. By choosing the label, they pay 5 cents extra which is passed on directly to the farmers (see http://www.bauernmolkerei.de). Today more consumers buy the more expensive milk with the extra 5 cent label than the 'normal' organic milk from the Uplaender Bauernmolkerei dairy.

To make complex quality profiles for organic fruit and vegetables better visible the 'Nature and More' foundation has developed a specific tool for online B2C-communication. Various quality parameters concerning product, social and environmental quality are evaluated regularly and test results are communicated at http://www.natureandmore.com . By entering a product specific code on the foundation's website the consumer gets information about the producer and the scoring of quality parameters behind the product. This example has received several international awards for its quality initiative.

However an ongoing study by Felder (2005), which is analysing information-related consumer behaviour for fruit, has found that fruit is clearly a low-involvement product. This means that consumers are not willing to look for information to the extent that they would be in the case of high-involvement products such as bicycles, cars or computers. Furthermore, they use fewer information sources than for high-involvement products. Consumers prefer to receive information from producers in shops or weekly markets, from well-informed sales people or from independent test assessments (e.g. Warentest foundation). Occasional organic buyers particularly prefer direct contact to producers or sales people. Felder further found that while the Internet is used quite often as an information platform in the case of high-involvement products, almost no occasional organic buyer looks for information about fruit in the Internet. As a result, the 'Nature and

More' Internet-based communication tool is totally unknown on the consumer side (at least in Switzerland, although products bearing the 'Nature and More' codes are also on offer in this country).

8 CONCLUSION

To make the organic food assortment more attractive to occasional organic consumers, the assortment itself as well as communication policy must focus more strongly on product quality rather than process quality issues. A suitable communication base to inform consumers about the extra quality values of organic food needs to include personal sales promotion by farmers at markets and other outlets, well-informed sales people and independent test assessments. Media such as the Internet or leaflets are scarcely used in the case of low-involvement products such as food.

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REPRODUCTIVE HEALTH OF RATS

For a contributed proceedings volume

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1 INTRODUCTION

Traditionally feeding trials with laboratory animals, mostly rats, are related to negative and positive effect levels of single components, either concerned with safety issues such as the ADI values of pesticide residues or with health effects e.g. of secondary metabolites. When feeding experiments are applied to investigate possible effects of differently cultivated products, the results are not traced back to single components of the test diets. Therefore the interpretation is more difficult and might seem less accurate resp. "scientific". These approaches reflect the two faces of natural science, the reductionist approach postulating independent linear cause-effect-chains in biological systems and the holistic approach based on the knowledge of an interactive, hierarchically organised network. This latter aspect complies with the epistemological background of organic agriculture and it has been the privilege of scientists in this field to introduce holistic research methods, giving back the phenomenological and more „narrative" character to biology.

The demand for organic food is rapidly growing especially in western civilized countries. Consumers perceive organic produce as "better for you", a perception largely based on intuition rather than information. The official point of view concerning product quality maintains the notion that there is no scientific evidence of superior quality properties in organic food. Some of the factors responsible for this relatively static view point are: The lack of appropriate funding for organic research and therefore the lack of data. Also a consequence of restricted funding is the difficulty to realize comprehensive scientific designs. Due to a certain lack of understanding holisic methods, "organic" project applications only have a chance, if they fulfil conventional scientific requirements, despite the potential discrepancy between the holistic background of Organic Farming and the linear approach of traditional science. But food composition data alone do not reveal much about how foods may be digested and metabolized in the body, only in connection with feeding studies a valuable answer can be achieved. A few relevant examples, demonstrating positive effects of organic products, are feeding experiments with rabbits (Gottschewski, 1975; Edelmüller, 1984; Staiger, 1986), with chicken (Plochberger, 1989) and with laboratory rats (Velimirov *et al.*, 1992; Lauridsen *et al.*, 2005). As can be seen from the last two references more than 10 years have gone by since the publication of the first rat feeding study until a new animal feeding project was granted in Danmark (Lauridsen *et al.*, 2005), although the findings 1992 clearly indicated the favorable effects of organic feed on the reproductive health of laboratory rats and further research in this field was strongly recommended.

It is the aim of this paper to look back and present the feeding study of 1992 in order to reassess the design, the results and also to discuss the difficulties in this line of research.

The study was conducted at the Ludwig Boltzmann Institute for Biological Agriculture and Applied Ecology in Vienna from 1987-1989 by four scientists: two zoologists (the author and Karin Plochberger) one botanist (Wolfgang Schott) and one veterinary (Ulla Huspeka) and was published in 1992 (Veimirov *et al.*, 1992).

2 METHODS

The basic idea was to compare the effects of conventional and organic feed on the reproductive health of laboratory rats. Based on dietary presriptions for laboratory rats the test diets were composed of 11,2% oats (*Avena sativa* L.), 25,9% barley (*Hordeum vulgare* L.), 25,9% field peas (*Pisum avense L.*) and 22.2% toasted soja beans (*Glycine max*. L.). Additionally the animals were fed with fresh carrots (*Daucus carota* L., 7,4%) and common beets (*Beta vulgaris* L., 7,4%). The dry ingredients were ground and pressed into pellets and given ad libitum, whereas the fresh food was apportioned in specific amounts (180 g carrots and 130 g common beets weekly per animal). Much attention was paid to the task of finding neighbouring farmers, who were prepared to cooperate in the project and to produce the feedstuff organically resp. conventionally. The seeds were supplied to make sure, the same varieties were used. All seeds therefore were untreated. After harvest all products were routinely analyzed. In order to provide nutritionally adequate diets for both groups of animals trace elements, minerals and vitamins were added, when necessary (*Table 1*). Thus any nutritional deficiencies were compensated for so that, according to analytical standards, the diets were of equal nutritional quality. The products of two harvests were tested.

Table 1: **Additions to food mixtures**

2.1 Feed mixture 1987	
Vitamin B 12 (0,1%)	14 g each
NaCl (cattle salt) iodated (40% Na)	1,8 kg each
$CaCO_3$ (lime) (36% Ca)	6,65 kg each
Managnese oxide (62% Mn)	12 g each
Vitamin D (500,000 IE/g)	3 g to conv. feed only

2.2 Feed mixture 1988	
Vitamin D	0,5 g each
Vitamin B 12	7,2 g each
NaCl (cattle salt) iodated (40% Na)	0,9 kg each
$CaCO_3$ (lime) (36% Ca)	3,3 kg each
Managnese oxide (62% Mn)	6 g each

The test animals were inbred laboratory rats, Long Evans strain. The animals were divided into 2 groups of 20 pairs each, according to the two test diets. Each female had two litters. Rats from the first litters were chosen at random to establish the next generation. Three generations and six litters were investigated. Data about the pregnancy rate, the birth weight and the weight development of the offspring, the rearing proportion and the weight gain or loss of the females during and after lactation were obtained.

3 RESULTS

3.1 Chemical analyses

The analytical results showed either no or very small differences, which were sometimes reverse in the two harvests and were often more pronounced between the two harvests than between the two variants of the same year. When this study was done these small differences were not considered to be of great consequence, but it is now known, that there are many nutrient interactions having a much bigger effect than could be expected from the small differences observed. The same is true for toxic substances such as pesticide residues. Therefore we have to reassess the analytical results. The contents of manganese, iron, zinc, copper as well as folic acid and vit. K1 were slightly higher in the organic variant 1987, but lower in 1988 as compared to the conventional feed. Biotin was always higher in the organic feed, whereas niacin and alpha-tocopherol were higher in the conventional one both years. Summarizing and comparing the mineral and vitamin contents the conventional dry feed of 1988 was slightly better (*Table 2*). But all data were within the range of biological diversity.

