QualityLowInputFood

# Towards Improved Quality in Organic Food Production

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

Monique Hospers-Brands and Geert-Jan van der Burgt (editors)

LOUIS BOLK INSTITUUT

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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.

# Contents

# 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

| | |
|---|---|
| <u>21 January 2009</u> | |
| 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 | |
| | |
| <u>22 January 2009</u> | |
| 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 Steinshamn, 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 | |

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

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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 focussing 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 adept 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, regionallity, 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 is 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.

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## Product Quality

The alpha and omega for further development of organic agriculture

Geert-Jan van der Burgt

QLIF Workshop, January 2009

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**Content of this presentation**

- Introduction
- Complexity of the theme
- Product quality – process quality
- Taste; sensory analysis
- New quality parameters
- Conclusion

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**Defenition:**

*Any property of a product that is related to a desired aspect of this product*

*Example: egg; tomato*

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**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*

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**Complex theme: examples**

- Tomato. Taste, brand, recognize. Tasty Tom. Wild Wonders. Lycopene-tomato
- Chips. Individual or collective taste, 'objective' taste. Professionals.
- Cookies. Personal preferences; collective imposed preferences.
- Eggs. Recognize. Taste. Animal welfare

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**Product quality – process quality**

**Statement:**

*1. The organic standards are exclusively focussing*
- *on process quality parameters*
- *in the agronomic part of the process*

*Beautiful words about product quality (IFOAM, EU regulations) but no formal system to support or to guarantee.*

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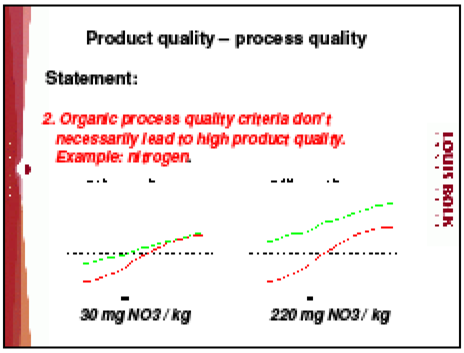
Product quality – process quality
Statement:
2. Organic process quality criteria don't necessarily lead to high product quality. Example: nitrogen.
30 mg NO3 / kg
220 mg NO3 / kg
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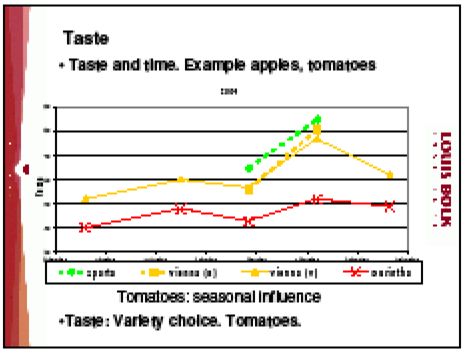
Taste
• Taste and time. Example apples, tomatoes
Tomatoes: seasonal influence
•Taste: Variety choice. Tomatoes.
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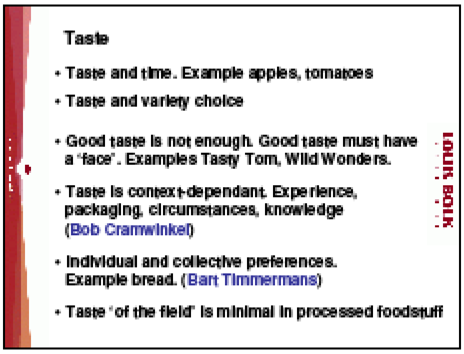
Taste
• Taste and time. Example apples, tomatoes
• Taste and variety choice
• Good taste is not enough. Good taste must have a 'face'. Examples Tasty Tom, Wild Wonders.
• Taste is context-dependant. Experience, packaging, circumstances, knowledge (Bob Cramwinkel)
• Individual and collective preferences. Example bread. (Bart Timmermans)
• Taste 'of the field' is minimal in processed foodstuff
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Other quality criteria out of an organic context
• Authentic, landscape, local, natural, social, fair, .... Tripple 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, menu, lifestyle.
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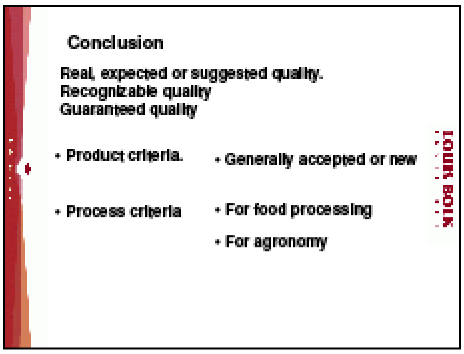
Conclusion
Real, expected or suggested quality.
Recognizable quality
Guaranteed quality
• Product criteria.
• Generally accepted or new
• Process criteria
• For food processing
• For agronomy
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This workshop
• Plant: Process - > product quality
Bart Timmermans, Ewa Rembialkowska, Soren Husted.
• Plant: health aspects. Charlotte Lauridsen
• Methodology: comparison conventional <-> bio
Lucy van de Vijver
• Sensory analysis. Bob Cramwinkel
• Animal: Process - > product quality.
Ewa Rembialkowska, Havard Steinshamm, Johanna Probst, Jan de Wit
• Health. Machteld Huber
Thanks you for your attention
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# 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 1. Nitrogen levels of additional fertilizers*

| Pellets (kg N ha-1) | Molasse (kg N ha-1) |
|---|---|
| 0 | 0 |
| 65 | 108 |
| 65 + 40 | 108 + 67 |

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.

*Tabel 2. RMSE (Average per Strategy) of inorganic nitrogen, simulated versus measured.*

| **Year** | **2006** | | | **2007** | | |
|---|---|---|---|---|---|---|
| **Strategy** | **S** | **C** | **F** | **S** | **C** | **F** |
| RMSE | 20,3 | 14,5 | 7,3 | 13,5 | 26,7 | 29,8 |
| 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.

