Towards Improved Quality in Organic Food Production

Proceedings of the 5th QLIF training and exchange workshop, Driebergen, 21 - 23 January 2009

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Abstract

From 21 to 23 January 2009 the fifth QLIF training and exchange workshop took place. Inspired by the theme “Towards improved quality in organic food production” a group of 20 participants and 11 lecturers had intensive days with lectures, discussion, exchange and some practical experience in research set-up and taste experiments. Fifteen nationalities exchanged their experiences in research in product quality. Many results from comparative studies between conventional and organic products were presented and discussed. In some presentations more emphasis was laid on exploring the mechanism behind the presence or absence of certain health-influencing plant components. Comparative studies will be continued, but exploring the mechanisms behind found differences in substances is suggested as an important direction for future research.
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Introduction

Consumers’ expectations about organic food are covering both production and the product itself. Organic production is regulated and guaranteed, which is not so in case of product quality. For a further consumers’ support, quality of organic produce might become a key factor.

As part of the EU-programme Quality of Low Input Food (QLIF; see www.qlif.org) a seminar is organised for researchers on the topic “Towards improved quality in organic food production”.

The seminar is organised by the Louis Bolk Instituut, the independent research institute for organic agriculture, nutrition and healthcare. Within the QLIF project four earlier meetings were organised by the Louis Bolk Instituut. The previous workshops were on “Healthy Soil, Healthy Crops, Healthy People” (2-4 February 2005), “Towards animal oriented rearing methods in organic production systems” (20-22 February 2006), “Measuring food quality: concepts, methods, and challenges” (12-14 February 2007), and “Soil nitrogen: research and extension” (13-15 February 2008).

This 5th (last) seminar within the QLIF project focuses on the most actual research output related to this quality question. Expert researchers from QLIF project partners and other European Institutions bring in their knowledge and experience related to food quality and to challenges for the organic sector, sharing their knowledge and experience with junior scientists and students. The meeting has the character of a ‘winter school’ with an intensive interaction between contributors and participants.

The aim of the workshop is to introduce participants to both background and actual knowledge on quality in organic food production, and both theory and practice of research approaches and techniques, which are suited for the questions around product quality and how to achieve it. Aspects of human health are touched but are not the central theme.
**Programme**

**Towards improved quality in organic food production**

5th QLIF training and exchange workshop, Driebergen, 21 - 23 January 2009

**21 January 2009**

13.00 – 13.30  Arrival and registration
13.30 – 14.00  Welcome and introduction
14.00 – 15.00  Geert-Jan van der Burgt, Louis Bolk Institute, Netherlands, Product quality, the alpha and omega for further development of organic agriculture

Tea Break

Theme: QUALITY IN PLANT PRODUCTS

15.30 – 16.30  Bart Timmermans, Louis Bolk Institute, Netherlands, Fusarium in wheat
16.30 – 17.30  Lucy van de Vijver, Louis Bolk Institute, Netherlands, Methodological aspects of the comparison of organic and conventional products

End of first day

**22 January 2009**

8.30 – 9.30  Ewa Rembialkowska, Warsaw University of Life Sciences, Poland, Quality of organically produced plant products
9.30 - 10.30  Søren Husted, University of Copenhagen, Denmark, Why is the chemical composition of organic and conventional plant products different?

Coffee break

11.00 – 12.00  Charlotte Lauridsen, Aarhus University, Denmark, Bioavailability of nutrients and health promoting substances in organically plant products investigated in an animal model
12.00 – 13.00  Contributions of participants

Lunch break

Theme: SENSORY ANALYSIS

14.00 – 15.30  Bob Cramwinckel, Centre for Taste Research, Netherlands, Consumer perception of the sensory quality of products - with practical exercises

Tea Break

Theme: QUALITY OF ANIMAL PRODUCTS

16.00 – 17.00  Ewa Rembialkowska, Warsaw University of Life Sciences, Poland, Quality of milk and meat from organic production
17.00 – 18.00  Håvard Steinesshamn, Bioforsk Økologisk, Norway, Relation between grassland management (organic managed long term or short term grassland and botanical composition) and bovine milk quality

18.30  Conference Dinner
23 January 2009

8.30 – 9.30  
*(not presented because of illness of speaker)* Johanna Probst, FiBL, Switzerland, Implications of a calmative handling procedure for cattle preliminary to transport and slaughter and the implications of animals behaviour, blood parameters and meat quality.

9.30 - 10.30  
Jan de Wit, Louis Bolk Institute, Netherlands, Milk quality

Coffee break

Theme: OUTLOOK TO HEALTH

11.00 – 12.00  
Machteld Huber, Louis Bolk Institute, Netherlands, Effects of diet type on chicken health

FINAL SESSION

12.00 – 13.00  
Conclusions and main findings, indicate future research needs and priorities

Lunch and departure
<table>
<thead>
<tr>
<th>Speakers</th>
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<tbody>
<tr>
<td>Geert-Jan van der Burgt, Louis Bolk Institute, Netherlands, <a href="mailto:g.vanderburgt@louisbolk.nl">g.vanderburgt@louisbolk.nl</a></td>
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## Participants

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1 Product quality - The alpha and omega for further development of organic agriculture

Geert-Jan van der Burgt
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I don’t have the answers, I have some topics to consider.

About the definition of quality.
The most open, but nevertheless very useful definition of ‘product quality’ is:
Any property of a product that is related to a desired aspect of this product. Useful because you are forced to answer first this question: Who is desiring what property, when, where?
In social and economic communication ‘quality’ as easily used and seldom clearly defined.

Statement: there is not a thing like ‘organic food quality’:
Food quality criteria may be developed, and organic produce might meet these criteria as well as conventional produce. The organic movement might organise itself in such a way that it can claim: we guarantee this and this quality level, and the organic movement might add criteria to the list of conventionally used criteria.

Product quality and process quality
In the organic market, consumers expect two things.
First, the product must be produced according to the organic standards. This is process quality: the way a product is coming into existence is described and ranked bad (not according to the standards) – good (in accordance with the standards). This can be checked by a certification body. Standards can be minimal or extended and they can be altered.
Second, the product itself is expected to fulfil certain quality parameters such as no pesticide residues, low nitrate content, high vitamin C (all measurable properties), healthy, authentic (not measurable properties).

Statement:
The organic standards are exclusively focusing on process quality parameters. Product quality is mentioned but not defined and not under control (Kahl, in prep.), in spite of consumers’ expectations.

Relation process quality – product quality
Just as an example: nitrogen fertilizer and nitrate content of vegetables (carrots, beetroot, lettuce, endive, spinach,…). Nitrogen application levels in organic and conventional agriculture show a wide range, overlapping each other for a considerable part. Thus, nitrate content of vegetables can not be expected to show a difference between organic and conventional agriculture (Huber, 2007)
Exploring product quality exclusively in terms of measurable content parameters is risky: tell me your criteria and I will produce it.

You want milk high in omega-3 fatty acids? No problem, we produce this milk or we add the desired compound.
You want no residues on your tomatoes? No problem. With high vitamin C? We make it, or we add it.
You want your eggs from a farm with good animal welfare? No problem, we go for a slow chicken breed with reduced beaks to prevent picking each other.
Is that sufficient? No, because process quality requirements (implicit, explicit) are not fulfilled.
Food safety, a special aspect of food quality, is often closely related to process quality. HACCP is an important instrument to improve this aspect of food quality.

An other aspect: taste as product quality parameter.
This might be a great item: one’s own experience as driving factor. Some challenges are mentioned.
How to recognise tomorrow what you bought yesterday? This is a marketing question when selling on distance. It is not an item for selling direct from the farm.
Your taste is influenced by what you know and what you see. This is again a marketing item. I can sell roasted bricks and fried air!
In case of processed foodstuff: the taste is only for a very limited extend influenced by the taste of the original ingredients. Here professional experience plays an important role.
Taste is an individual criterion but also a ‘crowd’ criterion. I personally want a tough bread, but if we want to expand the organic bread consumption we will have to adapt to the taste of the crowd: a light, airy bread. Consequence: high protein content required, so high nitrogen application on the wheat fields.
Taste and timing. It is perfectly known when to pick an apple to have the best taste. Nevertheless many apples are picked earlier (Bloksma et al, 2001, 2004) to be able to store them and have a still acceptable taste four (Eight? Eleven?) month later. ‘Good quality’ for direct consumption is different from ‘good quality’ for storing and selling later.

Other quality criteria.
Conventional agriculture is full of process quality criteria but we don’t recognise them. Allowed sprayings, allowed drugs for animals, allowed levels of fertilizer, …. They don’t serve as quality parameter because they cover the whole country or all EU countries. They can start being quality parameters in case of international trade.

The organic movement might introduce other and new quality criteria.
Process criteria: authenticity, regionality, embedded in landscape, natural, …. Product criteria: coherence (Bloksma et al, 2007). Not individual substances but their coherence as criterion. So far, this is conceptual and needs further development and validation, both of concept and the measurements. This concept integrates process quality (balanced growth and development) into product quality.
Human consumption criterion: is this foodstuff satisfying? Do you need two or five slices of bread before you are fine, and what about two hours later? Can this ‘satisfaction factor’ be measured apart from experience? Does it have a relation with coherence.
Human health as criterion. Very challenging and very complex. What is health, and what makes you healthy: food compounds, food as a whole, menu, lifestyle?
Development of the organic sector: quality and quantity of the sector itself.

Real, expected or suggested quality is a driving but very diverse factor in consumers decisions, so something must be done.

Clear product quality criteria (for any food, not organic exclusively) and minimum levels (for certified organic products) are to be settled. Once done so, conventional agriculture might be moving towards fulfilling these criteria too. Setting of these quality criteria and their minimum levels for organic products might reduce the growth of the organic sector.

Process quality criteria might be added (for processed food for example) or made more strict (in case of agronomic process criteria directly correlated to desired product criteria) in order to position organic produce in the conventional surroundings.

References


Kahl, J. (in prep.) Food quality research, an organic approach.
Product Quality

The alpha and omega for further development of organic agriculture

Geert-Jan van der Burgt
CLIF Workshop, January 2009

Content of this presentation

- Introduction
- Complexity of the theme
- Product quality – process quality
- Taster, sensory analysts
- New quality parameters
- Conclusion

Definition:
Any property of a product that is related to a desired aspect of the product

Example: egg: tomato

Statement:
There is not a thing like "organic food quality"

Food quality parameters must be clear

Organic might be "better"

New food quality parameters can and will be introduced

Parameters could be selected by means of criteria out of the organic movement

Complex theme: examples

- Tomato. Taste, brand, recognition. Tasty Tom, red onion, Lycopersicon-sanguine
- Chips. Individual or collective taste, collective taste. Professionals.
- Cookies. Personal preferences, collective impressions.
- Eggs. Recognize, taste, animal welfare

Product quality – process quality

Statement:
1. The organic standards are excessively focusing
   - On process quality parameters
   - In the agronomic part of the process
   - Desirable, but the product quality (FOAM, EU regulations) is not formalized in support or in guarantee.
Product quality - process quality

Statement:

2. Organic process quality criteria don’t necessarily lead to high product quality. Example: Nitrogen.

- 30 mg N/kg
- 220 mg N/kg

Taste

- Taste and time, example apples, tomatoes
- Taste and variety choice

- Good taste is not enough, good taste must have a ‘face’. Example: Tsay Tem, Wild Wonders
- Taste is context-dependent, experience, packaging, circumstances, knowledge (Bob Cramwelke)
- Individual and collective preferences, example bread, (Jan Timmerman)
- Taste of the field is minimal in processed food stuff

Conclusion

- Real, expected or suggested quality, recognizable quality, guaranteed quality
- Product criteria: Generally accepted or new
- Process criteria: For food processing, For agronomy

Other quality criteria out of an organic context

- Authentic, landscape, local, natural, social, fair, ... Triple P: Fair Trade, Regional products, Nature Conservation...
- Coherence, link between process and product quality
- Satisfying, I want more: I’m fine, thanks, slow food.
- Healthy, Food compounds, food as a whole, friend, lifestyle.

This workshop

- Plant: Process -> product quality
  - Mart Timmerman, Tsay Tem, Warehouse of sea, Serao Wenard
  - Plant health aspects, Charlene Lauritsen
- Methodology: comparison conventional -> chemical Lucy van de Vlijper
- Sensory analysis: Bob Cramwelke
- Animal: Process -> product quality
  - Sara Timmerman, Howard Bartsch, Johanna Prebes, Jan de Vl
- Health: Macsell Haber

Thank you for your attention
2 Fusarium in wheat

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Introduction

Several Fusarium species are creating quality problems in wheat cultivation (Fusarium Head Blight FHB). Seeds infected with Fusarium have a lower 1000 grain weight and will cause a less dense plant stand due to seedling blight, thus reducing the quality for use as seeding material. Fusarium on wheat can produce a variety of mycotoxins, of which deoxynivalenol (DON) is perhaps the most famous (Parry et al., 1995). If present in food or feed, DON can result in serious health problems (D’Mello et al. 1999; Peraica et al. 1999). In certain years, the availability of uninfected seeds may be limited due to the widespread nature of FHB epidemics (Jones, 1999). In the Netherlands on average once every two years organic wheat seed production is affected by FHB (Osman, et al., 2004).

Within the QLIF project research has been done into two directions:
Do commercially available spring wheat cultivars differ in their tolerance to seedling blight in vivo and if so, can these differences be linked to the initial development of the cultivars? (Timmerman et al, paper submitted January 2009 to European Journal of Plant Pathology)
Is there an influence of fertility management strategies on reducing fusarium infestation?
The latter item will be presented and discussed below.

Method and Materials

In 2006 and 2007 (replicates in time) a field trial was done on two locations. On one location with light clayish soil two management strategies were tested (compost (C) and Slurry (S)), on the other location with heavy clay only one strategy (Farm Yard Manure (F)) was tested. Within these three systems (no replicates except years), a top dressing of nitrogen fertilizer was applied in four replicates short before flowering with two types of fertilizer (Pellets and Molasse) and three nitrogen levels as shown in the table 1, with the highest nitrogen level applied in two charges with two weeks in between:

<table>
<thead>
<tr>
<th>Pellets (kg N ha-1)</th>
<th>Molasse (kg N ha-1)</th>
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<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>65</td>
<td>108</td>
</tr>
<tr>
<td>65 + 40</td>
<td>108 + 67</td>
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</table>

Yield of grain and straw was recorded as was nitrogen content of grain (Grain-N)and straw (Straw-N). Furthermore a blotter test was done on the seeds to measure the quality for seeding purpose, and the amount of mycotoxines was measured. Also the presence of Fusarium species was tested by means of the TaqMan-PCR (Waalwijk et al., 2004).
The nitrogen level in the soil during the season was measured a few times and the nitrogen dynamics were modelled with the NDICEA model (Van der Burgt et al, 2006). From this modelling the amount of plant available nitrogen (PAN, absolute and relative to zero-nitrogen application) was obtained.

Results
The model performance, judged by RMSE (Wallach and Goffinet, 1989), is given in table 2.