Table 2: **Selected results of the chemical analyses (dry ingredients)**

	harvest 1987		harvest 1988	
	org	con	org	con
Ca (mg/100g)	61,6	61,4	98,3	108
Mg (mg/100g)	160	160	168,5	187,9
Mn (mg/100g)	4	3,8	2	2,4

Fe (mg/100g)	13,3	11,2	7,6	8,6
Zn (mg/kg)	32	31	34,3	44,5
Cu (mg/kg)	7,2	5,9	17,5	19,9
Cr (mg/kg)	-	-	1,3	1,8
Biotin (micro g)	169	150	181	157
Thiamine-HCl mg	8,2	8,4	13,8	13,1
Riboflavin mg	3,8	3,7	3	2,3
Pyridoxol-HCl mg	1,3	1,3	0,9	0,9
Niacin mg	28,8	32	29,2	39,5
Folic acid mg	0,64	0,59	0,45	0,52
Pantothenic acid mg	10,7	10,1	10,4	9,4
Choline mg	1930	2000	1700	1210
Vit E complex mg	13,7	16	7,2	10
Alpha Tocopherol mg	12,4	14,5	6,6	9,16
Vit K 1 micro g	199	193	20,9	29,7

The products were not analyzed for secondary metabolites, since the health-related importance was not yet generally accepted then and these analyses would have gone beyond the available funds anyway.

The conventional farmer applied 8 different pesticides, some of which have either been shown or are suspected to be reproductive health hazards since. The dry ingredients were analyzed for chlorinated hydrocarbons. Again no detailed attention was paid to the toxic levels, all contents were under the accepted safety limits. Since then more and more research is showing the defiencies and limitations of these safety levels particularly in connection with synergistic effect increase when dealing with so-called pesticide cocktails.

3.2 Reproduction data

The results concerning the reproductive parameters showed favorable effects of the organic feed:

- In the first litters significantly fewer offspring were born dead or died within the first week of their lives (*Figure 1*).
- The survival rate until weaning time at the age of 28 days and the weight development were slightly more successful.
- The weight gain of the organically fed female rats in connection with litter size and pup weight during lactation was significantly higher (*Figure 2*).

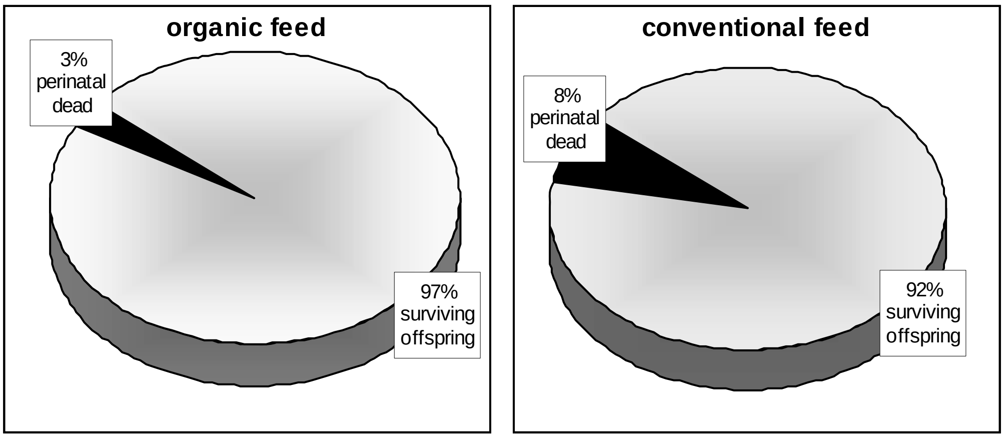

Figure 1: **Significantly less perinatal dead offspring in the organically fed group, 1st litters**

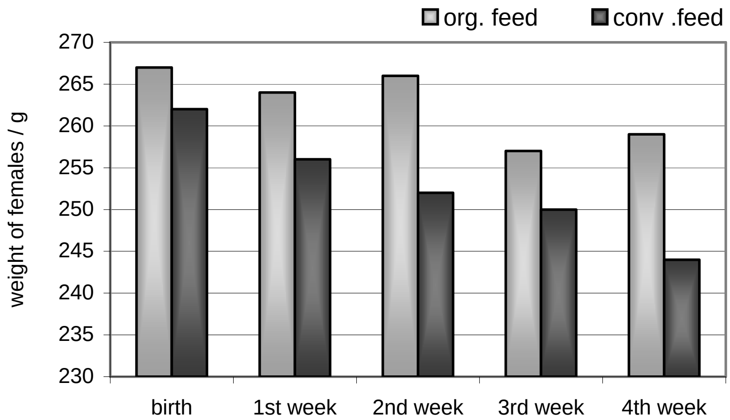

Figure 2: **Significantly higher weight gain in female rats of the organic group during lactation**

Between the 1st and the 2nd litter of the 2nd generation the new feed mixture (harvest 1988) was introduced. Weight gain as well as rearing performance of the 2nd litter of F2 was better in the conventional group. After adaptation to the new feed the organic group again displayed better results than the conventional one. These contradictory results could not be explained and are a good example for the interpretation difficulties, when dealing with complex systems.

4 CONCLUSION

The design and aim of any feeding study investigating the effects of whole diets, not single components have to be clearly defined. There are basically two approaches:

The investigation is carried out to reveal indirect effects of actually applied cultivation methods (farmers) on animal health. In this case, whatever the outcome might be, the researcher is likely to encounter interpretation difficulties if he relies too heavily on analytical contents and linear cause-effect-chains. Yet this kind of study is very valuable, because it reflects reality. The interpretation should be based on phenomenological and descriptive methods.

The study is seen as a contribution to basic research. In this case the growing conditions have to be defined beforehand and the application of pesticides should be restricted (field trials). The results would then only apply to the well defined framework of growing conditions, but the outcome could be more easily interpreted according to the officially accepted scientific rules.

More attention should be paid to the contents of non-nutrients, micronutrients and pesticide residues. After the rat feeding trial more and more scientific evidence has emerged, showing that small increases of health promoting contents as well as small decreases of toxic substances in a food can have a much bigger impact than was originally expected (Worthington, 1999; Soil Association, 2000). Even marginal deficiencies can contribute to lower vitality.

Still, nutrient concentrations do not give clear and definite indication of their bioavailability, therefore feeding tests are essential to make up for the shortcomings of chemical analyses, when applied as exclusive parameter for the definition of nutritional food quality.