*Table 3. Percentage of explained variance of Grain-N and Straw-N by parameter PAN*

| **Year** | **2006** | | | | **2007** | | | |
|---|---|---|---|---|---|---|---|---|
| **Strategy** | **CS** | | **F** | | **CS** | | **F** | |
| **explained variable** | **Grain-N** | **Straw-N** | **Grain-N** | **Straw-N** | **Grain-N** | **Straw-N** | **Grain-N** | **Straw-N** |
| PAN | 80 | 42 | 90 | 54 | 57 | 39 | 84 | 54 |

*Tabel 4. Percentage of explained variance of DON and TRR by parameters PAN, Grain-N and Straw-N*

| **Year** | **2006** | | | | **2007** | | | |
|---|---|---|---|---|---|---|---|---|
| **Strategy** | **CS** | | **F** | | **CS** | | **F** | |
| **explained variable** | **DON** | **TRR** | **DON** | **TRR** | **DON** | **TRR** | **DON** | **TRR** |
| PAN | 24 | | 28 | 28 | 16 | 21 | | |
| Grain-N | 22 | | 30 | 44 | | 16 | | 21 |
| Straw-N | 23 | | | | | | | |

**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
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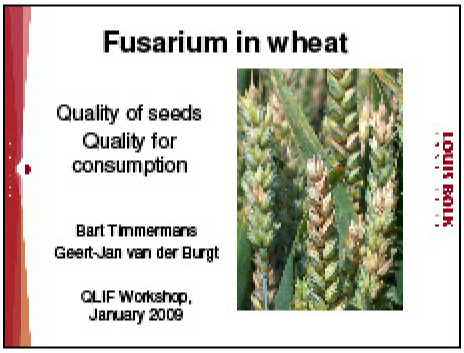
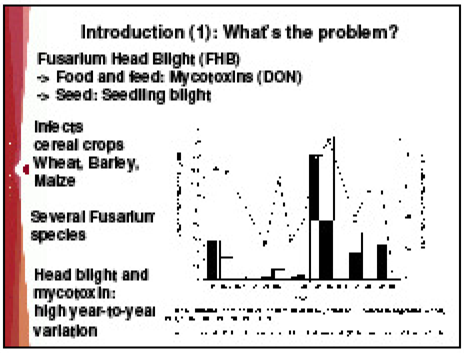
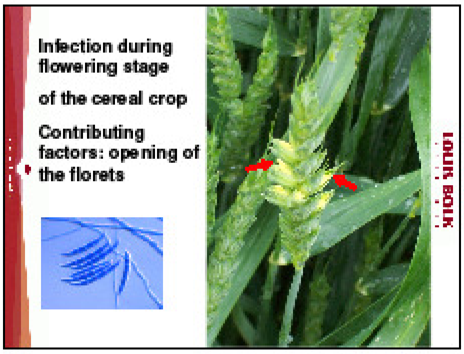
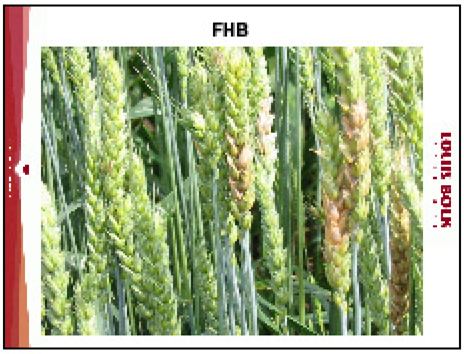
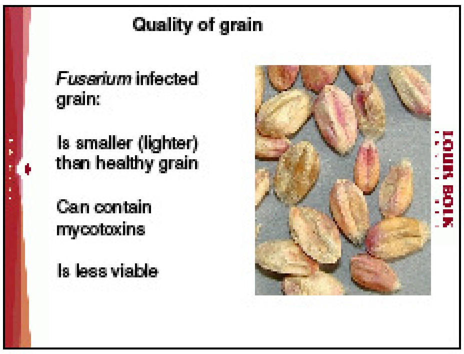
# *Presentation*

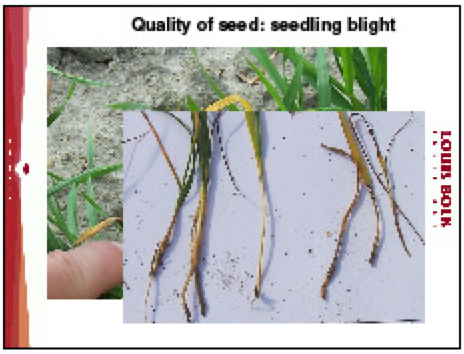
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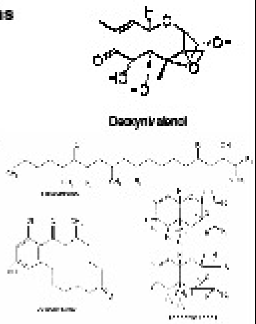
Effect of mycotoxins in food or feed:

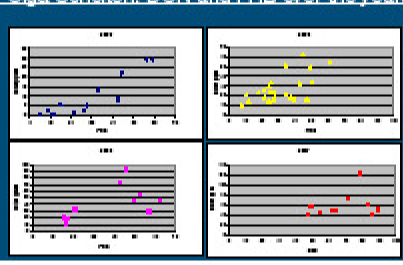
Low doses:

Reduced food intake, growth retardation, reduce immune system

Higher doses: severe weight losses, vomiting (pigs), infectious diseases




## Olga Scholten: DON and FHB over the years



## Introduction (1): What's the problem?

Fusarium Head Blight (FHB)
-> Food and feed: Mycotoxins (DON)
-> Seed: Seedling blight

Several Fusarium species

Head blight: high year-to-year variation

Mycotoxins: no straight forward relation with presence of fungi

Seedling Blight (SB): expression depends on year, soil

SB: crop can compensate for seedling losses

SB: yield losses due to later crop canopy closure, weeds.

## Introduction (2): Looking for solutions

Non-chemical seed treatment

Variety-dependant resistance to FHB?

Variety-dependant expression of SB

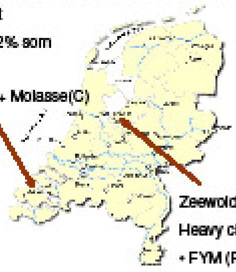
Impact of soil and soil fertility on FHB

## Trial setup (1): 2 years, 2 locations, 3 strategies

Colijnsplaat

Light clay, 2% som

- Slurry (S)
- Compost + Molasse(C)

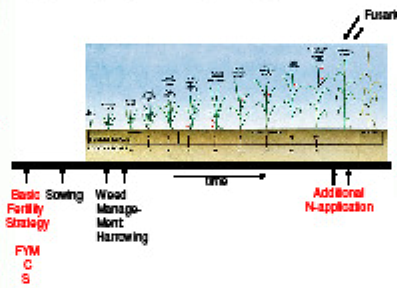


Zeewolde

Heavy clay, 3,6 % som

- FYM (F)