<table>
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<th>Strategy</th>
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<th>RMSE 2007</th>
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<td></td>
<td></td>
<td>20,3</td>
<td>14,5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7,3</td>
<td>13,5</td>
</tr>
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<td></td>
<td></td>
<td>26,7</td>
<td>29,8</td>
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</table>

Judgement: Reasonable, Good, Good, Good, Weak, Weak

In both years and all three strategies there was a significant relation between PAN at one side and Grain-N and Straw-N at the other side. In table 3 is given the percentage of variance of Grain-N and Straw-N which is explained by the parameter PAN.

In table 4 is given the percentages of variance of DON and TRR (Total root rot; on of the parameters from the Blotter test) which is explained by the parameters PAN, Grain-N and Straw-N.

<p>| Table 3. Percentage of explained variance of Grain-N and Straw-N by parameter PAN |
|-------------------------------------|------------------------------------------------------|</p>
<table>
<thead>
<tr>
<th>Year</th>
<th>Strategy</th>
<th>explained variable</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td></td>
<td></td>
<td>Grain-N</td>
<td>Straw-N</td>
<td>Grain-N</td>
</tr>
<tr>
<td>PAN</td>
<td>CS</td>
<td>80</td>
<td>42</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>90</td>
<td>54</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>CS</td>
<td>57</td>
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<td>84</td>
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<td>F</td>
<td>84</td>
<td>54</td>
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<tr>
<th>Table 4. Percentage of explained variance of DON and TRR by parameters PAN, Grain-N and Straw-N</th>
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<tr>
<td>Year</td>
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<td></td>
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Discussion
For judgement of the model performance an arbitrary, praxis-oriented maximum RMSE of 20 kg N ha⁻¹ is suggested (Van der Burgt et al, 2006). The 2006 model performance is good (table 1; C and F) and almost good (S); the performance in 2007 was weaker. The effect of a long period of drought after sowing in 2007 is probably not modelled correctly. However, the 2007 S model performance was good. The parameter Plant Available Nitrogen
(PAN), derived from the model, was used for further correlation with quality parameters. With a less adequate model performance, the derived parameter might also be less adequate.

There is a strong relation between PAN and nitrogen in the plant (table 2; Grain-N and Straw-N). In 2007 the percentage explained variance is lower than in 2006, which might be the result of the weaker model performance. Grain-N is to a higher degree explained by PAN than Straw-N, due to the late additional fertilizer application (around flowering). Overall we conclude that the plant N-content and mainly the grain N-content indeed expresses the differences in available N.

Significant correlations between soil nitrogen (PAN) and plant nitrogen (Grain-N, Straw-N) at one side and the quality parameters DON and TRR at the other side are present, but they are not strong and not consistent over the years and the strategies.

Overall nitrogen availability in 2006, C and S, was very high and there was no response to nitrogen application in grain yield and straw yield. Nevertheless there was a significant relation between applied nitrogen levels and DON. In only two situations (2006; C, S) straw-N was significantly related to DON whereas grain-N was in seven situations related to DON or TRR. Straw dry matter yield was significantly increased by nitrogen application in 2006 (F) and 2007 (S, C, F) (data not given), but is less significant than Grain-N in explaining DON and RTT. This all supports the idea that it is (at least partly) Grain-N and not microclimate influenced by straw quantity, that causes an increase in FHB when nitrogen levels are increased. Nevertheless, there must be other co-factors besides grain-N to explain the DON and RTT parameters. Location might be a co-factor: the Fusarium species composition on location F was different from location C/S (data not given).

Grain protein content is an important quality criteria for bakeries. In this experiment protein content was influenced by additional fertilizer much more than DON or RTT. For farmers it makes no sense to reduce plant available nitrogen levels in order to reduce DON or RTT. Presence of Fusarium and FHB is mainly a year-effect beyond farmer’s influence, and reducing the yield to minimize effects of Fusarium presence is no option because its effect is very limited and other unknown parameters play a role to.

Acknowledgement
The authors gratefully acknowledge funding from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Integrated Project QUALITYLOWINPUTFOOD, FP6-FOOD-CT-2003-506358.

References


Fusarium in wheat

Quality of seeds
- Quality for consumption

Bat Timmermans
Geert-Jan van der Burg
QLIF Workshop, January 2009

Introduction (1): What's the problem?
- Fusarium Head Blight (FHB)
  - Food and feed: Mycotoxin (DON)
  - Seed: Seeding blight
  - Infected
    - Wheat, Barley, Maize
  - Several Fusarium species
  - Head blight and mycotoxin: high year-to-year variation

Infection during flowering stage of the cereal crop
- Contributing factors: opening of the florets

FHB

Quality of grain
- Fusarium infected grain
  - Is smaller (lighter) than healthy grain
  - Can contain mycotoxins
  - Is less viable

Quality of seed: seeding blight
Towards Improved Quality in Organic Food Production

Effect of mycotoxins in food or feed:
Low doses:
- Reduced food intake, growth retardation, reduced immune system
Higher doses:
- Severe weight losses, vomiting (cica), infectious diseases

Introduction (1): What's the problem?
Fusarium Head Blight (FHB)
- Food and feed: Mycosphaerella graminicola
- Seed: Seeding blight
Several Fusarium species
Head blight: high year-to-year variation
Mycoses have no straightforward relation with presence of fungi
Seeding Blight (SB): expression depends on year, soil
SB: crop can compensate for seeding losses
SB: yield losses due to later crop canopy closure, weeds

Introduction (2): Looking for solutions
Non-chemical seed treatment
Variety-dependent resistance to FHB?
Variety-dependent expression of SB
Impact of soil and soil fertility on FHB

Trial setup (1): 2 years, 2 locations, 3 strategies
Collopaat
- Light clay, 1% organic
- Stoney (S)
- COMPET + NOILSOL (C)
Towndix
- Heavy clay, 3.5% organic
- FYM (F)

Organic spring wheat growing
Fusarium in wheat

Trial setup (3): 5 nitrogen levels, 2 fertilizer types

<table>
<thead>
<tr>
<th>Nitrogen Level (kg N ha⁻¹)</th>
<th>Fertilizer Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pellets</td>
</tr>
<tr>
<td>30</td>
<td>Pellets</td>
</tr>
<tr>
<td>55 - 60</td>
<td>Molasses</td>
</tr>
<tr>
<td>108</td>
<td></td>
</tr>
<tr>
<td>108 - 67</td>
<td></td>
</tr>
</tbody>
</table>

Fertilizer application short before flowering (19) and two weeks later (205)

Trial setup (4): Measurements
- Soil inorganic nitrogen 0-30 cm (4 - 5 each season)
- Straw yield, grain yield, some-N, grain-N
- Fusarium presence by stool test
- DON and other mycotoxins
- Fusarium species by TaqMan PCR

Decisions:
- Statistics: Sites C-S and F separately (due to possible different Fusarium species)
- Fertility regimes:
  - Different manure applications
  - 4-5 N-min measurements
  - Calculations of PAN using the NDICEA model

NDICEA: modeling nitrogen and SOM dynamics

Results (1): check on nitrogen dynamics: model performance

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>C</td>
</tr>
<tr>
<td>NRMSE</td>
<td></td>
<td>14.3</td>
</tr>
</tbody>
</table>

RMSE Root Mean Squared Error; 20 kg N ha⁻¹ as trigger for good model performance.
**Results: Yields 2005**

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
</tbody>
</table>

**Results: Yields 2007**

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
</tbody>
</table>

Factors other than PAR were responsible for yield: drought after sowing; delayed germination; irregular stand; low plant number.

**Results: Fusarium 2006**

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
<tr>
<td>F + S</td>
<td>166</td>
<td>226</td>
<td>226</td>
</tr>
</tbody>
</table>

**Results: Fusarium 2007**

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
<tr>
<td>F + S</td>
<td>14.4</td>
<td>16.4</td>
<td>17.8</td>
</tr>
</tbody>
</table>

Decision: 2007 (S) no slurry. (C) no molasses. No success: pre-crop, initial mineral N.

**Results: does the additional fertilizer application around anthesis influence grain quality?**

PAN = Plant available nutrients; derived from NOICEA calculations. Sowing = b harvest.

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
<tr>
<td>DON</td>
<td>22.6</td>
<td>22.6</td>
<td>22.6</td>
</tr>
</tbody>
</table>

% Explained variance by PAN

**Results: Fusarium 2006**

<table>
<thead>
<tr>
<th>Year</th>
<th>F</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0</td>
<td>151</td>
<td>235</td>
</tr>
<tr>
<td>F + S</td>
<td>166</td>
<td>226</td>
<td>226</td>
</tr>
</tbody>
</table>

**So...**

Something is going on. Not very consistently.

Fusarium in wheat

Results

FAN, Grain N and Srate-N explain most of the variation in DON. 2006 and 2007 explained variance for DON, TRR, DON, TRR, DON, TRR.

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>F</td>
<td>CS</td>
</tr>
<tr>
<td>Explained variance</td>
<td>DON</td>
<td>TRR</td>
</tr>
<tr>
<td>FAN</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Grain N</td>
<td>36</td>
<td>44</td>
</tr>
</tbody>
</table>

Significant but only very weak relations...

Results: relations with DON

So there are relations with grain N and DON

In 2007 we had a heavy weed pressure in the C and D site.

We tried to quantify the weed infestation in the plots...

Weed infestation after anthesis

Conclusions: fertility and Fusarium...

N-level indeed influences Fusarium (TRR, DON).

So far: Agron. FAN gives T-R DON, but other factors play a role.

Mechanism: microclimate or plant physiology?

2006, S rate not microclimate or crop canopy structure: no yield differences (grain, straw), but significant differences in Grain N and DON

Conclusions

Year and duration are dominant factors.

Impacts on yield and grain N are more important than impact on T-R DON.

DON: maximum allowed level not often reached. Peaks are leveled out by mixing several crops.

Therefore, no consequences for agronomic practice: affects are small and do not pay for the farmers.
Acknowledgement

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European Community financial participation under the
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Technological Development and Demonstration Activities,
for the Integrated Project QUALITYLOW/INPUTFOOD,
FP6-FOOD-CT2003-506358.

Thank you for your attention
3 Methodological aspects of the comparison between organic and conventional products

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In recent years more and more papers are published in which the nutritional value of organically produced foods and conventionally (or non-organically) produced foods are being compared. Since the first reviews about 10 years ago (Woese, 1997; Worthington, 2001, Heaton, 2001), the discussion on the methodology of comparison studies started. Heaton was the first to introduce criteria for the validation of the papers he reviewed. His most important criteria were that the organic products should be from certified organic origin and that the foods compared should have been produced according to agricultural practice common to the system in which it was grown – so in other words, the production should be typical to its system.

Design of a study

Different study types are available to perform a comparison study, all having their specific pro's and con's.

Field trials: organically and non-organically cultivated crops grown in close proximity under controlled conditions.
Farm surveys: crops are obtained from organic and non-organic farms, paired for location, climate and soil type.
Market of “shopping basket” surveys: organically and non-organically produced samples are obtained from retailers, as they are available to consumers.

A field trial on an experimental farm is the best way for optimal control of agricultural practice. However, due to logistics, accessibility and finances this study type is not commonly used. Farm surveys performed on existing neighbouring farms with good agricultural practice (best-practice) is a good alternative. If agricultural practices are not controllable, it is important to collect the information and report it (for instance manure use and pre-crops). In studies more interested in the nutritional value of the food at the point of the consumer, a market basket approach may be chosen. To have an idea about the average nutrient availability for the consumer it is necessary to have representative samples (relatively high numbers are needed), sampled at different locations (geographically, supermarket and specialist stores). This type of study is not suitable to compare the agricultural practice as such, because no information on the background of the products is available.

Several aspects need consideration when designing your study, and depending on the goal of your study it might be necessary to minimize its effects. Important aspects are: soil type, climatic conditions and agriculture management practices (manure use, variety, pre-crops). Further it is important to consider which food quality or food safety aspects will be measured. Choose the appropriate product and the appropriate chemical analytical method.

Report

Clearly describe the method used and give a foundation for the choices made. For instance within the scientific community discussions are going on whether or not the same varieties need to be used. Because variety choice is also an important system difference and not all varieties perform well in both organic and non-organic systems one
group of scientist claims that varieties may differ because varieties best suitable for the system need to be used. Other scientist say that a comparison only can be made with the same varieties. Describe your choice of variety and explain why this choice was made.

**Conclusion**

Different study designs give answers to different questions, therefore not one best method can be given. Irrespective of the chosen design, choices need to be made with respect to aspects influencing nutritional quality of the food.
Methodological aspects of the comparison between organic and conventional products

Lucy van de Vliet, PhD
Nutritionist, Louis Both Institute

Reviews of comparison studies
- 1997 sweeping review of European research
- 2001 Worthington/World Journal of Nutrition and Complementary Medicine
  -> 53 peer reviewed articles from 1985-2007
  -> 135 study-product comparisons of which 94 were judged to be valid

Criteria
- Certified as organic
  -> Only data from certified organic produce, certified organic farms, or crops grown in soil (not considered a representation of organic agriculture)
  Note: Only since early 1990's clear definition of organic exists (EU regulations - EU 2092/91)

Task:
What factors should be taken into account to make a valid comparison between the nutritional value of conventional and organic products?
Towards Improved Quality in Organic Food Production

**Criteria**

Agricultural practice reflects typical practice within the respective systems.

- Typical to conventional practice is the use of pesticides, herbicides, and fertilizers.

**Criteria**

Design should be suitable to answer the question.

- Chemical analyses should be suitable for the nutrient under investigation.

**Criteria**

- Design: split plot, random design
- Comparability: soil type and climate
- Variety: information available, should be comparable
- Clear description of the agricultural management, materials used, pre-crop (preferably the same)

**Criteria**

- Variety types
  - Farming organically and non-organically cultivated crops grown in close proximity under controlled conditions.
  - Farm survey: crops are obtained from organic and non-organic sites, paired for location, climate, crop variety, and soil type.
- Market of "shopping basket" survey: organically and non-organically produced samples are obtained from retailers, as they are available to consumers

**Group task**

- Design a study to compare nutritional quality of organic and conventional tomatoes
- Money and time is not an issue
- Which factors do you take into account and why?
- Which question can you answer?
- One of the group members will give a short presentation of the group result

**Conclusions**

- Different study designs give answers to different questions
- There is no one best method, one design
- Clearly describe the choices made
- Variety choice:
  - The variety should be common to the system
- Aspects to take into account
  - Location, climate, crop variety, soil type, year, year

1
4 Quality of organically produced plant products

Ewa Rembielakowska
Warsaw Agricultural University, Faculty of Human Nutrition and Consumer Sciences, Organic Foodstuffs Division, Nowoursynowska 159 C, 02 – 776 Warszawa, Poland

During the last decade, consumers' trust in food quality has drastically decreased, mainly because of the growing ecological awareness and several food scandals like BSE, dioxins and bacterial contamination. It has been found that intensive conventional agriculture could introduce contaminants into the food chain. Consumers have started to look for safer and better controlled foods, produced in more environmentally friendly, authentic and local systems. Organically produced foods are widely believed to satisfy the above demands, leading to lower environmental impacts and higher nutritive values. So far, studies have partly confirmed this opinion.

Organic crops contain less nitrates, nitrites and pesticides residues than do conventional ones. There is no clear difference in the content of heavy metals between organic and conventional crops.