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INFLUENCE OF BIODYNAMIC NUTRITION ON IMMUNOLOGICAL PARAMETERS AND WELL-BEING OF POSTMENOPAUSAL WOMEN

The convent study

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1 INTRODUCTION

The effect that organic and biodynamic foodstuffs have on the health and well-being of humans is an important consideration when evaluating organic and biodynamic farming. Numerous advantages have been shown for individual components, particularly antioxidants, vitamins, functional fatty acids and trace elements (Carbonaro *et al.*, 2002; Kraft *et al.*, 2003). Very few studies have been done on the overall effect of an organic diet on humans (Woese *et al.*, 1997; Biao *et al.*, 2003). One of the reasons for this is that it is difficult to carry out blind intervention studies on humans that investigate not one nutrient, but an entire diet. The findings of animal studies have been clear. Food selection studies have shown that rats prefer organic food when they are offered both organic and conventional food (Velimirov, 2001). Furthermore, doe rabbits fed biodynamic food (Staiger, 1991) and rats fed organic food (Velimirov *et al.*, 1992) had markedly better fertility rates compared to control groups fed conventional food. The present study was conducted in a convent with volunteer subject nuns. This was done to achieve a small variance in lifestyle and environmental conditions, which otherwise, given a relatively small sample size, would have been nearly impossible, and to have the most control over what was eaten.

2 METHODS

2.1 Sample

The participants in the study were 17 sisters belonging to a religious order, all post-menopausal and aged between 59 and 80 (M = 69.4). Participation was voluntary and no financial incentives were offered. When questioned, 53% responded that they were participating out of personal interest, while 47% were motivated by external factors.

2.2 Study design

The study was conducted in a convent over a period of eight weeks. To the extent possible, the existing menu was retained, but the origin of the food changed. First there was a two-week adjustment period, during which the frozen, ready-made meals usually on the menu were replaced by freshly prepared dishes (using conventional products). Following this was a four-week period during which the menu consisted of foods produced and processed according to organic methods. All told, 85% of the foods used were products of biodynamic farming. For the final two weeks, there was another phase of freshly prepared conventional food. All the sisters took part in the communal meals unless they were away from the convent, for example at a meeting. In such instances, they were given a packed meal prepared using the type of food corresponding to the given phase. In addition, a follow-up survey was conducted four weeks after completion of the study.

2.3 Recording the quantity of food consumed

The foods consumed and quantities of food consumed were recorded in a food diary. The various recipes and portion sizes were recorded every day. The food diaries were analysed using EBIS software for Windows 95 and Windows NT.

2.4 Questionnaire on well-being

The survey was conducted using a questionnaire ("Questionnaire on the effects of food on well-being") devised specifically for this study by the Centre for Empirical Pedagogical Research, ZepF (Zentrum für empirische pädagogische Forschung). Six slightly modified versions of the questionnaire were used for the different test times. The questionnaire consisted of standardized methods for recording psychological well-being (Steyer *et al.*, 1995) and any physical complaints (Dlugosch and Krieger, 2000), along with scales devised specifically to suit the issues under investigation. The scales were tested for reliability wherever possible and reasonable, and proved sufficiently reliable.

2.5 Statistical analysis

In order to test the issues forming the focus of the study, a variance analysis was carried out for each of the independent variables (perception of well-being, eating behaviour, and immunological parameters) with repeated measurements, using the statistics software SPSS11®. The potential effects of subjects’ expectations were also included as covariants to check for non-specific expectation effects. In addition, T-tests for dependent samples were performed to obtain values for total caloric intake and for the principal components (protein, fat and carbohydrates) averaged across the phases of conventional and biodynamic foods.

3 RESULTS

3.1 Eating behaviour

Although the meals prepared during both of the periods under comparison followed exactly the same menu, the mean daily caloric intake during the period when biodynamic food was provided was lower than during the period of "adapted" conventional food. This was due to a significantly lower intake of protein (T = -5.18; df = 1, p < .001) and carbohydrates (T = -4.74; df = 1, p < .01). The decrease in protein intake was largely due to reduced consumption of animal protein, i.e., less meat and dairy produce. As regards the intake of plant-derived proteins, in contrast, no difference could be discerned between the biodynamic and conventional phases. Fat consumption remained unchanged (T = .94; df = 1, p = n.s.), while intake of fibre increased.

3.2 Physiological parameters

During the biodynamic phase and the subsequent conventional phase CD4+ cells were noticeably reduced (*P*<0.01) and the natural killer cells increased, the latter only in those people who had expressed a positive expectation in relation to the improvement of their immune status at the beginning of the study. Blood pressure values fell to an equally significant degree in the biodynamic phase and the subsequent conventional phase (*Fig. 1*; *P*<0.01).

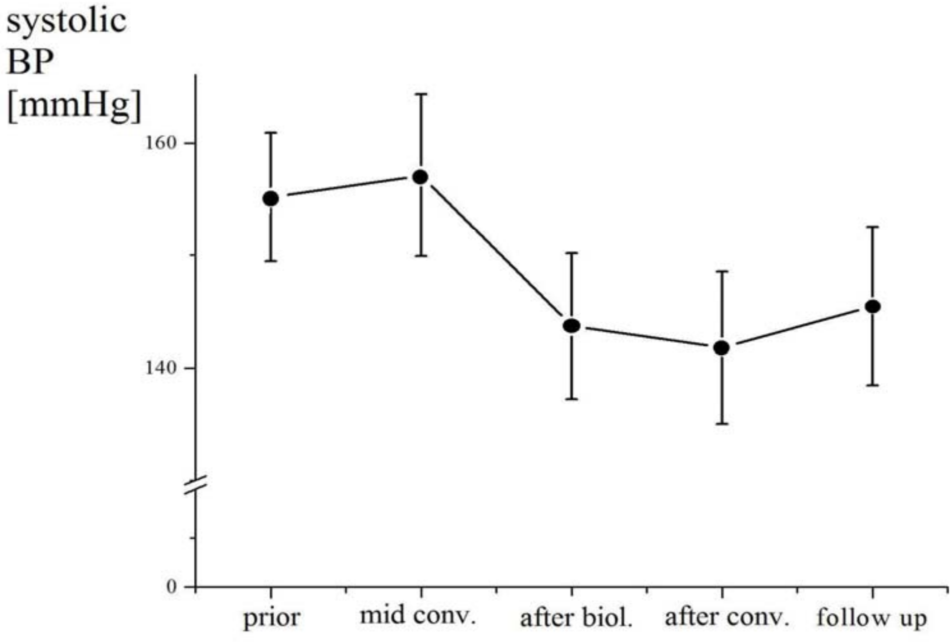

***Figure 1*: Systolic blood pressure of probands in dependence on the different experimental periods**

3.3 Changes in well-being

During the change in diet, the participants' physical fitness and their general ability to cope with exertion was statistically highly significant. The highest value was shown in the biodynamic phase and the lowest was in the follow-up phase. The curves representing the sisters' perception of their psychological well-being (*Fig. 2*) followed the same curve, so we can assume that a general psychotropic effect was produced by the change in diet.

The subjects' weight remained constant throughout the investigation period, regardless of whether they had hoped to lose weight during the change in diet. During the biodynamic phase, the participants noted frequently in the questionnaires that they had particularly enjoyed their meal.