## Organic spring wheat growing

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

| Pellets (kg N ha⁻¹) | Molasse (kg N ha⁻¹) |
|---|---|
| 0 | 0 |
| 65 | 108 |
| 65 + 40 | 108 + 67 |

Fertilizer application short before flowering (1st) and two weeks later (2nd)


## Trial setip (4): Measurements

Soil inorganic nitrogen 0-30 cm (4 – 5 each season)

Straw yield, grain yield, straw-N, grain-N

Fusarium presence by Blotter test

DON and other mycotoxins

Fusarium species by TaqMan-PCR

## Decisions:

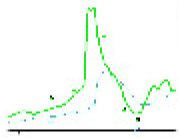
Statistics: Sites C+S and F separately (due to possible different *Fusarium* species)

Fertility-regimes:

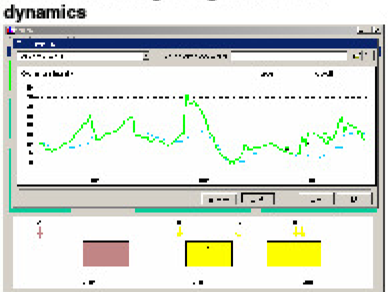
-different manure applications

-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

| Year | 2006 | | | 2007 | | |
|---|---|---|---|---|---|---|
| Strategy | S | C | F | S | C | F |
| RMSE | 20,3 | 14,5 | 7,3 | 13,5 | 26,7 | 29,8 |
| Judgement | Reasonable | Good | Good | Good | Weak | Weak |

RMSE Root Mean Squared Error: 20 kg N ha⁻¹ as limit for good model performance

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## Results: Yields 2006

| | PAN 2006 |
|---|---|
| F | 133 |
| S | 191 |
| C | 235 |

| 2006 | | 0 | 65 | 105 | 108 | 175 |
|---|---|---|---|---|---|---|
| F | Y gr | 3605a | 4589b | 4543b | 5838c | 4910b |
| S | Y gr | 8070a | 8017a | 8022a | 7830a | 7328b |
| C | Y gr | 7617a | 7965a | 6984a | 7873a | 7435a |

Decision: 2007 (S) no slurry, (C) no Molasse

No succes: precrop, Initial mineral N

## Results: yields 2007

| | PAN 2007 |
|---|---|
| F | 156 |
| S | 182 |
| C | 239 |

| 2007 | | 0 | 65 | 105 | 109 | 175 | |
|---|---|---|---|---|---|---|---|
| F | Y gr | 3730 | 3045 | 3396 | 3032 | 3126 | b |
| S | Y gr | 2723 | 2736 | 2809 | 2713 | 2672 | a |
| C | Y gr | 2794 | 2962 | 2901 | 2849 | 2761 | a |

Factors other than PAN were responsible for yield:

Drought after sowing: delayed germination, irregular stand, low plant number

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

PAN Plant available nitrogen: derived from NDICEA calculations. Sowing up to harvest.

% Explained variance by PAN

| Year | 2006 | | | | 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | F | | SC | | F | | SC | |
| explained variable | Grain N | Straw N | Grain N | Straw N | Grain N | Straw N | Grain N | Straw N |
| PAN | 90 | 54 | 80 | 42 | 84 | 54 | 57 | 39 |

## Results: Fusarium 2006

| | PAN 2006 | TRR | DON |
|---|---|---|---|
| F | 133 | 3.75b | 133.9a |
| S | 191 | 2.11a | 196.8b |
| C | 235 | 2.20a | 146.4a |

DON: effect of additional fertilizer application

| 2006 | 0 | 65 | 105 | 108 | 175 |
|---|---|---|---|---|---|
| F+C+S | 108.9a | 159.2a | 148.2a | 159.2a | 219.4b |

## Results: Fusarium 2007

| | PAN 2007 | TRR | DON |
|---|---|---|---|
| F | 156 | 16.38a | 457ab |
| S | 182 | 16.85a | 482b |
| C | 239 | 17.25a | 375a |

TRR: effect of additional fertilizer application

| 2007 | 0 | 65 | 105 | 109 | 175 |
|---|---|---|---|---|---|
| F+C+S | 14.4a | 16.6ab | 17.8b | 16.7ab | 18.7b |

So……

Something is going on

Not very consequently

Multivariate analysis: all subsets regression

Dependant variables: TRR and DON (ZEA, NIV)

Independent variables:

Straw DM, grain DM, Straw N, grain N, N-min measured, PAN

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## Results

PAN, Grain-N and Straw-N explain most of the variation

% variation accounted for

| Year | 2006 | | | | 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | F | | CS | | F | | SC | |
| explained variable | DON | TRR | DON | TRR | DON | TRR | DON | TRR |
| PAN | 28 | 28 | 24 | | | | 16 | 21 |
| Grain-N | 30 | 44 | 22 | | | 21 | | 16 |
| Straw-N | | | 23 | | | | | |

**Significant but only very week relations??**

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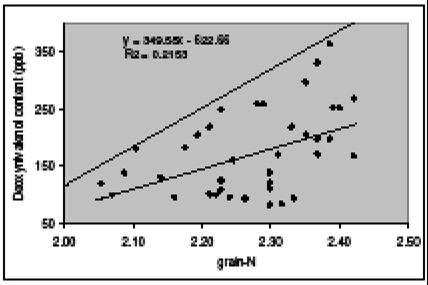
## Results: relations with DON




## So there are relations with grain N and DON

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

We tried to quantify the weed infestation in the plots…

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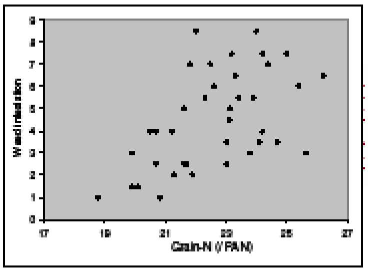
## Weed infestation after anthesis

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## Conclusions: fertility and Fusarium…..

N-level indeed influences Fusarium (TRR, DON)

always direction: >grain-N gives >TRR/DON, but other factors play a role

Mechanism: microclimate or plant physiology?