Organic plant products contain as a rule more dry matter, vitamin C and carotenoids, more phenolic compounds, more exogenous indispensable amino acids and more reducing and total sugars. Organic plant products contain also statistically more iron, magnesium and phosphorus.

Organic plant products have usually better sensory quality – they have more distinct smell and taste and they are sweeter and more compact because of higher dry matter content. Preference for organic products is typical not only for humans but also for animals like rats, rabbits and hens. This phenomenon was observed also in such cases in which – according to chemical analyses - both organic and conventional fodder satisfied physiological needs of tested animals.

Vegetables, potatoes and fruits from organic production show better storage quality during winter keeping – clearly fewer mass decrements, caused by transpiration, decay, and decomposition processes. The possible reason is connected with the higher content of dry matter, minerals and total sugars. It brings not only nutritive but also economic profits; in conventional system high yields are produced but big storage decrements undermine economic sense of this production.

The lower content of nitrates and higher content of phenolic compounds and vitamin C in organic crops have a special importance for health. The nitrates are easily converted in our digestive tract into the poisoning nitrites, which are the precursors of the carcinogenic nitrosamines. This process is hampered by vitamin C, and carcinogenesis is retarded by phenolic compounds. Therefore the organic vegetables can play an important role in anti – cancer prevention.

However, there are also some negatives: plants cultivated in organic system as a rule have 20 % lower yield than conventionally produced crops.

Several important problems need to be investigated in the coming years: environmental, bacterial and fungal contamination of the organic crops, and the most essential problem - the impact of the organic food consumption on animal and human health.
**Presentation**

**Quality of organically produced plant foods**

**Factors influencing human health**
- In 64% life-long, psychological reasons, people believe in human health
- In 11% environmental conditions, and food quality is concerned with it
- In 15% genetic background
- In 10% medical service activity

According to American Center of Diseases Control (1996)

**Factors affecting the quality of raw food materials**
- Environmental conditions (clean or contaminated environment)
- Method of farming (organic or conventional)
- Conditions of plant production and animal breeding (proper or improper for the particular variety or breed)
- Climate, weather conditions
- Storage and trade conditions of raw food materials

**Factors affecting the quality of processed foods**
- Quality of raw food materials (from bad grain not possible to produce good food)
- Technology of processing and culinary treatment
- Packing systems
- Storage and trade conditions of food products

**What is “ORGANIC FOOD”?**
- Food produced according to certain, legally regulated production standards
- Production methods are friendly for environment, maintain biodiversity and soil fertility
- Social criteria are important (small farms, using local means of production, activation of the country areas)
Quality of organically produced plant products

- Organic agriculture excludes the use of synthetic fertilizers, pesticides, plant growth regulators.
- Only natural organic fertilizers (compost, manure) and biological crop protection methods are allowed.
- Animal production excludes the use of antibiotics, hormones, and GMOs.
- Food processing processes maintain the quality, excludes synthetic food additives (preservatives, synthetic colour additives, etc.)

Organic Farming in EU Legislation

- The basic for organic farming and processing, applying in the EU is Regulation (EC) No 834/2007 of 24 June 2007 on organic production of agricultural products and indications relating to agricultural products and foodstuffs.
- In August 1999, the production, labelling and inspection of the meat from animals reared in which genetic traits, strains, lines and hybrids were also approved. Regulation (EC) No 1804/1999 of 10 July 2003. The regulation concerns such issues as feedstuffs, disease prevention and treatment, animal welfare, husbandry practices and the management of waste.

Factors Influencing the Quality of Organic Food Products

- Regulations on organic food production
- Regulations on organic animal production
- Regulations on organic material processing

Why do consumers look for organic food...???

Motivation

The loss of trust to conventional food produced on a massive scale

Food Scandals in Europe since 1996

- 1984: A problem linked between BSE (bovine spongiform encephalopathy) and CJD (Creutzfeldt-Jakob disease) was established. (Harries, 2000: 6)
- 1986: Beryllium was detected in milk due to use of water, purchased from a factory with C. parvum. (Gorin, 2000)
- 1997: The Horsemeat Doping Scandal. Polyvinyl chloride (PVC) and dioxins were used to fake a feed of animal broth. (Bernard et al., 2000)
OTHER MOTIVATIONS

- A strong conviction that organic food is safe for health
- The taste of organic food
- Care for natural environment
- Observance of animal welfare

PROFILE OF ORGANIC CONSUMER

- Well-educated, relatively young people
- Inhabitants of big cities
- Women with children
- Allergic patients
- Chronically ill people
- Vegetarians

The main basis

Consumers’ belief in higher health and nutritional quality of organic products

Is the belief justified?

There are some empirical evidences

POSITIVES

- Higher health quality/food safety

Undesirable substances
NITRATES' EXCESS IS HARMFUL TO HUMAN HEALTH

Quality of organically produced plant products
Towards Improved Quality in Organic Food Production

Pesticides cause at least four serious problems:

- Acute and heavy poisoning of people; there are every year 56 million such accidents in the world, and about 200,000 people die
- Chronic poisoning of people leading to various problems, various and tissue cancer, neurological disturbances, mutations, pain, mental disturbances, nervous and psychological change
- Disturbances of the normal balance in ecosystems and breeding systems, lowered resistance to diseases
- Development of resistance of pests to sprays, e.g. products that can be extinct in the market, and which in the market is done by 5-10% and instead of 5% cost 100%, on the contrary and peasants also decrease vitamins C from cabbage, milk, spinach and beans

Complex Mixtures

- The average person’s body carries a mixture of several hundred synthetic chemicals
- None of these could have been there before recent times - they are completely novel
- We have no way of characterising the toxicity of this mixture
- The highest dose is received early in life - the most vulnerable period for damage

Pesticides that have proved to have endocrine effects and that are still in use

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Endocrine Effects</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCB</td>
<td>Thyroid</td>
<td>Low</td>
</tr>
<tr>
<td>TCDD</td>
<td>Thyroid</td>
<td>Medium</td>
</tr>
<tr>
<td>TCDD</td>
<td>Thyroid</td>
<td>High</td>
</tr>
<tr>
<td>TCE</td>
<td>Thyroid</td>
<td>Low</td>
</tr>
<tr>
<td>TCE</td>
<td>Thyroid</td>
<td>Medium</td>
</tr>
<tr>
<td>TCE</td>
<td>Thyroid</td>
<td>High</td>
</tr>
</tbody>
</table>

(ref. Ahmed, 2005, Japan Oil and Gas)
Quality of organically produced plant products

**Pesticides - conclusions**

- Diffuse exposure to a complex mixture through multiple sources
- Current regulation addresses most pesticides one at a time
- There are changes in the incidence of a number of human diseases, including cancer and malformations

We do not and cannot know explicitly what is causing what. The precision of the main and available is critical.

Howard 2005

**Comparison of the pesticide residues in crops with different production systems**

<table>
<thead>
<tr>
<th>Quality</th>
<th>% Whole Fruits</th>
<th>% Processed Fruits</th>
<th>% Processed Residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA 2000-2001</td>
<td>29</td>
<td>47</td>
<td>33</td>
</tr>
<tr>
<td>England</td>
<td>12</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>France 2001-2002</td>
<td>9</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Police SDM</td>
<td>6</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>Police SDM</td>
<td>7</td>
<td>47</td>
<td>38</td>
</tr>
<tr>
<td>Police SDM</td>
<td>6</td>
<td>48</td>
<td>11</td>
</tr>
</tbody>
</table>

**Conclusion**

**Consumption of human milk with pesticides**

- Chlorinated hydrocarbons in relation to the share of organic food in diet (after Aubert 1987)

**Organophosphates Pesticide Exposure of Preschool Children with Organic and Conventional Diets**

(Acc. to Cifelli et al. 2002)

- Urea analysis of urine
  - Preschool children: 0.04 µmol/L
  - Preschool children: 0.34 µmol/L

**CONCLUSION**

Consumption of organic produce provides a safe way to reduce children's exposure to pesticides.
Towards Improved Quality in Organic Food Production

Lower content of hormone residues, antibiotics, growth regulators, food additives... in organic food

Higher nutritional value

Polyphenol content in organic and conventional vegetables and fruit

Mean concentrations of MIA and TCPY in three study phases

Frequency of MIA and TCPY detection in three study phases
### Polyphenols Content in Organic and Conventional Vegetables and Fruits

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Organic</th>
<th>Conventional</th>
<th>Difference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>0.5</td>
<td>0.3</td>
<td>-0.2</td>
<td>Weiler et al., 2013</td>
</tr>
<tr>
<td>Orange</td>
<td>5.2</td>
<td>3.1</td>
<td>-2.1</td>
<td>Leber et al., 2000</td>
</tr>
<tr>
<td>Tomato</td>
<td>0.9</td>
<td>0.5</td>
<td>-0.4</td>
<td>Trouvé et al., 2004</td>
</tr>
<tr>
<td>Carrot</td>
<td>0.7</td>
<td>0.3</td>
<td>-0.4</td>
<td>Scholze et al., 2008</td>
</tr>
<tr>
<td>Strawberry</td>
<td>0.8</td>
<td>0.4</td>
<td>-0.4</td>
<td>Vaidyanathan et al., 2005</td>
</tr>
</tbody>
</table>

### Carotenoids and Cysteine Content in Organic and Conventional Vegetables and Fruits

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Organic</th>
<th>Conventional</th>
<th>Difference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>5.6</td>
<td>3.1</td>
<td>-2.5</td>
<td>Leber et al., 2000</td>
</tr>
<tr>
<td>Carrot</td>
<td>1.2</td>
<td>0.5</td>
<td>-0.7</td>
<td>Scholze et al., 2008</td>
</tr>
<tr>
<td>Broccoli</td>
<td>0.8</td>
<td>0.3</td>
<td>-0.5</td>
<td>Trouvé et al., 2004</td>
</tr>
<tr>
<td>Spinach</td>
<td>1.1</td>
<td>0.6</td>
<td>-0.5</td>
<td>Weiler et al., 2013</td>
</tr>
</tbody>
</table>

### Vitamin C Content in Organic (ORG) and Conventional (CONV) Vegetables and Fruits

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Organic</th>
<th>Conventional</th>
<th>Difference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinach</td>
<td>7.9</td>
<td>5.2</td>
<td>-2.7</td>
<td>Vaidyanathan et al., 2005</td>
</tr>
<tr>
<td>Broccoli</td>
<td>1.5</td>
<td>0.9</td>
<td>-0.6</td>
<td>Scholze et al., 2008</td>
</tr>
<tr>
<td>Carrot</td>
<td>2.6</td>
<td>1.3</td>
<td>-1.3</td>
<td>Weiler et al., 2013</td>
</tr>
<tr>
<td>Tomato</td>
<td>0.9</td>
<td>0.5</td>
<td>-0.4</td>
<td>Vaidyanathan et al., 2005</td>
</tr>
<tr>
<td>Mandarin</td>
<td>5.8</td>
<td>3.1</td>
<td>-2.7</td>
<td>Leber et al., 2000</td>
</tr>
</tbody>
</table>

### Mean Values

- Polyphenols: +50% +32.4%
- Carotenoids and Cysteine: +25.6 +19.2%
- Vitamin C: +92.2 +20.0%
Better storage quality of organic vegetables
(Higher content of dry matter, lower losses during storage period)

Storage losses of apples and potatoes from organic and conventional farms (Britten, 1987)

<table>
<thead>
<tr>
<th></th>
<th>Carrot</th>
<th>Potato</th>
<th>Various vegetables and fruit-vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Conventional</td>
<td>5.0</td>
<td>8.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Rat studies on choice of organic vs. conventional food

<table>
<thead>
<tr>
<th></th>
<th>Oats</th>
<th>Wheat</th>
<th>Apple</th>
<th>Carrot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>85%</td>
<td>90%</td>
<td>80%</td>
<td>95%</td>
</tr>
<tr>
<td>Conventional</td>
<td>35%</td>
<td>40%</td>
<td>40%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Organic food

- Contains essential nutrients
- Promotes health
- Free from synthetic additives
- Supports biodiversity

Organic vs. conventional

- Reduced environmental impact
- Better animal welfare

Thank you

Quality of organically produced plant products
Why is the chemical composition of organic and conventional plant products different?

Søren Husted & Kristian Holst Laursen
Plant and Soil Science Laboratory, Life Science Faculty, University of Copenhagen, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark
E-mail: shu@life.ku.dk

The market shares for organic food products have increased dramatically during the last 10 years in Denmark (DK). The annual growth in sales increased with 25% from 2006-07 and the overall market share for organic food products is now close to 7% in DK. The most popular plant based food products are oats, carrots, wheat flour and potatoes with overall market shares equivalent to 27%, 16%, 11% and 3%.

Among organic consumers in DK, 70% indicate that the most important incentive to buy organic food products are related to a lower content of pesticide and pharmaceutical residues; 55% believe that the taste is better and 48% assume that organic products contain more health promoting substances such as vitamins and minerals.

The perception that organic plant products are better for human health than conventional grown products are typically related to the following broad classes of chemical compounds in plants: nitrogen metabolites, minerals, heavy metals, vitamins and a wide array of different dietary phytochemicals related to e.g. carcinogenesis, heart diseases and the immune system.

In the scientific literature there is currently a strong line of evidence, build up during the last decade, supporting that organic plant products contain significantly less pesticide residues than conventional plant products. However, when it comes to most nitrogen metabolites (nitrite, nitrate, nitrosamines and essential amino acids); minerals (e.g. Mg, Fe, Zn, Se); heavy metals (e.g. Cd, Hg, Pb); vitamins (C, E, D) and not least the health promoting phytochemicals, the picture is blurred and often contradictory. Thus, there is an urgent need to develop and test theories, which can explain differences between organic and conventional systems in a scientific context, not least in relation to plant nutrition and basic plant metabolism.

In most studies there is hardly any attempt to understand and interpret differences between systems for selected plant metabolites based on knowledge to the fundamental biochemical pathways. This is a serious problem, preventing a scientifically based understanding of agricultural systems at the plant metabolome and ionome levels.

In addition, it is very important to include human intervention studies in order to document that the differences found between cultivation systems are of any significant relevance to human health. It is important to note that differences in metabolite concentrations observed between agricultural systems, often are smaller than the typical genotypic differences or the differences induced by physiological plant age (e.g. harvest time) or differences caused by climatic fluctuations etc. Thus, it is of prime importance to document that the observed concentration differences in metabolites also translates into an increased retention in the body and influence human health markers significantly when complete diets are consumed.

In 2007 the research project "Content, Bioavailability and Health Effects of Trace Elements and Bioactive Components in Organic and Conventional Agricultural Systems" (OrgTrace) was initiated in order to improve the scientific basis for assessing the health effects of organic and conventional agricultural systems.
The main objective of OrgTrace is to study the impact of different agricultural management practices, relevant for organic farming, on the ability of cereal and vegetable crops to absorb trace elements from the soil and to synthesise selected bioactive compounds with health promoting effects. Based on the nine different plant products produced in OrgTrace, diets are composed and the bioavailability of health promoting substances are analysed in a human intervention study and, moreover, various health effects such as immune system responses are studied using rats as a model. The plant products are produced in four different geographical locations enabling us to analyse if differences between systems are consistent even on different soil types and microclimatic conditions. OrgTrace is one of the first studies, which follows selected bioactive compounds all the way from the plant and soil system to absorption in the human body. The first results from OrgTrace are expected ultimo 2009, when complete results from two consecutive growing seasons are available.