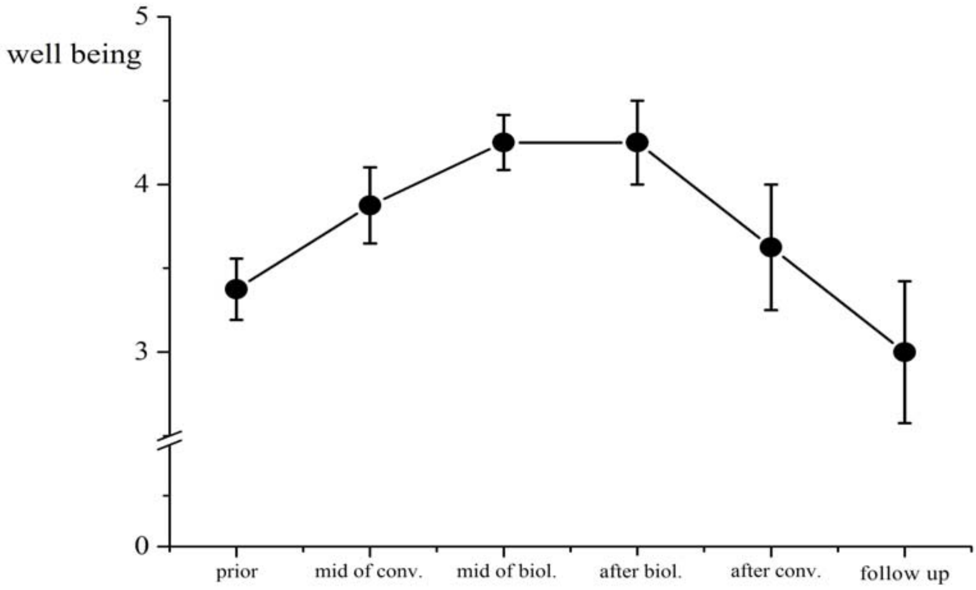

***Figure 2*: Subjectively evaluated well-being of probands in dependence on the different experimental periods**

4 DISCUSSION

The change in diet from conventional to biodynamic foods resulted in a change in the eating preferences of the survey subjects. They consumed smaller quantities of animal protein and carbohydrates, and as a result their overall energy intake was lower. At the same time, as a result of higher consumption of wholemeal products their dietary fibre intake increased, which has a satiating effect. The increase in the subject nuns' dietary fibre intake may be regarded as positive.

Some of the observed physiological effects of the biodynamic diet were linked to the subjects' psychological expectations. The fact that this context could be recorded and depicted is more of a validation of the study's unblinded design than it is a repudiation of it. For those who follow an organic diet, which is predicated on a certain type of awareness, one needs to assume such a psychosomatic predisposition, which, considered objectively, contributes to the overall effect of an organic diet (Köpke, 2005).

The changes in physical and psychological well-being over the course of the study are worth noting. The relevant parameters improve during the biodynamic phase, and then fall below the pre-survey values after the study. Alongside the effects of the food, the latter phenomenon may also be partly due to a non-specific effect arising from a reduction in the care and attention focused on the subjects. On the other hand, the withdrawal of an established diet of biodynamic food may bring about a more pronounced deterioration in mood than the enhancement of mood associated with the introduction of such a diet. The fact that the taste enjoyment experienced during the study ceased may have been one reason for this. The cultural and ethical associations of organically grown foods can account for a large degree of the subjective well-being caused by eating these foods (Köpke, 2005) and could have therefore contributed to the effects described here, in the form of an experience of heightened consciousness.

5 CONCLUSION

Irrespective of whether the results obtained were brought about by the biodynamic food itself or by the modification in eating preferences induced by this food, or both, we can conclude that for older people, switching to organic food leads to improvements in physical and psychological well-being, lower blood pressure and an immune status indicative of lower stress levels.

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FOOD QUALITY – FOCUS ON HUMAN OR ON PLANT?

Are processes useful as the connecting link?

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SUMMARY

The usual view on food quality is focused on nutrients. Food is interesting with respect to the substances it delivers. Results of various experimental studies give strong support to the theses, that this limited view on food quality has to be extended. Holistic investigations have focussed the view onto the plant. A view arising from processes can unite both and show what the term “inner quality” could stand for. Thinking in nutrition as inversion of plant processes may lead to new insights for healthcare and agricultural research.

1 FOOD QUALITY, ORGANIC FARMING AND NUTRITION

With view on the nutritional substances of a plant, why organic products should be preferred? If the field of residues of pesticides (Reinhard *et al.*, 1986; Schüpbach, 1986; Weber *et al.*, 2001; Baker *et al.*, 2002; CVUA, 2003; Stolz *et al.*, 2005a) is omitted, then from a strictly nutritional aspect it appears to be difficult to argue, why organic food should be healthier. For a rigorous comparison of farming systems it is well accepted to include additional aspects as soil fertility, sustainability, biodiversity, ecology (Mäder et al, 2002) as well as cultural and social aspects (Meier-Ploeger, 2001). In this paper we restrict the consideration to the plant-human interaction by food.

Differences between conventional and organic products with respect to single substances seem to be always in the range of the natural fluctuation observed in conjunction with variety and climatic or geographic dependencies for the specific product. The broad range of natural fluctuations of the components of food is reflected in the data tabularised by Souci *et al.*. (1994). Compared to conventional farming there seem to be tendencies of organic farming to increase some substances e.g. polyphenols, flavonols, cinnamic acids or certain amino acids, which are supposed to be relevant for health (Stolz *et al.*, 2000; Weibel *et al.*, 2001; Asami *et al.*, 2003; Stolz *et al*., 2004). The relevance of this effect is difficult to argue as changes in variety can be a multiple of the differences caused by farming method. Adequate studies on the nutritional quality of organic food were missing for long time (Williams, 2002). Small effects were reported in the meantime (Grinder-Pedersen *et al.*, 2003) but did not really change the situation.

The substantial findings are in contrast to sense of experienced persons, a recently reported pilot study (Huber *et al.*, 2005) and animal feeding experiments (Velimirov, 2001). In general physical and psychical well-being was reported. But this allusions would be to meagre to justify an extended view by experimental data. Unexpected support has come from big studies concerned with preventive healthcare.

2 REDUCTIONISM AT AN END?

In view of nutrition science the source of a nutrient was of nearly no impact. In this view the addition of isolated substances (e.g. vitaminising) is equivalent to the appearance of the same substance in natural coherence. This view might be valid in some cases. The general incompleteness of this view is emerging in the meantime. Stimulation of sound organic functions seems to be reduced by some isolated substances.

Antioxidant vitamin supplements provide no cardiovascular benefit (Group, 2002; Vivekananthan *et al.*, 2003). Instead a potential harm was suggested (Waters *et al.*, 2002). A diet rich in fruit and vegetables reduces the incidence of lung cancer by approximately 25%. Supplementation with vitamins A, C and E and beta-carotene offers no protection against the development of lung cancer. On the contrary, beta-carotene supplementation has, in two major randomised intervention trials, resulted in an increased mortality (Fabricius *et al.*, 2003). After these findings Heyden expects the end of antioxidant vitamin supplementation (Heyden, 2003). German federal institutions dissuaded from use of beta-carotene as dietary supplement for smokers and as food additive (BgVV, 1998; BfR, 2005).

Lycopene, the carotene making tomatoes red, was assumed to be preventive to cancer of the prostate. In contrast to isolated lycopene the tomato powder showed the expected preventive effect (Boileau *et al.*, 2003). Commentating this findings P.H. Gann and F. Khachik ask in the editorial of the Journal of the National Cancer Institute of the USA: ‘Tomatoes or lycopene versus prostate cancer: is evolution anti-reductionist?’ (Gann *et al.*, 2003).