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

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## Conclusions

Year and location are dominant factors

Impacts on yield and grain N are more important than impact on TRR / DON:

DON: maximum allowed level not often reached: peaks are leveled out by mixing several charges

Therefore: no consequences for agronomic practice: effects are small and do not pay for the farmers

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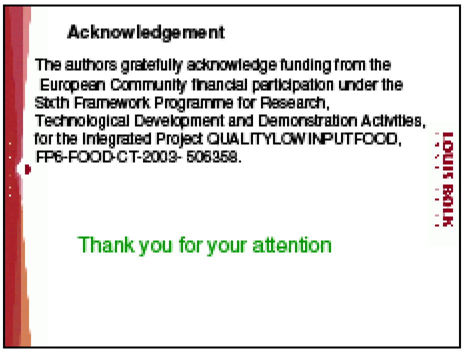
Acknowledgement
The authors gratefully acknowledge funding from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Integrated Project QUALITYLOWINPUTFOOD, FP6-FOOD-CT-2003- 506358.
Thank you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

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# 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.

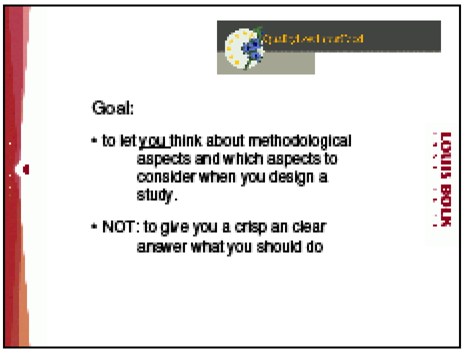
**Report**

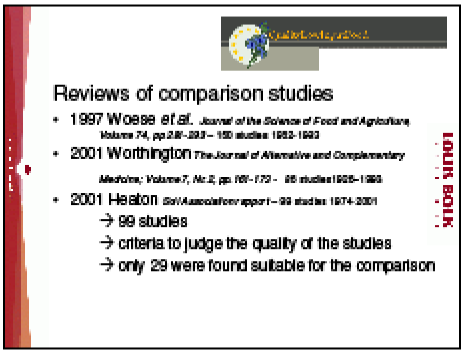
Clearly describe the method used and give a foundation for the choices made. For instance within the scientific community discussions are going on whether or not the same varieties need to be used. Because variety choice is also an important system difference and not all varieties perform well in both 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.

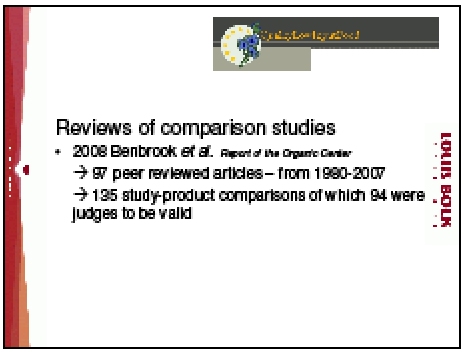
**Conclusion**

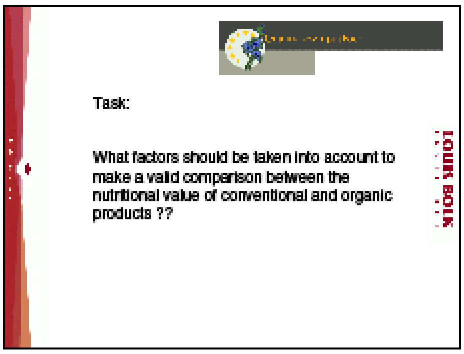
Different study designs give answers to different questions, therefore not one best method can be given. Irrespective of the chosen design, choices need to be made with respect to aspects influencing nutritional quality of the food.

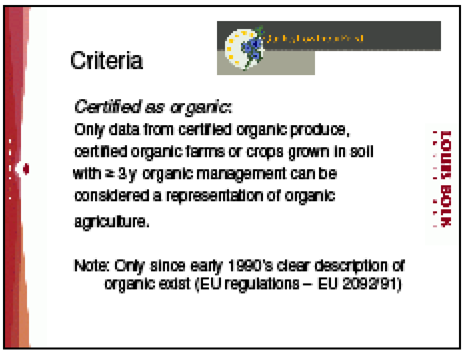
# Presentation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## Criteria

*Agricultural practice reflects typical practice within the respective systems:*

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

## 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

Comparable soil type and climate

Variety: information available, should be comparable

Clear description of the agricultural management; manure use, pre-crops (preferably the same)

**Study types**

- *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, crop variety and soil type.
- *Market of "shopping basket" surveys*: 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, how 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 not 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, pre-crop

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# 4 Quality of organically produced plant products

*Ewa Rembiałkowska*
*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.

## Quality of organically produced plant foods


prof. Ewa Rembiałkowska

Division of Organic Foodstuffs
Warsaw University of Life Sciences - SGGW
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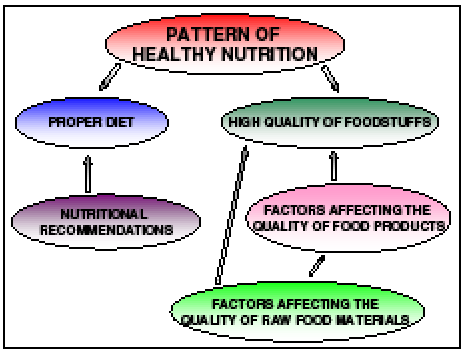
## Factors influencing human health

- In 54% lifestyle, psychological status, people behaviour, in that nutrition pattern
- In 21 % environmental conditions, and food quality is connected with it
- In 15 % genetic background
- In 10 % medical service activity

*According to American Centre of Diseases Control (1996)*

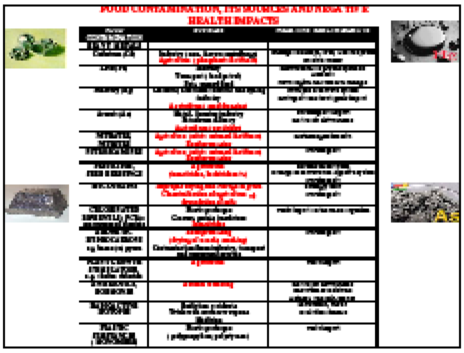



### Factors affecting the quality of raw food materials

- 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)
- climatic- 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 flour)
- technology of processing and culinary treatment
- packing system
- 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 cryteria are important (small farms, using local means of production, activation of the country areas)

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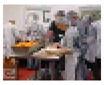
- Organic agriculture excludes the use of synthetic fertilisers, pesticides, plant growth regulators
- Only natural organic fertilizers (compost, manure), green manures and biological crop protection methods are allowed
- Animal production excludes the use of antibiotics, hormones and GMOs
- Food processing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

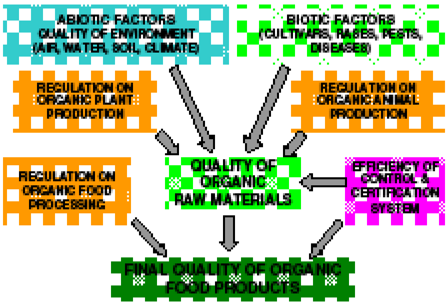


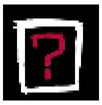
## ORGANIC FARMING IN EU LEGISLATION

- The basic law on organic farming and processing, applying in the UE is Regulation EEC No 2092/91 of 24 June 1991 on organic production of agricultural products and idications referring thereto on agricultural products and foodstuffs.
- In August 1999 rules on production, labelling and inspection of the most relevant animal species (cattle, sheep, goats, horses and poultry) were also agreed - Regulation (EC) No 1804/1999 of 19 July 1999. This agreement covers such issues as foodstuffs, disease prevention and veterinary treatments, animal welfare, husbandry practices and the management of manure.
- From 1 January 2009 Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91 will be in force.