In this oral presentation, the OrgTrace project will be presented and a number of plant science based key-theories, to explain differences between agricultural systems, will be discussed.

OrgTrace (http://www.orgtrace.elr.dk/uk)
Quality and safety of food are important issues, which receive ever-increasing attention in the general public. Many consumers believe that organic foods are of better quality, healthier and more nutritious than food produced using conventional methods. However, according to a Danish knowledge-synthesis reviewing the existing literature (O’Doherty Jensen et al. 2001), there is no evidence, which in an incontestable way support or refute such perceptions. A large number of studies have addressed the question “whether organic food is more beneficial for health than conventional one” and most of these studies have measured the content of well-known vitamins and minerals in plant food of more or less controlled origin and conclude that there are relatively small but often significant differences. However, it is not yet possible to extrapolate from compositional differences in the food to possible effects on health. In a recent published study the effect of 3 different farming systems (1) low input of fertilizer without pesticides (LminusP), (2) low input of fertilizer and high input of pesticides (LplusP), (3) and high input of fertilizers and high input of pesticides (HplusP) was investigated in three different experiments addressing the following issues:

- Nutrient bioavailability
- Food preference test
- Identification of health related biomarkers

The experiments were performed on rats (inbreed or outbreed), which were provided either single ingredients (apple, carrot, kale, pea, and potato) prepared for human consumption or complete diets composed of these ingredients, rapeseed oil, dl-methionine, calcium carbonate, salt and vitamin/mineral mixture. The experiment regarding nutrient bioavailability showed that growing year but not cultivation system influenced the protein quality and energy value of the vegetables and fruit (Jørgensen et al., 2008). With regard to trace element bioavailability, the experiment study furthermore did not support the belief that organically grown foodstuffs generally contain more major and trace elements than conventionally grown foodstuffs, nor that there appeared to be an effect on the bioavailability of major and trace minerals in rats (Kristensen et al., 2008). The food preference test showed that the majority of the experimental rats showed individual preference for the diets, and that an interesting interaction between diet choice and mothers diet appeared (Yong et al., 2005). Based on the third experiment it was concluded that differences between dietary treatments composed of ingredients from the different cultivation methods caused differences in some health-related biomarkers (concentration of α-tocopherol and IgG, daytime activity, volume of adipose tissue, liver metabolic function and liver peroxidation), which, in future studies on this topic should be assessed with respect to health implications (Lauridsen et al., 2008).
Overall, our studies concluded that it is of utmost importance that future investigations on the effect of organic food in relation to human health and well-being should be based on well-defined and controlled food produce system with replications. Thus, in an ongoing project “OrgTrace” ("Content, bioavailability and health effects of trace elements and bioactive componenets of food products cultivated in organic agricultural systems") funded partly by the International Centre for Research in Organic Food Systems (http://www.darcof.dk/) we are investigating the effects of organically cultivated foods, obtained from different locations and during two harvest years, on health and well-being after long-term consumption using the rat as a model, with special emphasis on the immune responses.

References


Bioavailability of nutrients and health promoting substances in organically plant products investigated in an animal model

5th QLIF Training and Exchange workshop, Driebergen, 2009

ICROFS 2008 (in Danish)

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</tbody>
</table>

Status anno 2001

- "Many consumers perceive that organic foods are of better quality, healthier and more nutritious than foods produced using conventional cultivation methods."
- According to a Danish Knowledge Council (O. Doherty Jensen et al., 2001) evidence that can definitely support or refute such perceptions is not available in the scientific literature.
- Limited knowledge on the area.

Organic food and health - what has been shown recently

- Grinder-Pedersen et al. (2003): Flavonoids and markers of antioxidative defense.
- Only one replication of each production system in both studies!
Towards Improved Quality in Organic Food Production

Nutritive value
- Chemical composition
- Bioavailability
- Secondary metabolites
- Unwanted residues

- several factors from “soil to table” influence the nutritional quality of foods!

Three cultivation methods
- “Organic”: Low input of fertilizer and without pesticides
- “Minimally fertilized”: Low input of fertilizer and with pesticides
- “Conventionally”: High input of fertilizer and with pesticides

Impact of cultivation method on content of primary nutrients
- Dry matter, protein, amino acids, carbohydrates, fatty acids, minerals: NS (few exceptions)
- Harvest year: Effect on several nutrients, although little when considering absolute values

What about bioavailability?
Rats (Wistar) in a balance trial

Published:
Protein
Energy
Major and trace minerals
Available data:
Fiber
Fatty acids
Vitamins

Evaluation of protein quality in plant foods
PUGASI - protein-digestible amino acid index score
(using the requirement of preschool children as a reference)

Animal model

Rat model
- 35 rats (12 on each treatment)
- Rat-type: GK-mol (inbred strain, predisposed to develop diabetes type II)
- Diets: Weaning until 44 weeks
- Experiment: 19 – 44 weeks

Bioavailability of nutrients and health promoting substances in organically plant products investigated in an animal model
Towards Improved Quality in Organic Food Production

### Dietary Composition

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Organically Produced</th>
<th>Con conventionally produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>300 g/kg</td>
<td>200 g/kg</td>
</tr>
<tr>
<td>Fat</td>
<td>85 g/kg</td>
<td>90 g/kg</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>150 g/kg</td>
<td>150 g/kg</td>
</tr>
<tr>
<td>Fiber</td>
<td>10 g/kg</td>
<td>10 g/kg</td>
</tr>
<tr>
<td>Calcium</td>
<td>250 mg/kg</td>
<td>200 mg/kg</td>
</tr>
<tr>
<td>Sodium</td>
<td>450 mg/kg</td>
<td>500 mg/kg</td>
</tr>
<tr>
<td>Potassium</td>
<td>2000 mg/kg</td>
<td>2500 mg/kg</td>
</tr>
</tbody>
</table>

### Content of nutrients and health-promoting substances

<table>
<thead>
<tr>
<th>Substance</th>
<th>Organically Produced</th>
<th>Conventionally produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kJ/100 g</td>
<td>2000</td>
<td>1800</td>
</tr>
<tr>
<td>Fat, g/100 g</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Carbohydrate, g/100 g</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Protein, g/100 g</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

No protein substances could be measured.

### Vitamin E in plasma

![Graph showing vitamin E levels](image)

- *P < 0.05*
- No difference comparing other measured antioxidants

### Effect of rapeseed oil

- Rapeseed oil contributed 25% of the energy content in the diet.
- Caused change in fatty acid composition in plasma and tissues of rats.
- Reflected - as for other monogastic animals - the content of the diet (e.g., minimally fertilized different)

### Measurement of rats’ health

- In vivo: Balance experiment, Energy metabolism, Activity, Organ function...
- Postmortem: Analysis of blood and tissue, Immune substances, Preference test...
Bioavailability of nutrients and health promoting substances in organically plant products investigated in an animal model
Conclusion

- For several responses no difference between the three diets was observed.
- But in most cases, where differences were observed, there was a beneficial effect of the “organic diet.”
- The rat is a sensitive animal model applicable when testing even minor nutritional differences.
- Not possible on the basis of the present project to conclude regarding “Importance of the cultivation method”.

Variability should be taken into account

- In cultivation systems, the field (not the animal) is the experimental unit.

Results from a pilot study

Equal (phytoestrogens) in bulk milk from 17 farms

Future research – some realizations

- Variability in the population of “organic” and “conventional”
- Complete diets – not just single ingredients
- What are the links between cultivation in different ways and health (mechanisms of effects)?

ORGTRACE (2007-2010)

- VEGIQUE: 1 cultivation-systems, 1 localisation, 2 years, 6 replications
- CROPSYS: 3 cultivation-systems, 1 localisation, 2 years, 3 replications

Human intervention study: 6 complete diets/year
- Rat study: 12 rats/year
- Biomarkers of health
- Immune system
Bioavailability of nutrients and health promoting substances in organically plant products investigated in an animal model
The problem is that there are no objective standards for the taste quality. The main reason is that taste is a human perception of product properties. Of course there exists general rules, such as freshness. But ‘fresh’ is not enough. Everyone collects emotional values during his or her live in association with products. By eating a product with positive feelings, these values are added to the product perception and becomes an essential part of the taste. So taste can be seen as a combination of the product properties and emotional values.

Eating products is a combination of filling the stomach and feeling the associations. For that reason that most of the consumers have a very limited food choice. There are about 20,000 different products available, but an average household uses only 1%. So, it is more common to use the same products again and again than looking for new, unknown products.

In order to improve the taste quality of organic food, it is necessary to improve the original taste and to combine it with the attractive story of the biological production.

Finding the best original taste can be done with target groups (people who love strawberries, lettuce, apples, tomatoes etc.) under strict blind conditions. The taste of biological products can then be compared with the taste of the common products.

This will be a long way. Not only the biological growing conditions influence the taste but also the genetic properties. So, beside the optimal biological growing conditions also the best genetic variants for that conditions must be found. Only the combination of a good feeling of the organic food production with a wonderful taste will convince the consumer to change their habits in buying organic food. I believe that positive associations in combination with a wonderful taste is the best stimulus for a healthy life.
Presentation

Centre of Taste Research
- Founded in 1991
- Clients: A3, Consumer Organization, Altert-Helio, AKE, KLM, Blikker test, Shell, etc.
- Dr. Z. Aarree, Natasha, Klijn, Leef, Copar, Steganum, Althoff, Wui, Mendo, NDC, VLA/VG, H. Meier

Contents
- What is taste?
- Developments in taste research
- Conclusions

First test: Cheese
1. Bio, Frieseker
2. Bio, Loererlaere
3. Regular, Farmer classic
4. Regular, Mesoanser

Taste is ...
Dictionary
1. Flavour: The soup had a very salty taste
2. Small amount: That's about one teaspoon of salt

Taste is also...
3. Liking: You can't always share your taste in eating
4. Ability to make good choices: The room had to be decorated with great taste
The start of CSO

- Assumption: products are at the base of taste/flavor
- The sense gives information to the brain

Example: test of lager & beer

- We selected people with high interest in taste
- They judged 18 products: lagers and ales
- Which product was higher appreciated: lager or beer?

Stimulus and the Response

- The surroundings dominate the consumers behavior
  - or
- The consumer dominates his surroundings

‘Ground’ taste

- S-R model: trained an expert paner on ground taste: The human being as instrument
- Reverse S-R model: ask consumers if they recognize a ground taste and ask their opinion

Answer

- Beer!
- But... which one is the best selling product?

Conclusion

- The result of a pairing taste test gives no prediction of a success in the market
- Reason: in a blind test the values of the labels are ignored
- Values of lager—pleasure, friendliness and easy to drink
Towards Improved Quality in Organic Food Production

**Ground taste**
- On the basis of correlation of the individual scores with the average two groups can be formed.
- Now it becomes clear: there are two different types of ground taste!

**Tilea test**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>6.3</td>
</tr>
<tr>
<td>Smell</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8.3</td>
</tr>
<tr>
<td>Texture</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9.3</td>
</tr>
<tr>
<td>Appearance</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7.3</td>
</tr>
<tr>
<td>Overall</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7.3</td>
</tr>
</tbody>
</table>

**Different type of taste research**
1. Form target group.
2. Explain the goal of the experiment.
3. Explain the value of a personal judgment.

**Understanding taste**
- Attention for the feelings for a product.
- But, how to do that?

**First feelings**
- An empty stomach (very bad feeling) becomes a filled stomach (very good feeling).
- The taste of human milk (37°C) is sweet and creamy.
- Learning process: products with a sweet and creamy taste give me positive feelings.
What's next?
- After the period of human consumption, new products are discovered.
- New tastes are learned.
- New good feelings are developed.

Four laws
1. Taste is always associated with feelings.
2. Observing differences gives the meaning to the taste of products.
3. With hunger, food becomes more tasteful.
4. There is no accounting for taste.

Blind test: Cheese
1. Sample 1
2. Sample 2
3. Sample 3
4. Sample 4

Codes
1. Bio, Remselle - as branded test nr. 1
2. Regular, classic - as branded test nr. 3
3. Bio, Lovernale - as branded test nr. 2
4. Regular, Messhansier - as branded test nr. 4

The 3-Taste Model
Towards Improved Quality in Organic Food Production

- Taste is complex
  - Taste is the interaction of sensing & product properties
  - The 5-Taste model makes this interaction visible

- Feel and taste

- Blindfolded wine test
  - Which one is the white, the rosé or the red wine?
Taste is complex

- Every person creates his own taste reality
- For a taste test it is important to select people with similar taste realities: target groups

Strategy

- Blind tasting. Compare with other products in the market
- For the selection of respondents:
  - Make a general sample of the population
  - Good variance among the products in the test
- The packaging can boost the taste: add feelings to the product as health, fun, easy to use, value, biologic, natural etc.

Summary

- First step: good product
- Good taste = good feelings
- Good feelings = good sales
- Cluster of respondents with equal kind of habitat/feelings
- Test the combination of feelings & taste
8 Quality of animal products

Ewa Rembialkowska
Warsaw Agricultural University, Faculty of Human Nutrition and Consumer Sciences, Organic Foodstuffs Division,
Nowoursynowska 159 C, 02 – 776 Warszawa, Poland

Farm animals from organic herds show less metabolic diseases like ketosis, lipodosis, arthritis, abscesses, mastitis and milk fever. The level of the somatic cells is similar in cow milk from the organic and conventional husbandry, but the level of heavy mastitis cases is significantly lower in the organic sector. A probable reason is that cows reared organically have more effective immune system, better prepared to fight against the infections. Milk and meat from organically reared animals has more profitable fatty acids profile and contains regularly more CLA (conjugated linoleic acid), which probably has an immunomodulating and anti-cancer impact on human health.

Most of the studies show that organic milk has better nutritive value than conventional milk: more vitamins as carotenoids, tocopherols, vitamin E, and B-group, more important minerals. Some studies show that coli form bacteria are more abundant in the organic than conventional milk; in the same time some dangerous bacteria (e.g. S. Streptococcus aureus and S. agalactiae) are more abundant in the conventional milk.

Sensory properties of the organic milk are evaluated differently in different studies.
There are some positive attributes of meat from organic livestock production: lower content of total fat in carcasses, higher intramuscular fat content, better profile of fatty acids, higher weight of breast and thigh muscles in poultry carcasses and sirloin and ham in pork carcasses, moreover in most cases better sensory quality.

There are also some negative attributes of meat from organic livestock production: lower total weight of carcasses (lower weight gain), higher TBARS value, faster lipid oxidation processes => inferior storage quality and lower tenderness in case of organic pork.

There are some additional negative aspects of the organic animal production. Yield of milk and meat in organic sector is about 20 % lower. It causes lower profit for the organic producer, increases the prices, and creates a barrier for many consumers to buy organic food.

More frequent parasitic afflictions in organically reared animals are typical. It can create some problems for the consumers though proper technological and culinary treatment can allow avoiding health risk. In organic production systems the animals are especially threatened by parasites because of the outdoor rearing and ban on prophylactic veterinary drugs. There remains the open question whether parasites really threat human health, because they are destroyed by cleaning and cooking treatments. However, for the consumers the presence of parasites in farm animals can be perceived negatively.
Comparison of the milk and meat quality from the organic and conventional production

Comparison of the factors affecting composition and properties of milk and meat

Factors affecting composition and properties of milk and meat:

- **Genetics and Breeds**: Different breeds of animals have varying genetic predispositions which can impact milk and meat composition.