3 HOLISTIC METHODS AND THEIR INTERPRETATION

The situation, emerging from the new findings mentioned above, suggests that either several substances and their combined natural balanced occurrence is required, or the coherence, the inner structure which forms the microscopic and macroscopic plant is of additional relevance for health.

For the view on products of organic farming this situation is not really new. There was early the insight, that ways must be found, to get an impression of the whole sample to characterize differences between organic and conventional farming (Engqvist, 1961; Popp, 1987; Balzer-Graf *et al.*, 1988; Meier-Ploeger *et al.*, 1988). In the meantime the methods were developed further and have been validated (Kahl, 2005; Geschäftsstelle *et al.*, 2005). In total these methods showed significant and reproducible differences between organic and conventional products (Alföldi *et al.*, 1998; Strube *et al.*, 2000; Strube *et al.*, 2002).

The view was focussed primarily on plant by the investigations with these methods. Question is still open, which factors of the plant influenced the results. This is related to the question 'by which concept do we understand what the results show us'.

Ursula Balzer-Graf called it a scientific challenge to come to clear interpretations of copper chloride crystallisations or paper chromatographic rising pictures (Balzer-Graf, 2001). She created the term 'arttypische Entwicklung' for the idea, that a plant might well develop all its phases of live under organic farming. Geier showed relations between plant organ and types of crystallisation pictures (Geier, 2005). Popp tried to link his biophoton measurements with Schrödingers hypothesis that living beings must collect order from their environment to keep their own order (Popp, 1988). We adopted the term 'arttypische Entwicklung' and showed at small series of different development states of plants and the related measurement data of fluorescent excitation spectra that morphological development and change of data are correlated (Strube *et al.*, 2002). Organic farming leads at least at the plants already investigated to a more emphasised phase of ripeness or seed dormancy. We interpret our findings as a confirmation of Ursula Graf's ideas which are of practical use (Strube *et al.*, 2004).

4 EXPERIMENTAL RESULTS AND PROCESSES

Especially the data of fluorescence excitation spectroscopy of wheat and other seeds showed that the process of development of seed dormancy is supported by organic farming. In conventional farming the vegetative process is enhanced and particular strong without of an equivalent intensified phase of ripeness, so that seed dormancy is reduced. Up to now the data did not reveal a relation to any special substance of the plants investigated, so we suppose that the enhanced vegetative process changes the inner configuration of the seeds at least at a lot of substances or in a structural manner.

As inner configuration we understand the set of substances and their coherence with total matrix which is associated with the processes which have taken place. For example during growth such processes are enhanced, which especially lead from nitrate-nitrogen over ammonium, amino acids to protein in its various forms. During ripeness these processes are reduced and instead processes are enhanced which lead to secondary plant substances. Therefore according to the development the inner configuration changes.

Processes inside the plant can be thought to be driven by external conditions or processes. Germination depends on water and warmth, growth depends on light, water and warmth and ripeness needs warm and dry conditions. The production of certain antioxidant phenolic substances is induced by insects. The enrichment of such substances in plants is understood as a reaction of the plant to fend insects.

The natural processes are modified by human interventions. For example a late nitrogen fertilisation of wheat forces processes of protein synthesis during a phase, when normally processes of ripening are dominating. Therefore probably almost all substances which are related to protein synthesis processes are affected. It can be expected, that the ratio of substances related to protein synthesis to substances related to ripeness will be changed.

5 INNER QUALITY

Viewing on processes can make understandable, why only in rare cases a single substance is suited for identification of farming conditions. Normally a change of the concentrations of a group of substances can be expected. One aspect of future research could be to investigate such relations of process related groups of substances (Stolz, 2005b).

This view also can give new insights to the results of the healthcare studies. Fruits and vegetables contain not only the prominent substances looked on, but in an adequate relation the accompanying substances which are related to the building and forming processes.

Inner quality (Northolt *et al.*, 2004) can be seen as the situation existing at time of harvest as a consequence of the intensity and deviations of phases of the plants life and the contributing forming forces or processes. Analytically indicators for inner quality can be obtained by analysing groups of substances which are indicative for development phases and forming processes. Holistic methods give indicators when a relation from the methods showings to the phases and processes of development can be derived.

6 FURTHER IMPLICATIONS

Of the digestion of plants by humans and of nutrition can be thought as an inversion of the plant processes. This inversion is basically well known and acknowledged. Humans (and animals) use the oxygen delivered by plants, oxidise the consumed material and exhale carbon dioxide. The energy stored in plant supplies energy required by humans.

What we suggest, is to utilise this general way of thinking in a free way to more details and try to use it to research questions and insights. The fending of insects by phenolic substances can be thought as part of the self-assertion of the plant. Are there relations to the action of phenolics as modulators of the human immune system? What is caused in a consuming organism, when in most of the fruits and vegetables the growing process is enhanced and the finer nuances of ripeness are reduced (as by conventional farming)?

Organic production is defined inside the EU as a process quality. That may have been the only way during a time, when product differences could not be argued. Viewing back it was a step towards a modern view of nutrition and health. For future changes of regulations of organic productions a qualitative way of thinking of processes may be helpful to stay at real organic ways of production. Research inspired by thinking in processes may be helpful to keep it at reality.

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POSTERS

WHEAT QUALITY IN ORGANIC AND CONVENTIONAL FARMING

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Consumer's have become more aware on environmentally friendly produced, healthy and safe food. We studied the quality of wheat (Triticum aestivum L., winter form) grown in a 21-year agro-system comparison between organic and conventional farming (DOK trial).

The 73% lower addition by soluble nitrogen to the organic field plots led to 14% lower wheat yields. However, the nutritional value, i.e. the protein content, mineral and trace element content and the baking quality were hardly affected by the systems. Despite the exclusion of fungicides from the organic production systems, the quantities of the mycotoxins detected in the wheat grains did not differ. Feed preference tests, as an integrative method, indicated a clear tendency for rats to prefer organically produced wheat over conventionally produced wheat. The wheat samples were also characterised by picture-forming methods (copper chloride crystallization, the capillary dynamolysis method, and circular chromatography). Using these procedures, a differentiation between organic and conventional farming was possible.

Results are presented at the FQH conference.

FiBL

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Holistic and Analytical Parameters for milk and blood of dairy cows and their relationship to cow constitution

Introduction/Methods

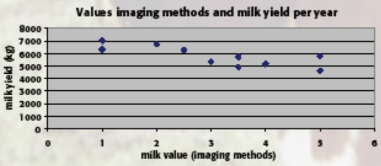
The aim of the FiBL-project "Correlation between species-specific physiology and behaviour and the constitution of dairy cows" was to investigate different physiological and behaviour parameters of dairy cows to look for differences between individuals with a strong constitution (low disease susceptibility) and individuals with a weak constitution (high disease susceptibility). The parameters were observed repeatedly in a herd of 50 cows and correlated to the number of diseases of each individual cow over a time span of two years. Besides the "conventional analysis" of milk and blood we wanted to know, if the imaging methods can give us further information. We picked out 6 cows with a weak constitution and 6 cows with a good constitution. 3 times in between 3 months we took samples of milk and blood from each of those cows at the same time. Milk components were analysed at the FAM (Forschungsanstalt für Milchwirtschaft, Liebefeld, CH), blood components were analysed at the vetmed-labor (Ludwigsburg, D) and the investigation with imaging methods for both, blood and milk, was done at the laboratory for sensitive crystallisation (Dornach, CH). The different investigations were carried out separately with blinded samples. This poster presents the results of the imaging methods only.