## FACTORS INFLUENCING THE QUALITY OF ORGANIC FOOD PRODUCTS

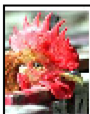



## Why do consumers look for organic food...???



## MOTIVATION

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



## Food Scandals in Europe since 1996

| | |
|---|---|
| 1996 | A probable link between BSE (bovine spongiform encephalopathy) and vCJD (Creutzfeldt-Jakob disease) has been established (Harris, 2000; Sy, 2003) |
| 1998 | Elevated levels of chlorinated dioxins in milk due to use of citrus pulp neutralized with waste of $Ca(OH)_2$ (Den Hartog, 2003) |
| 1999 | The Belgian PCB/dioxin incident. Polychlorobiphenyls (PCB) and dioxins were mixed into a tank of recycled frying oil, which was used for the production of animal feed (Bernard et al., 2002) |

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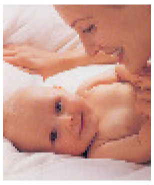
## OTHER MOTIVATIONS

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

(Żakowska-Biemans, Gutkowska, 2003)

## PROFILE OF ORGANIC CONSUMER

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



## The main basis

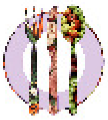
**Consumers' belief in higher health- and nutritional quality of organic products**

**Is the belief justified?**

## There are some empirical evidences


## POSITIVES

- **Higher health quality/food safety**



## Undiserable substances

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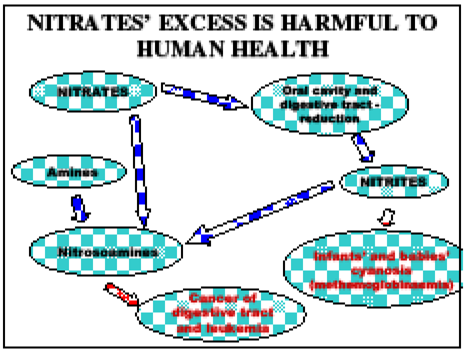



## Maximum levels for nitrates in foodstuffs

(Acc. COMMISSION REGULATION (EC) No 1881/2006)

| Foodstuffs | Maximum levels (mg $NO_3$/kg) | |
|---|---|---|
| Fresh spinach (Spinacia oleracea) | Harvested 1.10 to 31.03 | 3000 |
| | Harvested 1.04 to 30.09 | 2500 |
| Preserved, deep frozen or frozen spinach | | 2000 |
| Fresh lettuce (Lactuca sativa L.) (protected and open-grown) | Harvested 1.10 to 31.03:<br>Lettuce grown under cover<br>Lettuce grown in the open air | <br>4500<br>4000 |
| | Harvested 1.04 to 30.09:<br>Lettuce grown under cover<br>Lettuce grown in the open air | <br>3500<br>2500 |
| Iceberg-type lettuce | Lettuce grown under cover<br>Lettuce grown in the open air | 2500<br>2000 |
| Processed cereal-based foods and baby foods for infants and young children | | 200 |

## Nitrates content in organic (ORG) and conventional (CONV) vegetables

| Plants | Nitrate content (mg/kg) | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Beetroot | 1871 | 2690 | +43,77 | +35,81 | [illegible] 1993 |
| Leek | 370 | 499 | +34,86 | +29,69 | [illegible] 1993 |
| Parsley | 234 | 383 | +63,68 | +48,30 | [illegible] 1999 |
| Carrot | 158 | 283 | +80,38 | +42,19 | [illegible] 1999 |
| Potatoes | 146 | 233 | +60,00 | +33,33 | [illegible] 1999 |
| Beetroot | 932 | 2262 | +141,96 | +83,02 | [illegible] 1999 |
| Cabbage | 147 | 939 | +539,28 | +146,30 | [illegible] 1999 |
| Carrot | 52,2 | 209,7 | +301,72 | +120,27 | [illegible] 1999 |
| Head cabbage | 344,3 | 967,5 | +180,97 | +90,01 | [illegible] 1999 |
| Cabbage | 89 | 512 | +417,07 | +135,10 | [illegible] 1999 |
| Red cabbage | 179 | 693 | +285,36 | +114,09 | [illegible] 1999 |
| Carrot | 102 | 481 | +371,56 | +137,53 | [illegible] 1999 |
| Parsley | 119 | 381 | +220,45 | +108,08 | [illegible] 1999 |

## Nitrates content in organic (ORG) and conventional (CONV) vegetables

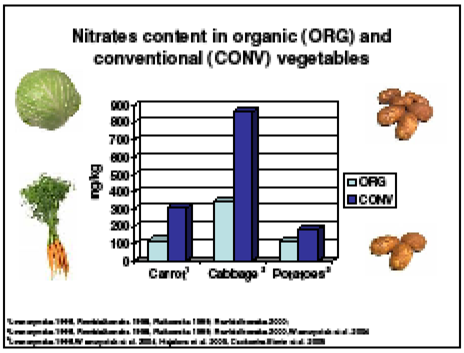
| Plants | Nitrate content (mg/kg) | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Potatoes | 98 | 229 | +131,31 | +78,27 | [illegible] 2000 |
| Carrot | 155 | 266 | +71,61 | +52,73 | [illegible] 2000 |
| Cabbage | 346 | 806 | +132,95 | +80,18 | [illegible] 2000 |
| Beetroot | 1543 | 2217 | +45,05 | +36,18 | [illegible] 2000 |
| Potatoes | 187,5 | 201,1 | +18,05 | +16,05 | [illegible] 2004 |
| Celery | 459,5 | 632,8 | +34,39 | +28,34 | [illegible] 2004 |
| Bok choy (Chinese leaves) | 553,1 | 1045,7 | +89,06 | +61,75 | [illegible] 2004 |