- **Age and Stage of Animal**: The age and stage of the animal (e.g., young vs. adult, lactation vs. post-lactation) can affect milk composition, including fat and protein content.

- **Nutritional Management**: The type and quality of feed provided can influence the composition of milk and meat. Organic feed often includes more natural and less processed components, which can affect the composition.

- **Environmental Conditions**: Factors such as weather, stress, and housing conditions can also affect milk and meat composition.

- **Health Status**: The health of the animal, including the presence of illness or disease, can impact milk and meat quality.

- **Management Practices**: The management practices, including milking frequency and handling, can influence the quality of milk and meat.

- **Genetic Makeup**: The genetic makeup of the animal can determine the type and quality of milk and meat produced.

- **Reproduction Cycle**: The stage of the animal's reproduction cycle, such as pregnancy or lactation, can affect milk and meat composition.

- **Supplementation**: The use of supplements, either organic or non-organic, can influence the quality of milk and meat.

- **Traditional versus Modern Practices**: Traditionally, organic farming practices have focused on avoiding synthetic inputs, such as pesticides and antibiotics, which can impact the quality of milk and meat compared to more modern practices.
Quality of animal products

**Comparisons of the health states of the dairy cows from the organic and conventional farms**

**Conclusions**
1. The milk, cheese, and yogurt samples from the organic farms showed higher levels of conjugated linoleic acid (CLA) compared to the conventional farms.
2. The milk from the organic farms had a better carbon footprint and lower environmental impact.
3. The cheese from the organic farms had a higher fat content and lower moisture content.
4. The yogurt from the organic farms had a better flavor and texture.

**Table: Quality of Animal Products**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Organic</th>
<th>Conventional</th>
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</thead>
<tbody>
<tr>
<td>Protein</td>
<td>4.2%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Fat</td>
<td>3.8%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.8%</td>
<td>4.5%</td>
</tr>
<tr>
<td>pH</td>
<td>6.7</td>
<td>6.5</td>
</tr>
</tbody>
</table>

**Main factors influencing FA profile in milk:**
1. Increased proportion of the total conjugated linoleic acid (CLA) in organic milk.
2. Better carbon footprint and lower environmental impact.
3. Higher fat content and lower moisture content.

**CLA**

- **Conjugated linoleic acid (CLA)**
- **Forms:**
  - 7,12-CLA
  - 7,9-CLA
  - 10,12-CLA
- **Health benefits:**
  - Prevention of cancer
  - Suppression of inflammation
  - Anti-inflammatory properties

**Effect of pasture season on milk yield, milk composition and post of healthy cows in milk (Elbers et al., 2004)**
Organic livestock health and performance are optimized by careful attention to the basic principles of livestock husbandry, such as selection of appropriate breeds, appropriate management practices and nutrition, and avoidance of overstocking.

Source: www.nat.co.uk

**ORGANIC FARMING IN EU LEGISLATION**

- In August 1999, rules on production, labelling and supervision of the most relevant animal species (cattle, sheep, goats, horses and poultry) were also agreed – Council Regulation (EC) No 1884/1999 of 19 July 1999.

  - This agreement covers such issues as animal husbandry, housing conditions, animal nutrition, disease prevention and veterinary treatment, animal welfare, husbandry practices and the management of manure as well as labelling of products.

**ORGANIC FARMING IN EU LEGISLATION**


  - More detailed rules are included in the IFOAM Basic Standards and Accreditation Criteria.

**Organic livestock production standards**

- Use of antibiotics, growth-promoters, GM-O is prohibited except for situations where using animal feed and lack of other medicinal products.

- Use of livestock feed additives is prohibited.

**Organic livestock production standards**

- Livestock must graze or browse only on certified pastures and rangelands.

- All farm-produced feeds and forages must be organically-grown.

- Primarily obtaining feed from the holding and the animals where kept or from other organic holdings in the same region.
Organic livestock production standards:

- The livestock shall have permanent access to open air areas, preferably pasture, whenever weather conditions and the state of the ground allow this.
- All livestock on organic farms must have access to fresh air, direct sunlight, shade, shelter, clean water and exercise areas suitable to the species, its stage of production, the climate, and the environment.
- Rearing and maintenance conditions in organic farms must ensure species-specific needs (e.g., for poultry, access to water basins for waterbirds, etc.).
- Optimal stocking levels should be 0.5 - 1.5 livestock units per hectare of forage area.
- Use of appropriate clean, dry bedding in stock buildings.

Organic livestock production standards:

- Appropriate breeds shall be chosen.
- The number of livestock shall be limited with a view to minimising overgrazing, preaching of soil erosion, or pollution caused by animals.
- Any suffering shall be kept to a minimum during the entire life of the animal, including at the time of slaughter.

Changes according to new Council Regulation (EC) No 834/2007 of 28 June 2007:

- Organic livestock shall be born and raised on organic holdings. Non-organically reared animals may be brought onto a holding under specific conditions.
- Tethering or isolation of livestock shall be prohibited, unless for individual animals for a limited period of time and in so far as this is justified for safety, welfare or veterinary reasons.

Changes according to new Council Regulation (EC) No 834/2007 of 28 June 2007:

- Livestock shall be fed with organic feed that meets the animal’s nutritional requirements at the various stages of its development.
- A part of the ration may contain feed from holdings which are in conversion to organic farming. (in the case of bovines, no more than 5% of feed may come from intensive conventional farms and up to 20% in case of other species for farms only till 31 XII 2000)

- According to the criteria of the Animal Welfare Act, the regulations on animal welfare apply as for the “in-herd” and the processing plants for organic foods are more important to the farmer and facilities in the animal feed is prohibited.

- Livestock farms that are not certified organic shall not be used as feed is prohibited.
The consumer's decision to purchase specific food, especially in developed countries, is greatly influenced by perceptions of healthiness, which in the case of meat is largely related to its fat content and the fatty acid composition, namely the polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), and saturated fatty acids (SFA) content.

Factors influencing meat quality:
- kind of feed given to animals
- rearing system, including physical activity
- breed, age and sex of animals
- way of slaughter and post-slaughter interventions including bleeding, bum and chilling of carcasses.

Organic meat quality parameters differ depending on animal species.

Quality attributes of organic mutton depending on breed and production system:

<table>
<thead>
<tr>
<th></th>
<th>Suffolk ORG</th>
<th>Suffolk CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass weight [kg]</td>
<td>20.9</td>
<td>16.3</td>
</tr>
<tr>
<td>Intramuscular fat [%]</td>
<td>5.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Subcutaneous fat [kg]</td>
<td>1.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Fat-free body weight [kg]</td>
<td>16.5</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Organic mutton of Suffolk breed showed higher intramuscular fat content and higher share of fat-free body weight compared to meat of the same breed from conventional husbandry. Such parameters decide on better taste of meat keeping at the same time high nutritional quality as the result of lower total fat content.

Quality attributes of organic mutton:
- higher content of PUFA, especially linoleic acid
- reduced ratio of SFA:MUFA
- lower content of EFA.

Source: Jersak 2005

Source: Tray et al., Jersak et al. 2000

Quality of animal products
Quality attributes of organic meat depending on breed and production system

- When comparing n-6:n-3 ratio in meat samples it was found that the ratio is more favourable in meat obtained from Soys sheep that was pastured. This specific British breed (Ovis aries L) is said to be the oldest from currently occurred, the closest to sheep from Neolithic period (Byerd, 1984).
- Most of this breed has the most beneficial ratio of polyunsaturated acids to saturated fatty acids (PUFA).

Angood et al. 2007

Fatty acid composition and eating quality in organic vs. conventional lamb

- A study showed that there were systematic differences in fatty acid composition and eating quality between conventionally produced lamb offered for sale to UK consumers.
- The results indicated that organic meat had:
  - higher n-3 PUFA content
  - better eating quality in terms of juiciness, flavour, and overall liking than conventional lamb.
- The increased juiciness can be attributed to the higher level of intramuscular fat in the organic chops.

Angood et al. 2007

Essential fatty acid content in organic vs. conventional beef

- The increased flavour (preferred by UK consumers) can be attributed to differences in fatty acid composition, in particular a higher level of linoleic acid (18:2) and total n-3 PUFA in organic beef (derived from grass feeding).
- Conventional beef had a higher percent of linoleic acid (18:2) - indicating more concentrate feeding.
- Both types of beef had favourable n-6:n-3 ratios.
- There was a modest price differential between the two production systems of no more than £1.87 per kg.

Angood et al. 2007

Ratio of n-6:n-3 EFA in beef from organic and conventional husbandry

- Organic beef: 4.9:1
- Conventional beef: 29.2:1

Poulsen et al. 2000; Eivind et al. 1996

Ratio of n-6:n-3 EFA in the human diet

- n-6:n-3 = 1:1
- n-6:n-3 = 2.3:1
- n-6:n-3 = 4:1
- n-6:n-3 = 30:1

Diets that are low in n-6 fatty acids (linoleic acid) are preferred for optimal health.
Quality of animal products

Ratio of n-6:n-3 EFA in the human diet

- In the past meat in human diet used to be naturally richer in n-3 fatty acids and contain much less saturated fatty acids than meat from current livestock production. In the diet of people who consumed venison or meat from pastured animals the n-6:n-3 ratio was 1:1. Contemporary in developed countries this ratio amounts to 20:3:1.
- It is due to the fact that industrial production of animal feed nowadays is granite in n-6 fatty acids, resulting in performance of n-6 fatty acids in meat and not enough amount of n-3 polyunsaturated fatty acids.

Rahimi et al. 2005

Comparison of organic and conventionally reared sows

- According to study by Wobbe et al. (2015), organic samples (O) were significantly lower in fat content and therefore significantly higher in moisture content than conventional samples (C).
- No significant differences were observed between (O) samples for protein, ash, fat, water, alpha-linolenic, retinol, as well as fatty acid content.
- C samples outperformed O samples with respect to shelf life stability.
- O samples proved to have greater color and lipid stability, which stored under retail conditions — due to the greater fat content of O samples — increased oxidation of O samples even though O samples contained greater level of unsaturation.

Wobbe et al. 2015

Quality attributes of organic pork

- Meat quality is strongly influenced by feed composition. In case of pork, this is in turn driven by the amount of organic feed consumed.
- Carrion from organic livestock animals were fed on concentrates in 70% and grass in 30% and both composition to conventional animals.
- Lower portion of intramuscular fat
- Similar weight of fat and lean significant from the technological point of view

Hansen et al. 2006

Quality attributes of organic pork

- In case of feed composition only from organic cow’s milk, weight gain and fat-free body weight were similar in both conventional group (Hansen et al., 2006).
- According to Hant et al. (2006) and Hant et al. (2009), meat of fattening pigs from organic husbandry had considerably higher intramuscular fat content than from conventional husbandry (1.92 ± 0.17%).
- Statistical results in both groups are obtained by Hant et al. (2006).
- In comparison of meat from organic and conventional husbandry, the meat from conventional husbandry, the meat from organic husbandry showed a higher amount of intramuscular fat content.


Quality attributes of organic pork

- Organic pork has a higher intramuscular fat content. In organic pork, there is a higher intramuscular fat content, which is reflected in higher vitamin E content in organic pork that results in higher shelf life stability.
- Carrion from organic husbandry have a higher percent of fat-free body weight and the value is evaluated higher due to lower cholesterol and lower in comparison is carnitas from conventional husbandry.


Quality attributes of organic pork

- Quality of animal products

Quality of animal products 75
Towards Improved Quality in Organic Food Production

Quality attributes of organic poultry and rabbit meat:
- Higher color intensity in chickens from organic husbandry
- Higher live content in organic poultry
- Lower fat content in poultry and rabbit meat from organic husbandry
- Higher palatability of organic poultry (research in sensory panel)
- Organic poultry was more accepted by thegmentation of the sensory panel.

Conclusions:
- Lower content of total fat in carcasses.
- Higher intramuscular fat content vs. higher marbling.
- Different gout of fatty acids:
  - Lower levels of SFA
  - A higher level of IMFA
- Higher weight of breast and thigh muscles in poultry carcasses, and loin and ham in pig carcasses
- In most cases, better sensory quality (+).

Quality attributes of organic poultry meat:
- Directly associated with organic poultry in comparison to conventional poultry ➔ indicating intensive nutrition
- Different FA quality of organic meat: higher content of SFA and IMF, and lower MUFA.
- Lower weight gain and lower final weight of rabbits and chickens in organic husbandry ➔ the effect of higher activity of organic chickens and higher energy at piano in comparison with thermoregulation
- Lower muscular fat and fewer development of tendons and thigh muscles in carcasses from organic husbandry (decrease that significantly increase commercial productivity).

Conclusions:
- Positive attributes of meat from organic husbandry production:
  - Lower total weight of carcasses (lower weight gain)
  - Higher IMF, value, faster lipid oxidation processes ➔ inferior storage quality
  - Lower tenderness is case of organic pork

Thank you for your attention!
9 Relationship between grassland management and bovine milk quality

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E-mail: havard.steinshamn@bioforsk.no

Introduction
Studies have revealed that dairy cow milk from organic systems may have higher concentrations of beneficial fatty acids (FA) and antioxidants compared with milk from to conventional systems (Bergamo et al., 2003; Butler et al., 2008; Collomb et al., 2008; Ellis et al., 2006; Jahreis et al., 1997). Higher forage:concentrate ratio and higher proportion of fresh grass and clover in the diet of the cow in organic farming may explain some of these differences. Both white and red clover silage yields milk with higher proportion of n-3 FA than pure grass silage (Dewhurst et al., 2003), and red clover seems also to be superior to white clover in this respect (Steinshamn and Thuen, 2008). Other plant species may also affect milk FA, as milk from cows offered botanical diverse forage has yielded milk with higher proportion of conjugated linoleic acid and n-3 FA than cows offered more pure grass based diets (Leiber et al., 2005; Lourenco et al., 2005). Although short-term grassland is recommended for high productivity, long-term grassland with high proportion of unsown species and low proportion of clover is common in both organic and conventional production in Norway. The aims of the present study were to determine whether there is a difference in composition of milk from farms having long-term grassland and milk from farms where short-term rotational grassland prevails, and to compare the effect of organic and conventional management on milk composition from these grassland management systems. We present the first year results of a two-year study of commercial farms.

Material and methods
Bulk-tank milk was collected every second month (from February to December 2007) from 32 farms in Middle Norway. Half of the farms (16) were certified organic (O) and the other half were conventionally managed (C). In both farming systems, 9 farms practiced short-term rotational grassland (S) and 7 farms had long-term grassland (L). Milk FA composition and milk content of α-tocopherol, β-carotene, retinol and phytoestrogens were analyzed at the University of Aarhus. The data were analyzed according to a factorial analysis of variance with farming system (F; O or C), grassland management (G; S or L) and Month (M) as fixed factors and farm within farming system and grassland management as random factor.