Results: milk

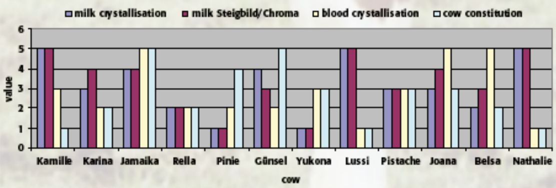
Significant correlations between the valuation of the crystallisation images and lactation stages, yearly milk yield of the cows and feeding were found. But there were no correlations between the valuation of the images and constitution parameters and milk yield of the sampling day.
The valuation of the capillary dynamolysis-images and the circle chromatograms show the same correlations to lactation stages, yearly milk yield and feeding.

Results: blood

The crystallisation images show an individual, animal-specific morphology with respect to the number and type of the patterns and also in reference to the overall image. Using a coarse-grained classification, the morphologic characteristics can be described as intense, medium or weak. They were correlated to the cow constitution parameters. Overall deviations were found that are probably due to the feeding. In contrast to the investigation of milk samples, there were no hints on stage of lactation or milk yield.



Graph 1: Correlation between yearly milk yield and values of imaging methods: $r = -0.79$; $n=12$; $p<0.01$



Graph 2: Values of imaging methods for milk and blood and constitution value for each single cow (high values = good structures and forming capacities in the pictures and good constitution of the cow; low values = weak forming capacity and weak constitution of the cow

Imaging methods (crystallisation pictures, capillary dynamolysis / Steigbilder, circular chromatograms)

The evaluation is based on a comparative inspection of the images. The evaluation criteria for milk are mainly based on state of order, coordination, similarity of forms, forming capacity and differentiation. The evaluation criteria for blood refer to the characteristics of the basic structure, to the amount and character of disturbances, state of order and dynamics of formation.

Weak *Medium* *Strong*

Fig. 1: Blood crystallisation images from cows with different constitution

early lactation stage *medium lactation stage* *late lactation stage*

early lactation stage *late lactation stage*

Fig. 2: Images: details of crystallisation images (top) and capillary dynamolysis (bottom).

Discussion

The question was to look for expressions of cow constitution by observing their milk and blood with imaging methods. Our results show that the animal's actual life processes play a great role for the forming capacity of milk, which shows up in the images.
Blood pictures however point to a different aspect. They can show us more about the cow's constitution. Feeding is modifiing both blood and milk pictures.
We worked with a small amount of samples. Therefore those preliminary results have to be seen as tendencies. They drew our attention on the wide range of influences on individual cow's milk we have to consider in taking and analysing milk samples. Depending on the context it might make more sense to take mixed samples of similar groups of cows that differ just in the parameters in question.

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FIRST RESULTS WITH THE GAS DISCHARGE VISUALISATION (GDV) METHOD (KIRLIAN PHOTOGRAPHY) TO ASSESS THE INNER QUALITY OF APPLES

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WHAT IS THE GDV OR KIRLIAN PHOTOGRAPHY METHOD?

Kirlian Photography is a physical treatment where intact tissue of a sample is exposed to a high voltage and high frequency electrical field which causes the emission of electrons and photons accompanied by light emission. This light emission can be photographed or digitally recorded. The method is therefore also called Gas Discharge Visualisation (GDV). The shape of the resulting light "corona" can differ according to the composition of the tissue and is thus a potential indicator of the inner quality of the fruit. Because the tissue examined is fresh and not manipulated before the measuring process the method is suited to give a complementary or "holistic" information of the tissue's inner quality.

The advantages of the GDV method are that it is cheap, many measurements can be made per day (around 100 apples per day, including standard quality assessments in parallel with two persons occupied), and the picture analysis process is completely digital, thus objective.

GOALS OF OUR RESEARCH?

The goal of our studies, supported by Coop and starting in 2002 is to find out the possibilities and limits of the GDV method for complementary quality assessment.. Questions are:

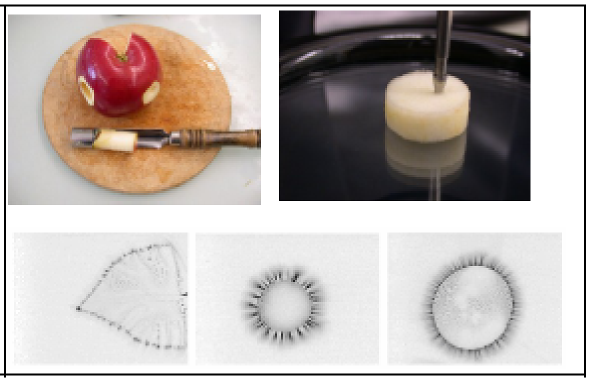
1) Reproducibility of the measurements
2) Variation studies (within different parts of a fruit; within batches of 15-30 fruits)
3) Correlation of GDV data with standard quality parameters (e.g., sugar, firmness, taste)
4) Potential to differentiate the growing system (organic and conventional)
5) Correlation to other complementary methods such as, e.g., fluorescence emission spectroscopy
6) Suitability of different algorithms for statistical analysis of the data

PRELIMINARY STUDIES AND RESULTS

In several studies we recorded GDV coronas of apple tree leaves and fruits in order to verify and compare their vitality under different conditions. We used GDV Assistant Software for pre-processing and for numerical parameterization of corona pictures and then various machine learning algorithms for analyzing the data (Sadikov et al. 2004).
For six measuring series results with different machine learning methods are presented in Tab. 1. Last column shows how good a default classifier would be. Positive scenarios (values better than a default classifier) are highlighted. It can be seen that "See5" algorithm is very robust. Thus, for further study we use the See5 algorithm.

Table 1. Classification accuracy (%) of different machine learning methods in 9 studies

Algorithm / Study	see5	core.reliefF	core.CI	HINT	default cl.
variety s41 vs s50	**68**	**69**	70	75	50
sick vs healthy tree	**84**	**81**	**81**	**84**	**50**
cultivars: Resi vs Arriwa	50	54	54	50	50
rootstocks: M7 vs J-TE-G	32	48	50	0	50
conventional vs organic	36	46	37	24	51
rootstocks: M7 vs Sup2	43	49	54	0	50
variety Rajka vs Rosana	75	77	82	79	57
aphid-stressed vs healthy trees (fruitlets)	72	74	**68**	**76**	**50**
aphid-stressed vs healthy trees (leaves)	48	50	56	0	50



CONCLUSIONS

GDV technology can provide useful information for distinguishing healthy and stressed plants and, in some cases, it can provide useful information for distinguishing different varieties and rootstocks. It can also provide information for distinguishing fruits grown using different fertilization treatments. However, in our cases with fruit of very similar standard quality, we were not able to find complementary information to distinguish organically from conventionally grown apple fruit. Currently we are carrying out two larger and refined studies on just that topic with 5 convent./organic comparison pairs from harvests of two years.

Sadikov A, Kononenko I and Weibel F P 2004 Analyzing Coronas of Fruits and Leaves. In Measuring Energy Fields: State of the Science, Ed K Korotkov. Backbone Publishing.