## Nitrates content in organic (ORG) and conventional (CONV) vegetables

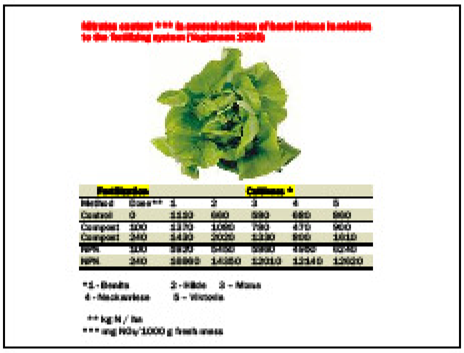
| Plants | Nitrate content (mg/kg) | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Head cabbage | 738,7 | 1001,6 | +34,80 | +30,50 | [illegible] 2004 |
| Potatoes | 132 | 210,3 | +59,32 | +45,75 | [illegible] 2005 |
| Spinach (frozen) | 659 | 1011 | +53,41 | +42,18 | [illegible] 2005 |
| Lettuce | 919 | 1383 | +50,50 | +40,73 | [illegible] 2006 |
| Arugula | 4873 | 6307 | +32,82 | +27,60 | [illegible] 2006 |
| Potatoes | 16,5 | 73,8 | +350,66 | +129,73 | [illegible] 2006 |
| Mean: | | | + 148,39% | +70,47% | |

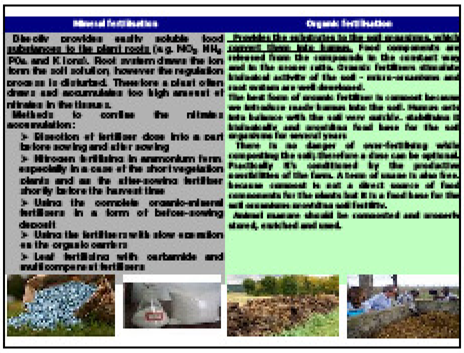
*Calculated according to Worthington's system (2001): (CONV-ORG)/ORG x 100%

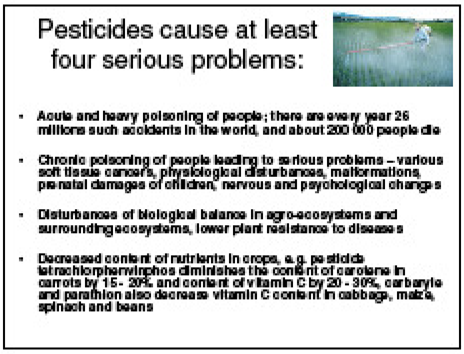
**Calculated according to Lockeretz's system: (CONV-ORG)/[(ORG+CONV)/2]x 100%

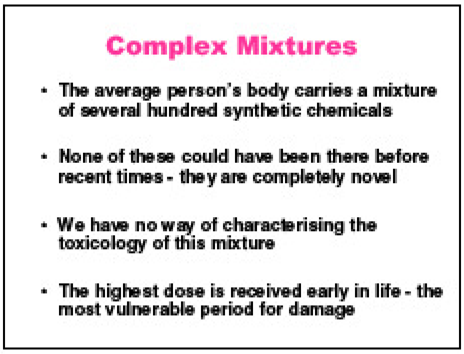


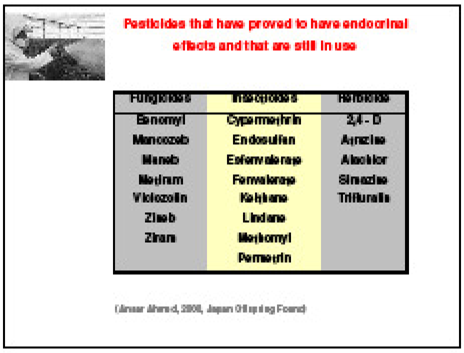

1

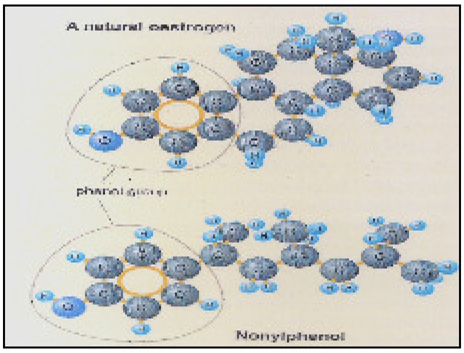

Method Dose** 1 2 3 4 5
** kg N / ha

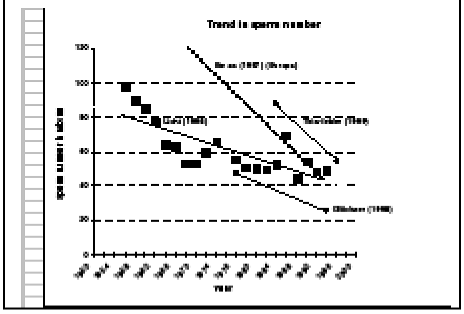

Mineral fertilisation
Organic fertilisation


Pesticides cause at least four serious problems:
Acute and heavy poisoning of people; there are every year 26 millions such accidents in the world, and about 200 000 people die
Chronic poisoning of people leading to serious problems – various soft tissue cancers, physiological disturbances, malformations, prenatal damages of children, nervous and psychological changes
Disturbances of biological balance in agro-ecosystems and surrounding ecosystems, lower plant resistance to diseases
Decreased content of nutrients in crops, e.g. pesticide tetrachlorphenvinphos diminishes the content of carotene in carrots by 15 - 20% and content of vitamin C by 20 - 30%, carbaryle and parathion also decrease vitamin C content in cabbage, maize, 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 toxicology of this mixture
The highest dose is received early in life - the most vulnerable period for damage


Pesticides that have proved to have endocrinal effects and that are still in use
Fungicides Insecticides Herbicides
Benomyl Cypermethrin 2,4 - D
Mancozeb Endosulfan Atrazine
Maneb Esfenvalerate Alachlor
Metiram Fenvalerate Simazine
Vinclozolin Kelthane Trifluralin
Zineb Lindane
Ziram Methomyl
Permethrin
(Anser Ahmed, 2000, Japan Offspring Fund)