Results
Average age of leys was 2.2, 11.4, 2.8 and 9.9 years, and the proportion of legumes of the total yield in the first cut was 0.31, 0.14, 0.03 and 0.01 on OS, OL, CS and CL, respectively (Table 1). The proportion of other herbs was highest on OL (0.34), intermediate on CL (0.17) and lowest on OS (0.08) and CS (0.04). Average daily concentrate supplementation per cow was 38, 30, 46 and 50 MJ net energy lactation for OS, OL, CS and CL, respectively (Table 1). Daily milk yield and milk fat concentration was significantly lower on OL than on the other farming systems (Table 2). Milk protein concentration was higher on farms with short-term than on farms with long term grassland. Season had strong impact on the other milk quality parameters. However, the seasonal effect was generally consistent.
across farming and grassland systems. Therefore, only the effects of grassland and farming systems are presented here. There were only minor effects of grassland management on milk FA composition but a strong effect of farming system. Milk from O had higher proportion of short and medium chained FA (<18 C), 18:3n-3 and FA with >18 C and lower proportion of 18:0, 18:1n-9, 18:2n-6 and lower n-6/n-3 FA ratio than the milk from the C farms. Milk concentration of β-carotene was higher on C than on O, but there was no difference in the contents of vitamins. Milk from O farms, particularly OS, had higher content of the mammalian phytoestrogens equol and enterolactone than C.

Table 1 Farm characteristics of the surveyed farms managed organically (O) or conventionally (C) with either short term (S) or long term (L) grassland in Middle Norway 2007.

<table>
<thead>
<tr>
<th></th>
<th>OS</th>
<th>OL</th>
<th>CS</th>
<th>CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farms</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Total area per farm, ha</td>
<td>41.2</td>
<td>32.4</td>
<td>35.2</td>
<td>22.3</td>
</tr>
<tr>
<td>Annual crops, proportion of total area</td>
<td>0.14</td>
<td>0.01</td>
<td>0.19</td>
<td>0.0</td>
</tr>
<tr>
<td>Average number of lactating dairy cows per month</td>
<td>19.7</td>
<td>12.5</td>
<td>19.0</td>
<td>14.5</td>
</tr>
<tr>
<td>Average lactation, number per cow</td>
<td>2.2</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Concentrate, NEI/day</td>
<td>5.5</td>
<td>4.4</td>
<td>6.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Botanical composition of the cut grassland, proportion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasses</td>
<td>0.61</td>
<td>0.52</td>
<td>0.93</td>
<td>0.82</td>
</tr>
<tr>
<td>Legumes</td>
<td>0.31</td>
<td>0.14</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Other herbs</td>
<td>0.08</td>
<td>0.34</td>
<td>0.04</td>
<td>0.17</td>
</tr>
<tr>
<td>Number of species in the grassland</td>
<td>14.4</td>
<td>17.3</td>
<td>11.6</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Discussion
The effect of farming system on milk FA composition is to some extent in accordance with other studies, particularly with respect to the proportion of 18:3n-3 and the n-6/n-3FA ratio (Butler et al., 2008; Ellis et al., 2006). Lower concentrate level and higher clover proportion in the diet on O farms has probably led to higher intake and transfer of 18n-3 from feed to milk. In addition, organic certified concentrates in Norway contains some fish meal, explaining higher milk proportion of long chained n-3 FA (>18 C). Supplementation with the commercial concentrates used in the present study not only increase the dairy cows’ intake of non–structural carbohydrates but also the intake of lipids containing C18 FA; mainly 18:2n-6 that is to a large extent biohydrogenated to 18:0 in the rumen and 18:0 is partly desaturated to 18:1n-9 in the udder. This probably explains higher milk fat proportion of 18:0 and 18:1n-9 in C than in O. However, difference between O and C are likely due to other effects as well, as the milk content of β-carotene was lower in O than in C. Usually, milk β-carotene content is reduced when the concentrate level is increased due to reduced intake of β-carotene. A major difference between OS and the other systems is the much higher content of red clover in the grassland and consequently in the dairy cows’ diet. This explains that milk from OS has a higher content of equal than the others (Steinshamn et al., 2008), but the higher milk content of enterolactone from these same farms is less obvious and warrants further examinations.
Table 2 Milk production and concentration of protein, fat, fatty acids (FA), α-tocopherol, β-carotene, retinol, equol, enterolactone and selenium in milk samples from farms managed organically (O) or conventionally (C) with either short term (S) or long term (L) grassland in Middle Norway 2007.

<table>
<thead>
<tr>
<th>Farming and grassland system</th>
<th>SED</th>
<th>Significance, P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OS</td>
<td>OL</td>
</tr>
<tr>
<td>Number of farms</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>*Milk yield, kg/day</td>
<td>19.8</td>
<td>16.3</td>
</tr>
<tr>
<td>Milk fat, g/kg</td>
<td>41.3</td>
<td>38.9</td>
</tr>
<tr>
<td>Milk protein, g/kg</td>
<td>34.6</td>
<td>32.8</td>
</tr>
</tbody>
</table>

Fatty acids, g/100 g FAME

<table>
<thead>
<tr>
<th>FA</th>
<th>OS</th>
<th>OL</th>
<th>CS</th>
<th>CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0</td>
<td>3.82</td>
<td>3.24</td>
<td>3.21</td>
<td>3.03</td>
</tr>
<tr>
<td>C14:0</td>
<td>12.5</td>
<td>11.8</td>
<td>11.1</td>
<td>10.8</td>
</tr>
<tr>
<td>C16:0</td>
<td>30.7</td>
<td>30.9</td>
<td>27.6</td>
<td>27.7</td>
</tr>
<tr>
<td>C18:0</td>
<td>10.1</td>
<td>10.5</td>
<td>13.0</td>
<td>13.4</td>
</tr>
<tr>
<td>C18:1c9</td>
<td>21.6</td>
<td>22.8</td>
<td>25.5</td>
<td>25.5</td>
</tr>
<tr>
<td>C18:11:11</td>
<td>1.07</td>
<td>1.06</td>
<td>1.01</td>
<td>0.89</td>
</tr>
<tr>
<td>C18:2c9,t11</td>
<td>0.69</td>
<td>0.83</td>
<td>0.72</td>
<td>0.64</td>
</tr>
<tr>
<td>C18:2c9,c12 n-6</td>
<td>1.85</td>
<td>1.73</td>
<td>2.04</td>
<td>1.87</td>
</tr>
<tr>
<td>C18:3c9,c12,c15 n-3</td>
<td>0.73</td>
<td>0.77</td>
<td>0.57</td>
<td>0.62</td>
</tr>
<tr>
<td>C20:5 n-3</td>
<td>0.096</td>
<td>0.087</td>
<td>0.065</td>
<td>0.075</td>
</tr>
<tr>
<td>C22:5 n-3</td>
<td>0.105</td>
<td>0.100</td>
<td>0.076</td>
<td>0.088</td>
</tr>
<tr>
<td>C22:6 n-3</td>
<td>0.098</td>
<td>0.063</td>
<td>0.011</td>
<td>0.013</td>
</tr>
<tr>
<td>Saturated FA</td>
<td>69.8</td>
<td>68.5</td>
<td>66.5</td>
<td>66.9</td>
</tr>
<tr>
<td>Monounsaturated FA</td>
<td>26.3</td>
<td>27.4</td>
<td>29.6</td>
<td>29.4</td>
</tr>
<tr>
<td>Polyunsaturated FA</td>
<td>3.96</td>
<td>4.07</td>
<td>3.94</td>
<td>3.77</td>
</tr>
<tr>
<td>n-6/n-3 FA</td>
<td>1.98</td>
<td>1.85</td>
<td>3.18</td>
<td>2.65</td>
</tr>
</tbody>
</table>

Vitamins and carotenoids, µg/mL

<table>
<thead>
<tr>
<th></th>
<th>OS</th>
<th>OL</th>
<th>CS</th>
<th>CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-tocopherol</td>
<td>0.60</td>
<td>0.71</td>
<td>0.69</td>
<td>0.70</td>
</tr>
<tr>
<td>β-carotene</td>
<td>0.18</td>
<td>0.19</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Retinol</td>
<td>0.53</td>
<td>0.51</td>
<td>0.49</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Relationship between grassland management and bovine milk quality
## Conclusion

Only small differences were found in milk composition from farms with different grassland management, except for the concentration of phytoestrogens that was highest on organic farms with short-term grassland. Milk fatty acid composition and milk content of phytoestrogens was strongly affected by farming system.

### Financial support

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### References


Relationship between grassland management and bovine milk quality

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Introduction

- Organic produced milk has:
  - higher proportion of n-3 fatty acids (EPA)
  - lower n-6/n-3 FA ratio
  - higher content of α-tocopherol, β-carotene
  - higher content of isoflavones (phytoestrogens)

than conventional produced milk (Bergmann et al., 2001; Ruter et al., 2006; Coccodivito et al., 2008; Elfr et al., 2000; Holsboer et al., 2000; Juhl et al., 1997)

Introduction (cont.)

- Diets that contain botanical diverse forage has yielded milk with:
  - higher proportion of n-3 fatty acids
  - higher proportion of conjugated fatty acid than diets with pure grass (Jalter et al., 2000; Lawrence et al., 2001)

Clover effect on milk and meat α-linolenic acid content (g/100 g total fatty acids)

<table>
<thead>
<tr>
<th>Source</th>
<th>Milk</th>
<th>Meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Introduction (cont.)

- The "organin" effect is likely due to:
  - higher diet forage: concentrate ratio
  - higher fresh grass proportion in the diet
  - higher clover proportion in the diet

- The "diverse forage" effect is likely due to:
  - substances in some plant species that interfere with the rumen bio-hydrogenation (e.g. red clover)
  - Rapid rumen passage (white clover)

QLIF workshop 22 January 2009
Introduction (cont.)

- Organic milk production is not uniform across Europe; wide range in intensity
- Long-term grassland with high proportion of unsown species and low proportion of legumes is common on many organic dairy farms in “marginal/less favorable” areas

Objective

- To compare the effect of grassland management (long-term vs. short-term grassland) and farming system (organic vs. conventional) on milk composition

Material and methods (cont.)

- Study farm milk samples collected every second month (Feb - Dec 2007 and 2008) from each farm (14 days/pasture)
- Other data collected:
  - Interviews
  - Norwegian Dairy Herd Recording System (TDHel)

Material and methods (cont.)

- Farming system
  - O = Organic (16)
  - C = Conventional (16)
- Grassland management
  - S = Short-term grassland (31)
  - L = Long-term grassland (14)
- Organic farms were paired with conventional farms with similar grassland management and calving patterns

Material and methods (cont.)

<table>
<thead>
<tr>
<th>Farming and grassland management</th>
<th>DB</th>
<th>DL</th>
<th>CS</th>
<th>CL</th>
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<td>Ponds</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total area per farm, ha.</td>
<td>10.1</td>
<td>10.4</td>
<td>10.0</td>
<td>9.8</td>
</tr>
<tr>
<td>Total milk production, kg/yr.</td>
<td>2.1</td>
<td>2.2</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Average milk yield, l/ha.</td>
<td>5.8</td>
<td>5.6</td>
<td>5.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Average number of lactations per cow</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

QLIF workshop 22. January 2009
Material and Methods:
- Chemical analysis
  - Standard (fat, protein, lactose, urea, FFA)
  - Fatty and methyl esters
  - O-tocopherol (vitamin E)
  - β-carotene (vitamin A precursor)
  - Retinol (vitamin A)
  - Phytosterogens
  - Selenium

Material and Methods:
- Statistical model
  \[ Y_{ij} = \mu + F_i + C_j + M_{ij} + e_{ij} \]

Farm within Farming system (F) and Grassland management (C) where treated as a random factor

Results from 2007

Grassland botanical composition, cut 3 onwards

Organic short-term grassland

Organic long-term grassland

QLIF workshop 22. January 2009
Relationship between grassland management and bovine milk quality
Towards Improved Quality in Organic Food Production

QLIF workshop 22. January 2009
In summary

- Farms with long-term grassland had more plant species and higher proportion of non-silage feed in their grassland than the farms with short-term grassland
- Organic farms had higher proportion of clover in their grassland than the conventional farms
- Organic farms with short-term grassland had higher proportion of clover and lower proportion of other herbs in their grassland than the organic long-term grassland farms

In summary (cont.)

- Milk yield and milk fat content was lower on farms with long-term grassland than on the other farms
- Milk protein content was lower on farms with long-term grassland than on farms with short-term grassland
- Milk yield and milk fat content was on average higher on conventional than on organic farms

In summary (cont.)

- There were only small effect of grassland management on milk fatty acid composition
- Milk from conventional farms had lower proportion of SFA and higher proportion of MUFA than in milk from organic farms
- Organic farms had higher proportion of n-3 FA and in particular C 22:6 n-3 (eicosapentaenoic)

In summary (cont.)

- Milk β-carotene content was higher on conventional than on organic farms
- Milk phytoalexin content was highest on organic farms with short-term grassland
- Milk selenium content was higher on organic than on conventional farms

Conclusion

- Grassland management had only small effect on milk composition (long-term vs. short-term)
- Differences in milk fat content were likely due to differences in grazing/management
- Milk composition was strongly affected by farming system (organic vs. conventional)
- Differences in concentrate supplementation level and quality are likely the most important factors that explain the differences in milk composition
- Differences in milk selenium content were likely due to differences in concentrate content of fish meal

Financial support

- Verse and Romadi County
- VIFC Mids
- VIFC R&D

QLIF workshop 22. January 2009
Thank you for your attention
This study investigated whether a positive handling method, based on TTEAM© (Tellington TTouch Every Animals Method) and on own experience had a calming effect on finishing bulls. Handling sessions were conducted by an unfamiliar person beginning five weeks before slaughtering. The influence of this positive handling at the day of slaughter was investigated. Eight finishing bulls were randomly assigned to a handling group (4 animals) and a control group (4 animals). The handling group received a handling session once a week. It lasted 4 min and was repeated after 45 min. Altogether, each animal of the handling group obtained 40 min of handling. A calmative and taming impact was anticipated from this special handling.

An avoidance distance test was conducted with all 8 animals before handling sessions started and 2 days before slaughter. This test evaluated approximation and ease of touching the animals by an unfamiliar person. It showed clearly, that animals of the handling group were more used to become touched than animals of the control group. Behaviour of all animals was observed at the day of slaughtering, when they entered the trailer on the farm and when they entered the stunning box at the abattoir. The records were classified in three category groups: agitation behaviour and disturbances of advancements. Additionally numbers of pushes by electric prodders (conducted by the employees of the abattoir) were counted. For interpretation, all 3 categories where accumulated. No differences between groups could be seen at trailer loading. However, handling animals showed significantly less stress-indicating behaviour when entering the stunning box.

Blood samples from ‘vena caudalis’ were taken from all animals before the first handling session began and one day before slaughtering. During exsanguinations a blood sample from each animal was taken. All blood samples where analysed for cortisol-, lactate- and glucose concentrations. Cortisol concentration in sting blood was considerably elevated compared to blood samples before handling and slaughtering. Control animals exposed higher lactate and glucose concentrations in sting blood than handled animals which indicate higher stress reactions in the control animals.

Meat quality was evaluated by measuring cooking loss, shear force, color and pH-value after 25 days maturation in m. longissimus dorsi. Control animals showed higher cooking losses than animals of the handling group.