Application of a multivariate design approach for maximisation of the observed differences between organically and conventionally grown wheat grains in biocrystallisation method

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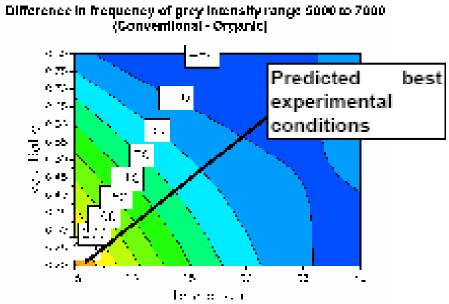
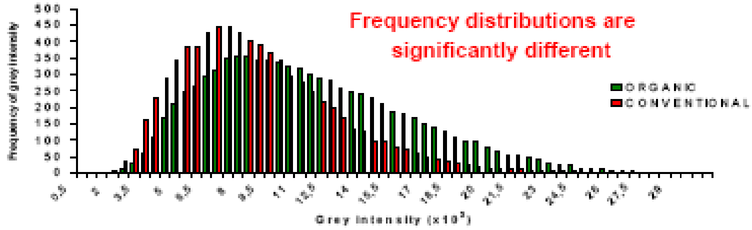
❑ Introduction

Biocrystallisation method, based on a phenomenon of dendritic pattern formation during crystallization from an aqueous solution containing plant extracts and $CuCl_2$, was used for discrimination between the agricultural systems of origin for wheat samples. Application of controlled conditions in the course of crystallisation was found to be essential factor for reliability and reproducibility. Certain conditions influence the range of the possible to detect difference between samples. A multilinear quadratic model, with factor interactions, was applied. The selected factor ranges were as follows: temperature from 20 to 40°C, relative humidity from 40 to 60% and volume ratio ($CuCl_2$ / plant extract) from 0.32 to 0.8. Thus the selected experimental region covered the most representative region of interest for optimising the analytical method under consideration. This model demands only twelve experiments plus three experiments at the centre of the experimental region to assess the method repeatability.

❑ Experimental conditions

- Plant extracts were prepared from lyophilized, grinded organic and conventional wheat grains.
- Crystallising solutions containing different volume ratios (0.8 mL of 10% aqueous solution of dehydrate $CuCl_2$ / certain volume of plant extract) and MiliQ water were poured on glass plates.
- Crystallisation, according to experimental design schedule, took place in a climatic chamber Sapratin Excal 2211-HA.
- Biocrystallograms were scanned using ImageScanner™ (Amersham) (image depth: 16 bits/pixel → 65536 possible grey levels).





❑ Image Analysis

The images were analysed using ImageMaster™ (Amersham) software. According to the pattern smoothness and curvature selected regions of the images were divided into small areas called "spots". Spot intensities (based on the highest grey level value of pixels in a spot) were detected. Their frequency distributions within ranges of 500 were calculated. Consequently the data were plotted on histograms. The investigated responses were the differences between mean frequencies of grey intensities (grey levels) (conventional - organic for ranges 5 - 7 (x10³) and organic - conventional for ranges 13 - 15 (x10³).

❑ Conclusion

Temperature and the volume ratio $CuCl_2$ / plant extract have a crucial effect on the maximisation of the differences observed in the number of spots that present certain grey level intensity. Inversely, relative humidity has given multilinear regression coefficients which were considered as statistically not significant. Optimised experimental conditions are therefore predicted whereby the temperature should be set at 15°C, relative humidity fixed at 50% and the volume ratio at 0,32. those conditions allowed statistically significant differentiation between organic and conventional wheat samples.

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EUROPEAN COMMISSION
Joint Research Centre

NUTRITIVE QUALITY OF ORGANICALLY VS. CONVENTIONALLY PRODUCED PLANT CROPS

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cv. Koralik

Introduction

Organic food is perceived by the consumers as safer and tastier. Therefore the studies concerning nutritive value of organically produced foods are becoming more and more important. Studies on raw organic plant products such as fruits and vegetables show as a rule more beneficial parameters of the wholesome and nutritive quality than conventional crops. The tomatoes and apples organically produced contain more antioxidant and chemical components then conventional grown crops, but the studies concerning the quality of fresh organic vegetables and fruit are lacking. Therefore it was found appropriate to conduct studies on selected features of the nutritive quality of the tomatoes, red pepper and apple from the organic vs. conventional production

Materials and Methods

In 2004 five tomato cultivars: three large – fruit (Atol, Awizo and Etna) and two cherry cultivars (Piko and Koralik) were selected for the investigation. Vegetables were cultivated in certified organic and conventional field in Skierniewice. In 2005 five tomato cultivars: (Rumba, Kmicic, Juhas, Gigant) and cherry (Koralik) were selected for research. Vegetables were cultivated in certified organic and conventional private farms in Mazowia region. In 2003 apples cv. Lobo and Cortland also in 2004 cv. Jonagold and Red Boskoop were selected gained from certificated organic orchard and situated in these same region conventional orchard.

cv. Cortland

In apples and tomatoes the total flavonoids content was calculated by Christ – Müller's methods and result was given as sum of total flavonoids counted on quercitine contains (mg x $100g^{-1}$.f.m.). The vitamin C contain was calculated by Tillman's method (PN – 90 (A-75101/11)) and result was given as mg vitamin C x $100g^{-1}$.f.m. The total and reducing sugars were calculated by Luff'a – Schoorla method and result was given as g sugars x 100 $100g^{-1}$.f.m. Also content of dry matter was calculated by the scale method (PN-91/R-87019). The results of those qualitative characteristics of fruit were statistically calculated using Statgraphics 4.1 program specifically Tukey's test at $\alpha = 0.05$.

cv. Gigant

cv. Jonagold

Results

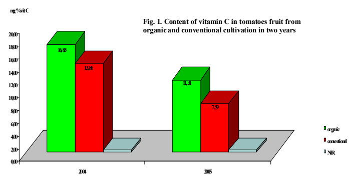


Fig. 1. Content of vitamin C in tomatoes fruit from organic and conventional cultivation in two years

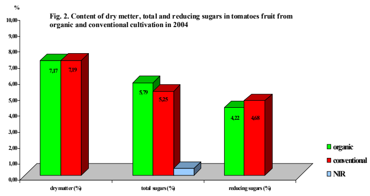


Fig. 2. Content of dry metter, total and reducing sugars in tomatoes fruit from organic and conventional cultivation in 2004

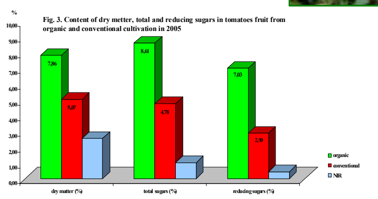


Fig. 3. Content of dry metter, total and reducing sugars in tomatoes fruit from organic and conventional cultivation in 2005

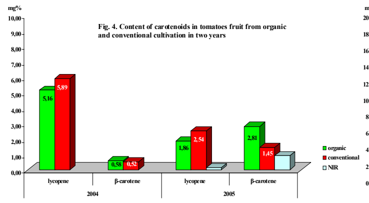


Fig. 4. Content of carotenoids in tomatoes fruit from organic and conventional cultivation in two years

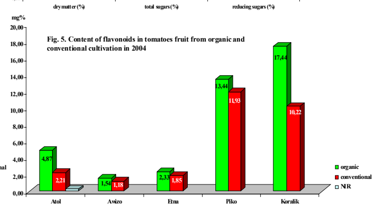


Fig. 5. Content of flavonoids in tomatoes fruit from organic and conventional cultivation in 2004