A natural oestrogen
phenol group
Nonylphenol




## 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 ⟶ precaution is the main tool available to us!

==========================

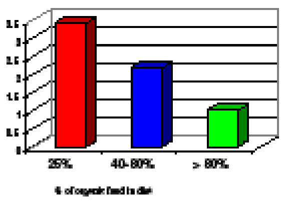
*Howard 2005*

Comparison of the pesticide residues in crops from different production systems in several countries

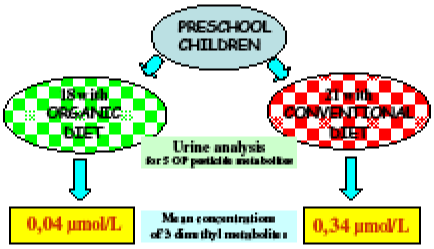
| | Organic farming | Integrated farming | Conventional farming |
|---|---|---|---|
| Country | % samples with residues | % samples with residues | % samples with residues |
| USA[1] 1993-2002 | 23 | 47 | 73 |
| Belgium[2] | 12 | No data | 49 |
| Sweden 2002-2003[3] | 3 | 11 | 44 |
| Poland 2004[4] | 0 | 50 | 44 |
| Poland 2005[5] | 7 | 47 | 28 |
| Poland 2006[5] | 5 | 48 | 21 |

[1] USDA (Baker et al. 2002)
[2] FSCA – FAVV 2001; big-scale studies 1995 – 2001
[3] National monitoring of plant origin food 2003
[4] Official control of national plant origin food 2005
[5] Gnusowski and Nowacka 2006

Contamination of human milk with pesticides (chlorinated hydrocarbons) in relation to the share of organic food in diet (after Aubert 1987)




Organophosphorus Pesticide Exposure of Preschool Children with Organic and Conventional Diets
(Acc. to Curl et al. 2003)




## CONCLUSION

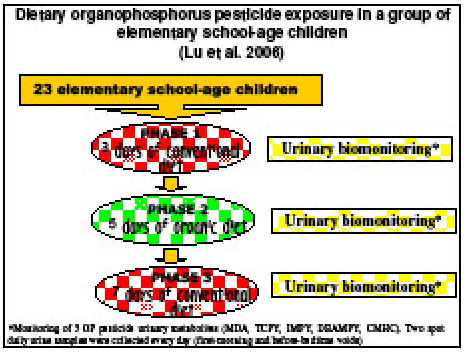
CONSUMPTION OF

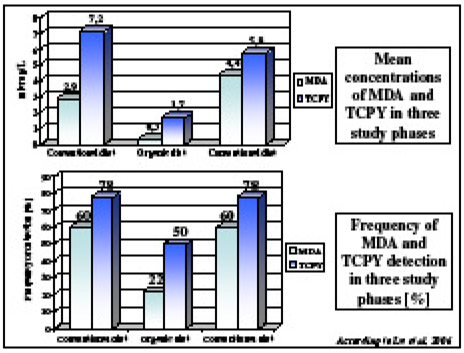
ORGANIC PRODUCE

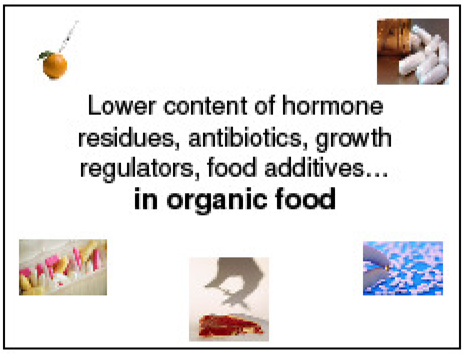
PROVIDE A SIMPLE WAY TO REDUCE CHILDREN'S EXPOSURE TO OP PESTICIDES

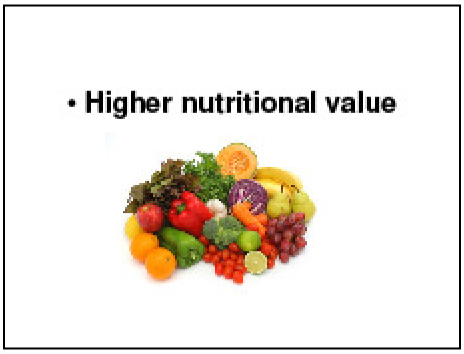
Acc. to Curl et al. 2003

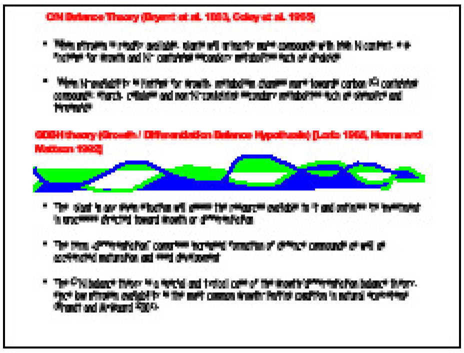
1

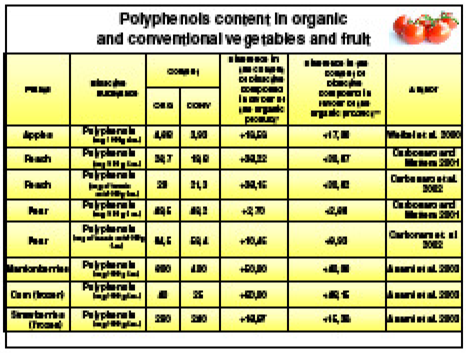




Polyphenols content in organic and conventional vegetables and fruit

| [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|
| | | ORG | CONV | | | |
| Apple | Polyphenols | 4,69 | 3,93 | +19,59 | +17,[illegible] | Weibel et al. 2000 |
| Peach | Polyphenols | 39,7 | 19,9 | [illegible] | [illegible] | Carbonaro and Mattera 2001 |
| Peach | Polyphenols | 28 | 21,3 | [illegible] | [illegible] | Carbonaro et al. 2002 |
| Pear | Polyphenols | [illegible] | [illegible] | +2,70 | [illegible] | Carbonaro and Mattera 2001 |
| Pear | Polyphenols | 84,6 | 69,4 | [illegible] | [illegible] | Carbonaro et al. 2002 |
| Marionberries | Polyphenols | [illegible] | [illegible] | [illegible] | [illegible] | Asami et al. 2003 |
| Corn (frozen) | Polyphenols | [illegible] | 25 | [illegible] | [illegible] | Asami et al. 2003 |
| Strawberries (frozen) | Polyphenols | [illegible] | [illegible] | [illegible] | [illegible] | Asami et al. 2003 |