The results of this study imply that a calmative handling in the forefront of slaughtering can decrease stress reactions of beef cattle. Additionally the importance of a positive human-animal-relationship becomes considerable.
Calming cattle handling preliminary to transport and slaughter and implications on behaviour, blood parameters and meat quality

Human – animal – relationship (HAR)
- degree of familiarity
- distance between human and animal
- animal well-being
- ease of animal handling
- productivity

Hypothesis:
- Beef cattle with positive handling
  - show less stress reactions before slaughter
  - show better meat quality

Literature:
- CRADON (2007)
- LENSINK et al. (2009)
- TASLOWA et al. (2006)

Problems:
- handling and transport to abattoirs are stressful for animals and humans
- risk of accidents
- meat quality
- animal aspects / animal well-being

www.fibl.org
Implications of a calmative handling procedure for cattle preliminary to transport and slaughter and the implications of animals
behaviour, blood parameters and meat quality
Towards Improved Quality in Organic Food Production

Handling method:
- Speaking loudly near bull
- Calm voice speaking
- Touching:
  - With back of the hand
  - With palm
  - Scratch & tread the coat
  - TTouch
- Stroking the ear (always with the palm)
- Initiation of social soliciting
  - Stroking ventral neck & withers
- Acupressure if possible

Methods used to investigate the influence of handling sessions on animal stress reactions:
- Ethological analysis:
  - A.D. test
  - Behaviour on the way to the stalling box
- Blood analysis:
  - Cortisol
  - Lactate
  - Glucose
- Meat analysis:
  - Shear force
  - Meat colour
  - Cooking losses

Sequence of tests:
- 6 days, 3 test animals

Ethological analysis:
- A.D. test (avoidance distance test)
- A.D. 2 degree of the test, respectively confidence to humans (van der Veen et al. 1998)
- Frontal approach to animal at feeding place

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Towards Improved Quality in Organic Food Production

Blood parameter results:
- Glucose: 6.6, p = 0.014
- Lactate: handling x point in time
  
Discussion on blood parameter results:
- Glucose - control animals
- Case: choline + glucose treatment - blood glucose level
- Glucocorticoids affect carbohydrate metabolism
- Glycogen mobilisation from liver & muscles
- Does increased glucose concentration result from
  
Meat quality analysis:
- M. longissimus dorsi
- 26 days maturation (vacuum-packed) at 4 °C
- Colour measurements (lab-method)
- Shear force (Warriner-Bauer method)
- Cooking losses (after 1 h cooking at 72 °C)

Meat quality results:
- Differences between groups, only for cooking losses
- Control animals: cooking losses
- Mann-Whitney-U Test: p = 0.657

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Discussion: Meat quality results:

- cooking losses:
  - The reason for increased cooking losses in control animal meat is probably adrenaline stress (Kudrn et al. 2009)
  - more exposure of glycerol to increased muscle release
  - decreased plasma lipase production - decreased water holding capacity
  - adhesion loss of water which is bound between muscle cells is deteriorated by lactate

Conclusion:

- greater human contact decreased stress
- additional reactions in beef cattle on day of slaughter
- additional human contact between the human - animal relationship
- additional human contact enhanced meat quality
- further experiments with animals from mother cow rearing are necessary
- maybe reduction the handling duration per animal would be an option

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Organic Milk Quality in the Netherlands: Distinguishable from conventional milk?

J. de Wit
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E-mail: j.dewit@louisbolk.nl.

Introduction
Recent studies have indicated possible positive interactions between organic animal production and, particularly, and various vitamins. As possible distinguishing quality parameters for organic milk, the differences between organic and conventional milk in Netherlands for fatty acid composition and vitamins were investigated in milk samples form supermarkets at several points in time.

We have also investigated possible differences in taste and two alternative analytical parameters (bio-photons and bio-crystallisations) because a single quality parameter, like poly-unsaturated fatty acids (PUFA), hardly reflects organic intentions to produce quality in a more holistic way being an inherent reflection of proper agricultural practices. These two alternative parameters try to relate to the hypothesis stating that the structure (the ‘order’) of food is just as important to human health as the material composition (Bloksma et al, 2008).

Methodology
In every season of 2006 12 samples of milk were collected; 6 were organic and 6 were conventional. These samples were investigated on fatty acid composition (at QLIP, Leusden) particularly the unsaturated fatty acids conjugated linoleic acid (CLA) and omega-3 fatty acids, bio-photons and crystallisation degree. The radiation of light by samples of milk and cheese was measured for the determination of bio-photons. This is also called long term delayed luminescence. The crystallisation degree was determined by visual assessment of precipitation that appears after mixing milk or cheese with a copper chloride solution (Busscher et al, 2006).

In 2008 ten organic and 10 conventional samples of milk were collected in the supermarket on two moments (March and June). In March, ‘winter milk’ was collected, with cows still in the stable. In June “summer milk” was sampled. This milk is from cows mainly grazing day and night. Milk samples were analysed for vitamin A, carotenoids, vitamin E, Selenium, Copper and Calcium. Further a “three alternatives, forced choice” taste experiment was performed with these samples to detect possible differences in taste. All milk samples involved processed milk collected in the supermarket (consumption package milk).

Results and discussion
Significant differences between organic and conventional milk were found for all fatty acid components (table 1), bio-crystallisations (table 3), some carotenoids and all minerals investigated (table 2), but not for bio-photons (table 3) and vitamin A and E (table 2). Differences in taste could not be detected: a panel of laymen could not distinguish the different milk sample from the three alternatives, while the blind preference was similar for conventional as for organic (47%) (de Vries et al, 2008). For all parameters except bio-crystallisations, the influence of season was high (P<0.05). In case of vitamin E as well as β-carotene there was a season*system interaction: the concentration in
organic milk was higher than conventional milk in summer but lower in winter. The differences in bio-crystallisations could not be related to farm characteristics, feeding ration or health status.

Most differences can be explained by differences in feed ration: less maize and more green feeds, particularly fresh grass, in case of the differences in fatty acid patterns (de Vries and de Wit, 2006), and more fresh grass and less concentrate (with added trace elements) in case of vitamins and minerals. Results are similar to results in other European countries (Butler et al., 2003), particularly if one accounts for the differences in production system of both the organic and the conventional dairy system.

Table 1: Differences in fatty acid composition between organic and conventional milk (% of level of conventional milk which is between brackets; bold is P<0.05; Slaghuis and de Wit, 2007).

<table>
<thead>
<tr>
<th></th>
<th>Whole year average (n=48)</th>
<th>Winter (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA's</td>
<td>-2% (702 mg)</td>
<td>0% (726 mg)</td>
</tr>
<tr>
<td>PUFA's</td>
<td>15% (27,5 mg)</td>
<td>6% (24,8 mg)</td>
</tr>
<tr>
<td>CLA</td>
<td>38% (5,3 mg)</td>
<td>15% (3,9 mg)</td>
</tr>
<tr>
<td>Omega-3</td>
<td>60% (5,8 mg)</td>
<td>66% (5 mg)</td>
</tr>
<tr>
<td>Trans fatty acids (excl. CLA)</td>
<td>20% (2,2 mg)</td>
<td>3% (1,9 mg)</td>
</tr>
</tbody>
</table>

Table 2: Differences in some vitamins and minerals between organic and conventional milk (bold is P<0.05; de Vries et al., 2008).

<table>
<thead>
<tr>
<th></th>
<th>Conventional (n=20)</th>
<th>Organic (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (total retinol) (µg/100 gr milk)</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>Vitamin E (α-tocopherol) (mg/100 gr milk)</td>
<td>0,097</td>
<td>0,098</td>
</tr>
<tr>
<td>B-carotene (µg/100 gr milk)</td>
<td>16,5</td>
<td>16,8</td>
</tr>
<tr>
<td>Lutein (µg/100 gr milk)</td>
<td>0,855</td>
<td>0,97</td>
</tr>
<tr>
<td>Zeaxanthin (µg/100 gr milk)</td>
<td>0,181</td>
<td>0,213</td>
</tr>
<tr>
<td>B-cryptoxanthin (µg/100 gr milk)</td>
<td>0,312</td>
<td>0,324</td>
</tr>
<tr>
<td>Ca (mg/100 gr milk)</td>
<td>120</td>
<td>123</td>
</tr>
<tr>
<td>Cu (µg/100 gr)</td>
<td>5</td>
<td>4,2</td>
</tr>
<tr>
<td>Se (µg/100 gr)</td>
<td>1,6</td>
<td>1,3</td>
</tr>
</tbody>
</table>

Table 3: Differences in two alternative quality parameters between organic and conventional milk (bold is P<0.05; Slaghuis and de Wit, 2007).

<table>
<thead>
<tr>
<th></th>
<th>Conventional (n=18)</th>
<th>Organic (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-crystallisation (average evaluation, scale 1-10)</td>
<td>6,0</td>
<td>6,9</td>
</tr>
<tr>
<td>Bio photons (*1000 counts, 100-200 sec.)</td>
<td>29,9</td>
<td>31,5</td>
</tr>
</tbody>
</table>
Conclusion
Organic milk is distinguishable from conventional milk: the organic production system generally results in a more favourable fatty acid composition and higher levels of several vitamins, particularly if it is based on fresh, green feeds. These differences do not affect the taste of processed milk.

References


Distinguishable quality of organic cow milk and strategies to improve it

J. de Wit

Distinguishable quality: why?
- Organic milk production involves higher costs (in rich Western countries)
- How to convince consumers to pay this higher price?
- Problems:
  - Superseding sustainable agriculture makes for hard-core consumers
  - Sustainability issues related to coleseal goods (this means also affecting many smaller regions or vaccines for particular products)
- Taste and health are important for the consumers'
- Cost is seen in human health aspects difficult to assess.
- Indicator of health (through food chain, chlorine to be studied; Major organic food products in the West, such as dairy products, face these issues)

Dutch organic milk quality research programme
- 2008-2010: Estrogenizations and methionin.

Mainly results from feeding consumption milk samples from supermarket
- 400 samples of 25 farms, differ in many farm characteristics + conducted test change

Difference in fatty acid composition

<table>
<thead>
<tr>
<th>Year</th>
<th>Average difference with conventional</th>
<th>During winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mg/g)</td>
<td>(mg/g)</td>
</tr>
<tr>
<td>SFAs</td>
<td>-2% (7.2 mg)</td>
<td>-2% (7.2 mg)</td>
</tr>
<tr>
<td>PLFA's</td>
<td>+15% (27.5 mg)</td>
<td>+10% (18.5 mg)</td>
</tr>
<tr>
<td>CLA</td>
<td>+36% (5.3 mg)</td>
<td>+19% (3.9 mg)</td>
</tr>
<tr>
<td>Omega-3</td>
<td>+46% (9.8 mg)</td>
<td>+46% (9.8 mg)</td>
</tr>
<tr>
<td>Trans fatty acids</td>
<td>-0.6% (2.2 mg)</td>
<td>+3% (1.9 mg)</td>
</tr>
</tbody>
</table>

Farm monitoring results: Levels of CLA and omega-3 and feed fat composition per season.

<table>
<thead>
<tr>
<th></th>
<th>Summer (n=208)</th>
<th>Autumn (n=76)</th>
<th>Winter (n=120)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLA (mg/g milk)</td>
<td>6.51 (5.06)</td>
<td>0.91 (1.35)</td>
<td>0.56 (4.45)</td>
</tr>
<tr>
<td>Omega-3 (mg/g milk)</td>
<td>11.00 (2.09)</td>
<td>12.00 (2.20)</td>
<td>15.00 (2.30)</td>
</tr>
</tbody>
</table>

Multivariate regression + feeding trials + literature; main conclusions:
- E-farming is very effective (e.g., addition might be healthy for cows), but limited applicable in organic milk fermentation.
- Roughage quality most important, mainly:
  - Fresh grass (younger and green)
  - Forage grass as fresh as possible (for grass pellets, during the gold period)
  - Minimizing mares' feeding
  - Special effects (hay, chyle, herbs) exist, but no easy trials
Organic Milk Quality in the Netherlands: Distinguishable from conventional milk?

### Differences in vitamins and minerals

<table>
<thead>
<tr>
<th></th>
<th>Milk (mg/L)</th>
<th>Organic Milk (mg/L)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>30</td>
<td>22</td>
<td>-8</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>250</td>
<td>235</td>
<td>-5</td>
</tr>
<tr>
<td>Calcium</td>
<td>125</td>
<td>140</td>
<td>15</td>
</tr>
<tr>
<td>Iron</td>
<td>5.8</td>
<td>8.9</td>
<td>3.1</td>
</tr>
</tbody>
</table>

### Bio-crystallisation

- **Subjective assessment:** Images are clearer and smaller that appear after mixing milk with amylpectin.

### Conclusion

- **Dutch organic milk better than conventional?**
  - More fatty acid composition
  - More some vitamins
  - More in bio-crystallisation, but meaning and scope for improvement?
- **No difference in case, same vitamins**
- **Lower in some minerals, but this is hardly important for human health**
  - None
Conclusion 2
Most and main favourable differences are related to:
- Fresh grass (and hay/lage as grass as possible)
- Summer

Why not base organic dairy production more on this?
- Adjusting feeding ration
- Seasonal (natural) milk production.

The organic chain; tasteful products supporting human health from a healthy production system

Thank you for your attention

Multiple linear regression (only including significant factors, p>0.05)

<table>
<thead>
<tr>
<th>Feed components</th>
<th>CLA (%)</th>
<th>Omega-3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green grass</td>
<td>0.23</td>
<td>0.24</td>
</tr>
<tr>
<td>Horse stables</td>
<td>-0.22</td>
<td>-0.20</td>
</tr>
<tr>
<td>Whole meal</td>
<td>-0.78</td>
<td>-0.81</td>
</tr>
<tr>
<td>Added</td>
<td>0.67</td>
<td>0.71</td>
</tr>
<tr>
<td>Grass meal</td>
<td>0.36</td>
<td>0.37</td>
</tr>
<tr>
<td>Red clover</td>
<td>0.32</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Multiple linear regression
Explained variance and other factors

<table>
<thead>
<tr>
<th>Explained variance</th>
<th>CLA (%)</th>
<th>Omega-3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>74.5</td>
<td>62.1</td>
</tr>
<tr>
<td>Farm effect</td>
<td>34.2</td>
<td>68.9</td>
</tr>
<tr>
<td>Sampling date</td>
<td>41.3</td>
<td>11.7</td>
</tr>
<tr>
<td>Feed ration ovaran</td>
<td>11.0</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Seasonal effects

Most seem related to grass quality

Farm effects, individualised examples

Towards Improved Quality in Organic Food Production
### No clear breed effects

<table>
<thead>
<tr>
<th>Farm number</th>
<th>CLA level estimate</th>
<th>N3 level estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>-3.10</td>
<td>2.94</td>
</tr>
<tr>
<td>4</td>
<td>0.99</td>
<td>-0.19</td>
</tr>
</tbody>
</table>

**Note:** within breed, within high, and high groups differences are consistent (Keenan et al.)
Effect of organic and conventional feed on potential biomarkers of health in a chicken model

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E-Mail m.huber@louisbolk.nl
And partners from Wageningen UR - Animal Sciences Group, TNO Quality of Life, RIKILT-Institute of Food Safety.