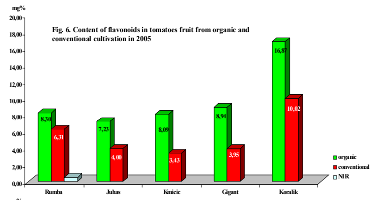


Fig. 6. Content of flavonoids in tomatoes fruit from organic and conventional cultivation in 2005

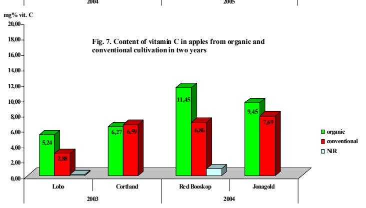


Fig. 7. Content of vitamin C in apples from organic and conventional cultivation in two years

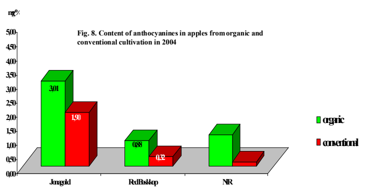


Fig. 8. Content of anthocyanines in apples from organic and conventional cultivation in 2004

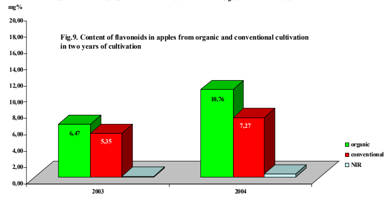
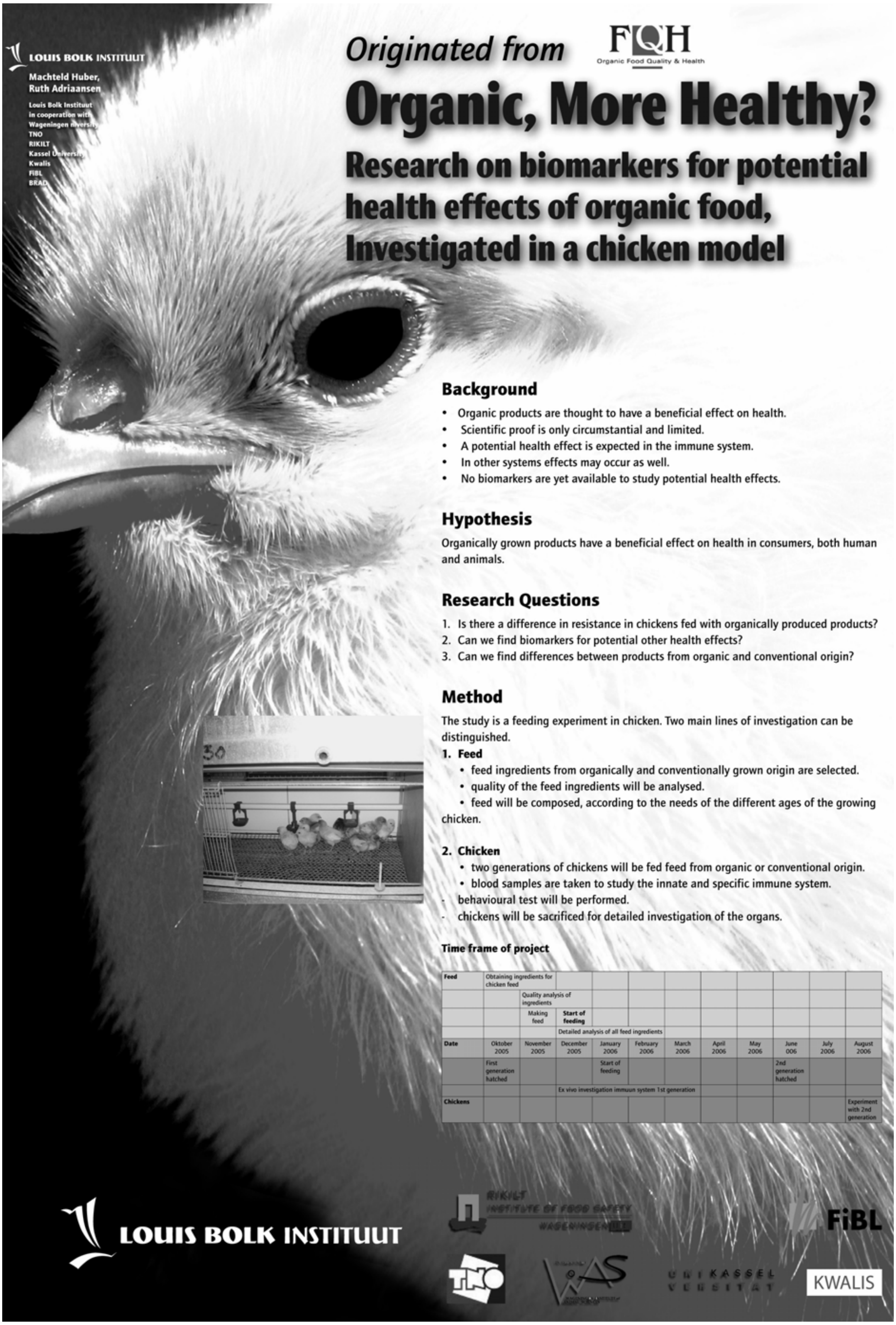


Fig.9. Content of flavonoids in apples from organic and conventional cultivation in two years of cultivation

Conclusions

1. Organically produced tomato fruits (both large-fruited and cherry cultivars) contained significantly more vitamin C, betacarotene, flavonoids and total sugars compared to conventionally produced tomato cultivars.

2. Organically produced apples contained significantly more vitamin C, anthocyanines, flavonoids and total sugars compared to conventionally produced tomato cultivars.



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Organic Food Quality & Health

Organic, More Healthy?

Research on biomarkers for potential health effects of organic food, Investigated in a chicken model

Background

- Organic products are thought to have a beneficial effect on health.
- Scientific proof is only circumstantial and limited.
- A potential health effect is expected in the immune system.
- In other systems effects may occur as well.
- No biomarkers are yet available to study potential health effects.

Hypothesis

Organically grown products have a beneficial effect on health in consumers, both human and animals.

Research Questions

1. Is there a difference in resistance in chickens fed with organically produced products?
2. Can we find biomarkers for potential other health effects?
3. Can we find differences between products from organic and conventional origin?

Method

The study is a feeding experiment in chicken. Two main lines of investigation can be distinguished.

1. Feed

- feed ingredients from organically and conventionally grown origin are selected.
- quality of the feed ingredients will be analysed.
- feed will be composed, according to the needs of the different ages of the growing chicken.

2. Chicken

- two generations of chickens will be fed feed from organic or conventional origin.
- blood samples are taken to study the innate and specific immune system.
- behavioural test will be performed.
- chickens will be sacrificed for detailed investigation of the organs.

Time frame of project

Feed	Obtaining ingredients for chicken feed											
		Quality analysis of ingredients										
		Making feed	**Start of feeding**									
			Detailed analysis of all feed ingredients									
Date	Oktober 2005	November 2005	December 2005	January 2006	February 2006	March 2006	April 2006	May 2006	June 006	July 2006	August 2006
	First generation hatched			Start of feeding					2nd generation hatched		
			Ex vivo investigation immuun system 1st generation								
Chickens											Experiment with 2nd generation

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