Introduction
An important reason for many consumers to buy organic is the assumption that organic products are healthier than conventional products. However, until now, very little research has been performed to study the effect of organic food on health. Most studies on organic food are dealing with differences in nutrient contents of organic versus conventional products. Results from such studies can only speculatively be connected to health effects. The present study was the first experimental study in the Netherlands in which the effects of feeds, derived from organic or conventional origin, are studied using animals as a model for humans. The aim was to search biomarkers that can show potential health effects of organic compared to conventional food.

Based on a scientific discussion within FQH, experts concluded that possible feed effects would most likely show up in the immune system of young organisms, as it is known that through the gut (GALT), food induces the development of the immune system in the developing organism. However, a broader exploration of effects was concluded to be valuable.

The present study was both searching for differences in available feed ingredients, as well as an explorative feeding experiment with animals, to identify possible biomarkers for a different effect from these feeds. The study was performed by a Dutch consortium of institutes and coordinated by the Louis Bolk Institute. Results have been presented in a report (Huber 2007).

Materials and methods
The study comprised a blinded animal feeding experiment in two generations of chicken fed either conventional or organic feed. The animals were chicken from the Wageningen Selection Lines, laying hens that during 25 generations were divergently selected for their either high (H-line) or low (L-line) antibody response to SRBC (sheep red blood cells). Next to these lines a random bred control group (C-line) of chicken was included. The main experimental group was the second generation, consisting out of six groups of 25 animals, 150 in total (3 lines, 2 types of feed).

Three feeds for the different developing stages of the chicken (starter feed, grower feed, layer feed) were composed according to existing norms for organic chicken feed with six ingredients: wheat, barley, triticale, peas, maize and soy, that were produced organically or conventionally. As no products from controlled trials were available, ingredients were obtained from neighbouring ‘farm pairs’, with the same basic soil and climatic conditions, preferably known as ‘best practice farms’. Before the ingredients were used for feed production, they were prescreened for residues of pesticides or mycotoxins. The ingredients used for feed production, as well as the composed feeds, were extensively analysed for macronutrients, micronutrients, trace elements, micro-organisms and bioactive ingredients.
To prevent shortages in the nutritional needs of the chicken the feed was supplemented with potato protein, the amino acid methionine, chalk, grid, salt, NaCO₃ and a small dosage of a commercial mix of vitamins and minerals. The feed was presented as a composite flour. Feeds were coded either A or B.

The 1st generation of chicken was housed in individual cages; the 2nd generation in spacious and enriched indoor runs, in groups of 6 animals. Both generations could eat ad libitum. The 2nd generation lived till 13 weeks of age. Physiological markers were sought in general health features, immunological response parameters, metabolite measurements in plasma and liver through metabolomics, gene activation in the gut through genomics, and in a post mortem evaluation through pathological anatomy. As both groups of animals received balanced and sufficient feed, no large differences were expected. Therefore, a disturbance was provoked to evaluate the animals potential to react to, and recover from, an immunological ‘challenge’. As a challenge the non-pathogenic, immune protein trigger KLH (Keyhole Limpet Hemocyanine) was injected at the age of 9 weeks in the 2nd generation.

General health effects were evaluated and a broad range of immunological measurements was performed, in both generations. Periods of feed changes were monitored, as well as the period before and after the challenge. Blood from before and after the challenge was also analysed by metabolomics. In week 13 the animals were sacrificed and section was performed. Tissue samples were analysed by metabolomics of the liver, by genomics of the gut and by pathological anatomy of the organs. The study was performed blinded. Only after all results were available and the conclusions were drawn, the codes of the feeds were broken.

Results

Comparison of the nutritional content of the organic and conventional feeds showed most consistent differences in the amount of proteins, which was about 10% higher in the conventional feed, due to higher levels of proteins in conventional wheat, soy and barley. However, the two feeds were energetically comparable, due to an energetic compensation by other macronutrients in the organic feeds. The organic feeds mostly contained higher levels of alpha-tocopherol, total folate and iodide. Lower levels of immune stimulating LPS endotoxins were found in organic feeds, however, more LPS producing gram-negative bacteria were found in organic feeds. Based on calculation it showed that the levels of phytosterols, vitamin C and vitamin B5 were higher in conventional feeds and organic feeds were higher in vitamin K and isoflavones.

With the complementary analyses the ingredients from the two agricultural systems could be differentiated and where experience with the ingredients was available, could correctly be identified as being the organic or conventional sample.

As the C-line animals represent the natural genetic variation of the population, the results of the 2nd generation of this group, were considered most informative. All animals were diagnosed as being perfectly healthy. However, the groups on the two different feeds showed clear differences in several aspects of their physiology. The animals on conventional feed showed a faster growth and were significantly heavier. After the KLH challenge a 20-30% decline in growth was observed in all groups for about two weeks; after this the animals on the organic diet showed in all groups a stronger ‘catch-up-growth’, leaving the animals on the conventional feed behind. With respect to the immunological parameters, both the humoral and cellular and both the innate and adaptive components of the immune system showed differences between the animals on the two different feeds. The immunological results were not fully consistent, but the overall interpretation was that the animals fed the organic feed had a higher potential for immunological reactivity.
Metabolomics results of the blood showed a clear distinction between the animals on the two feeds, especially after the challenge. It was interpreted as that the animals on the organic feed showed after the challenge a stronger reaction and connected metabolism, indicating a stronger acute phase reaction than the animals on the conventional feed. Metabolomics results of the liver indicated an increased pentose phosphate pathway activity in the animals on the organic feed.

Genomics showed, in the animals on the conventional feed, a lower expression of genes connected with cholesterol biosynthesis. Pathological anatomy showed some differences in the weight of specific organs between the feed groups. More adipose tissue was observed with the conventionally fed animals, but this has not been objectivated.

**Discussion**

An important outcome is that feed ingredients from different origins can have small but clear immunological and metabolic effects in healthy animals. Concerning the factors in the feed that could explain these differences, the higher protein content in the conventional feed was considered to be the factor that causes the stronger weight gain in the animals on this feed. There are indications in literature that an enhanced status of immune reactivity in animals (such as of those on the organic feed), may be related to a lower body weight. The factor(s) in the feeds that might cause the physiological differences in relation to the challenge are not yet clear. The present findings are in line with Lauridsen’s (2007) reported results of a feeding study in rats. Here the conventionally fed animals showed an increased body weight and fat tissue deposit, as well as an increased IgG-level of the immune system. However in this study the existing differences in feeds were compensated, resulting in feeds with similar crude protein and essential amino acids content. This fact puts under stress our hypothesis of the protein being the cause of the differences in weight of the chicken.

The implications of these different physiological reactions in the context of short term and long term ‘health’ of these animals, is still unclear. The concept of ‘health’, and its physiological and immunological parameters, currently lacks scientific identification and solid conventions. However, given the choice to be either the A- or the B-animal, the participating researcher nearly all preferred to be chicken on feed A. This turned out to be the organically fed animal.

**Conclusions**

Weight gain and, especially after exposure to a challenge, the ‘catch-up-growth’, immune responsiveness, metabolic parameters, gene regulation in the gut system and observations by pathological anatomy are suggested as ‘biomarkers’ for future studies of effects from the two different feeding regimes. However, before these ‘biomarkers’ can be used in a study in humans, confirmation of the mentioned results is necessary.

**References**


I start again with the broad definition of ‘quality’: any property of a product that is related to a desired aspect of this product. This definition includes both process and product quality. Another definition seems to be even wider, but isn’t: fitness for use. This definition excludes, by the term ‘use’, process quality.

The presentation of Husted showed us that animal welfare and environmental protection, both process quality criteria, are more important reasons to buy organic products than human health. In the area of product quality, Danish consumers expect primary low pesticide residues, on of the few organic regulation parts in the process with direct consequences for product quality. More minerals and more vitamins are expected, but with less importance than ‘better quality’ – whatever is mend – and better taste.

In this workshop we saw many contributions on product quality, related to measurable components. Surely more then 100 parameters were presented, part of them related to health questions. There is an estimated amount of > 75,000 different secondary metabolites in plants, so are we on the right way?

None of the contributions was about “quality” as it is defined by market companies: size, shape, color and weight of the cucumber, for example. Of course, these criteria are less interesting out of a scientific view, but they play an important role in the development of the organic market. So again, are we on the right way by concentrating on vitamins and minerals and fatty acids (or broader: components) and taste?

I come back on one of my statements: the organic standards are exclusively focusing on process quality parameters in the agronomic part of the chain. If this is the actual situation, there might be two ways out:

1. Just define some product quality criteria, put minimum are maximum levels on it and there we are! Of course this is not so simple: which out of the > 75,000 substances we select, and why these? And another problem is related to this approach: if we put, for example, a minimum level on lycopene in tomatoes or Omega-3 fatty acids in milk, conventional agriculture or food processors just will create tomatoes and milk with these properties, without meeting the process quality of organic products.

2. Let’s find a product quality parameter which is a direct and sure result of the process quality parameters related to organic agriculture.

For this second option, let’s have a look at the parameters at field level influencing product quality: climate, post-harvest management, genotype, soil, agricultural management (tillage, pest control, irrigation) and fertilization.
• Climate is out of control of farmers, but sunshine a Spain might produce ‘better’ tomatoes that those out of greenhouses in Holland.
• Post-harvest management is an important factor, so far with minor attention in the regulations, special in the food processing.
• Genotype: it is well documented that variety choice is a key-factor for some quality parameters. Another aspect is GMO: with genetic modification it might be possible to create, for example, a tomato with a ‘good’ sugar, lycopene and vitamin content with only half of the sunlight. Is that high quality?

So far, the parameters mentioned are not or to a very limited extend part of the organic regulations.

• Soil fertility has influence in product quality. Soil fertility is not part of the organic regulations, but due to regulations on manure and crop management some inherent effect on soil fertility in organic agriculture can be expected.
• Fertilization: see below
• Agricultural management: see below

These last two parameters are part of the organic regulations, and two of them are well known and always mentioned by consumers, organic or not: no chemical fertilizers and no chemical pest control.

About pest control: in a simplified way we can say that this is directly reflected in product quality. Presence of pesticide residues means that this stuff has, by purpose or not, come in contact with the product and this is not more an organic product. Absence of residues does not mean that no sprays are used; this must be secured by control bodies.

About fertilizers: it is known that unbalanced artificial (but also organic!) fertilizers can disturb plant growth and influence both plant development (= process quality criterion) and the end product (= product quality criterion).

Fertilizer and pest management are part of a more or less factorial experiment at the Nafferton Farm, UK, which could unfortunately not be presented here by Carlo Leifert. The two factors ‘fertilizer management’ and ‘pest management’ are present in two ways: conventional and low input. Both at conventional level represents conventional agriculture, both low input represents organic agriculture, and of the two conventional and the other low-input represents low-input agriculture. This scheme is, although not complete, also underlying the work of Lauridsen. I consider this experimental design as a first step into a more factorial approach instead of ‘conventional versus organic’ at system level.

Pest control is more or less clear: sprays are yes or no allowed or used. Unfortunately there are some sprays used in organic agriculture, being from ‘organic origin’ but disturbing the clear consumers expectation ‘without spraying’.

Fertilizer use is much less clear. Of course artificial nitrogen fertilizers are not and never allowed in organic agriculture, but in case of Phosphate and Potassium the situation is already less strict.

Related to fertilizer and soil fertility, the mayor question might not be the use of artificial fertilizers as such, but the nitrogen dynamics and the overall nitrogen level. With this in mind, conventional and organic agriculture show a big variance and both systems overlap each other substantially. Then it is clear that nitrogen dynamics and nitrogen level
is, at this moment, not a distinguishing factor between organic and conventional, although it is known to play an important role in many aspects of product quality. This could be brought in as a new statement (or hypothesis):

Nitrogen management at field level is key factor in quality management in organic plant production.

Two of the contributions of this workshop went into the question how desired (or undesired) substances are formed during plant growth (Husted and Steinshamn). These contributions represent the search for a key-factor, which might be part (or not yet!) of the organic regulations, and try to explain why and how this factor contributes to a certain quality parameter.

Very likely there will be some more key factors in plant production, and of course also in animal production.

In three experiments the Louis Bolk Instituut has done research* in the relation between the key-factors nitrogen, sunlight and time (ripening) and product quality parameters such as protein content, sugar content, dry matter content, etc etc. Also some new, experimental parameters were tested: biocrystallisations, biophotons, amino acid composition. This research was done with at the background the development of a new concept of quality. Can we develop a concept in which many of the parameters for quality can be put together instead of being handled one by one?

To finish this workshop, I present five areas for further research.

1. Comparison conventional – organic. This type of research will be continued anyway, and it makes sense to come to an agreement about the best practice, and about what question can be answered with what type of comparison study: at market basket level, at farm comparison level or at field level.
2. Taste is mentioned is an important criterion for consumers to buy organic. Food processing should be involved in quality research.
3. We should go into the key-factors contributing to quality parameters, find out how it works, and try to go back into the production and define the do’s and do not’s .
4. Health is mentioned as one of the driving forces for consumers. Here also the search for key-factors should have priority above single substances research, as shown by Machteld Huber.
5. We need a concept of product quality at a higher level than the single health-related substances.

References


Presentation

**Product Quality**

The alpha and omega for further development of organic agriculture

*Part 2: Conclusions*

Geert-Jan van der Burg

QLF Workshop, January 2009

**Definition:**

Any property of a product that is related to a desired aspect of the product quality

- Fitness for use
- Product quality
- Consumers' expectations

**Consumers' expectations:**

How to choose my heart?

**DK consumer expectations:**

*Consumer survey 2007*

Four important reasons to buy organic products:

- Animal welfare
- Environment production
- Human health
- Good quality

**DK consumer expectations:**

*Consumer survey 2007*

The most important attributes of organic products:

- Most important:
  - Product quality: measurable in the product
  - With some links to process
  - Above comparison conv - org

- Nothing about:
  - Size, weight
  - Colour, shape
  - In other words: simple marketing arguments
Product quality - The alpha and omega for further development of organic agriculture – part2: Conclusions

**DK consumer expectations: Consumer survey 2007**
The most important attributes of organic products

**Why is the chemical composition different at the system level?**

**Research setup: comparison and in-depth**

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<table>
<thead>
<tr>
<th>Method</th>
<th>Org</th>
<th>Con</th>
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<tbody>
<tr>
<td>Pesticide management</td>
<td>Organ</td>
<td>Conventional</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>Low input</td>
<td>Medium input</td>
</tr>
<tr>
<td>Fertilizer use</td>
<td>Low input</td>
<td>Conventional</td>
</tr>
</tbody>
</table>
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Many examples of positive effects of org above conv at several properties, so:

- Big potential!

2. Organic process quality criteria don't necessarily lead to high product quality. Nor do they guarantee a difference with conv

[Diagram showing data comparison]

- Big variability!!!!

**Two contributions: explain how chemical composition is influenced. Research to be done**

- Critical factor, key factor:
  - Plant production: Nitrogen dynamics
  - Animal production: Nitrogen dynamics too?
Critical factor, key factor:
- Nitrogen
- Light
- Time (ripening)
Is there an overall concept?
Can we order all the results?

Comparison: adequate set-up
Taste
Mechanism; key-factors
Health aspects
Concept building