## Polyphenols content in organic and conventional vegetables and fruit

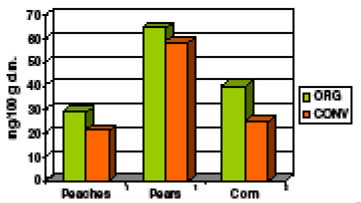
| Plants | [illegible] | [illegible] | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|---|
| | | ORG | CONV | | | |
| [illegible] | Polyphenols [illegible] | 13,6 | 13,6 | +0,00 | -7,89 | Young et al. 2005 |
| [illegible] | Polyphenols [illegible] | 15,2 | 11,6 | +30,17 | +27,72 | Young et al. 2005 |
| Apple [illegible] | Polyphenols [illegible] | 387,3 | 284,9 | +35,93 | +30,41 | [illegible] 2005 |
| Apple [illegible] | Polyphenols [illegible] | 712,4 | 604,9 | +17,83 | +16,37 | [illegible] 2005 |
| Tomatoes | Phenolics [illegible] | 0,83 | 0,48 | +73,83 | +53,44 | [illegible] 2003 |
| Apples | Phenolics [illegible] | 1,38 | 0,73 | +89,59 | +59,98 | [illegible] 2003 |
| Apples | Phenolics [illegible] | 2,75 | 2,37 | +16,03 | +14,88 | [illegible] 2005 |

## Polyphenols content in organic and conventional vegetables and fruit

| Plants | [illegible] | [illegible] | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|---|
| | | ORG | CONV | | | |
| Red pepper | Flavonoids [illegible] | 33,81 | 14 | +141,49 | +82,88 | [illegible] 2006 |
| Onion | Flavonoids [illegible] | 95,37 | 84,81 | +12,80 | +11,95 | [illegible] 2006 |
| Strawberries | Quercetin [illegible] | [illegible] | 0,69 | +4,64 | +4,53 | [illegible] 2006 |
| Strawberries | Kaempferol [illegible] | [illegible] | 0,784 | -11,73 | -12,47 | [illegible] 2006 |
| Apples | Anthocyans [illegible] | 9,18 | 3,2 | +217,73 | +122,74 | [illegible] 2003 |
| Apples | Anthocyans [illegible] | 1,65 | 0,972 | +69,75 | +51,72 | [illegible] 2003 |
| Onion | Anthocyans [illegible] | 14,81 | 8,37 | +74,55 | +56,81 | [illegible] 2006 |
| **Mean:** | | | | **+50%** | **+32,4%** | |

*Calculated according to Worthington's system (2001): (ORG-CONV)/CONV x 100%
** Calculated according to Lockeretz's system: (ORG-CONV)/[(ORG+CONV)/2] x 100%

## Polyphenols content in organic and conventional vegetables and fruit




*Carbonaro et al. 2002
*Asami et al. 2003

## Carotenoids and chlorophyll content in organic and conventional vegetables and fruit

| Plants | [illegible] | [illegible] | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|---|
| | | ORG | CONV | | | |
| Carrot | β-carotene | 13,80 | 14,49 | -4,8 | -5,70 | [illegible] 1998 |
| Tomatoes | β-carotene | 1,43 | 0,48 | 198,03 | 99,99 | [illegible] 2003 |
| Red pepper | β-carotene | 3,17 | 2,38 | 33,39 | 28,14 | [illegible] 2006 |
| Red pepper | β-carotene | 3,41 | 2,56 | 33,43 | 27,31 | [illegible] 2007 |
| Tomatoes | Licopene | 3,33 | 3,53 | -50,13 | -58,48 | [illegible] 2003 |
| Red pepper | Licopene | 4,28 | 4,59 | -6,76 | -6,43 | [illegible] 2006 |
| Red pepper | Licopene | 4,13 | 4,66 | -11,33 | -12,06 | [illegible] 2007 |
| Red pepper | Lutein | 6,048 | 4,48 | 33,41 | 27,88 | [illegible] 2006 |
| Red pepper | Lutein | 5,43 | 4,48 | 21,38 | 19,33 | [illegible] 2007 |
| [illegible] | Chlorophyll | 121,3 | 236,6 | 7,80 | 7,33 | [illegible] 2003 |
| **Mean:** | | | | **+25,5** | **+13,8** | |

## Vitamin C content in organic (ORG) and conventional (CONV) vegetables and fruit

| Plants | vit. C content [mg/100g f.m.] | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Spinach | 70,3 | 55,5 | +37,49 | +31,59 | Vogtmann et al. 1984 |
| Spinach | 53,1 | 39,9 | +77,59 | +55,90 | Schuphan 1974 |
| Celery | 8,1 | 7,3 | +10,96 | +10,39 | Leclerc et al 1991 |
| Celery | 14 | 11,9 | +18,64 | +17,06 | Schuphan 1974 |
| Savoy cabbage | 73,5 | 41,9 | +75,84 | +54,59 | Schuphan 1974 |
| Cabbage | 47,03 | 40,57 | +15,96 | +13,59 | Rembiałkowska 2000 |
| Cabbage | 44,58 | 34,30 | +30,12 | +26,19 | Rembiałkowska 1998 |
| Lettuce | 15,4 | 9,7 | +58,76 | +45,42 | Schuphan 1974 |
| Leek | 37,8 | 30,1 | +25,52 | +24,88 | Lairon et al. 1986 |
| Potatoes | 18,1 | 15,5 | +16,77 | +15,48 | Petterson 1978 |
| Potatoes | 33,1 | 28,3 | +16,96 | +15,66 | Schuphan 1974 |
| Potatoes | 21,1 | 10,6 | +98,96 | +66,25 | Fischer and Richter 1986 |
| Potatoes | 26,8 | 22 | +20,91 | +19,90 | Rembiałkowska and [illegible] 1998 |

## Vitamin C content in organic (ORG) and conventional (CONV) vegetables and frui

| Plants | Vit. C content [mg/100g f.m.] | | [illegible]* | [illegible]** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Potatoes | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 2003 |
| Potatoes | [illegible] | [illegible] | [illegible] | -7,74 | [illegible] 2003 |
| corn (frozen) | 2,1 | 3,2 | -34,38 | -41,51 | [illegible] 2003 |
| Swiss beetroot leaves | 19,35 | 16,5 | +10,91 | +10,37 | [illegible] 2003 |
| Onion | 30,16 | 13,34 | +126,09 | +76,75 | [illegible] 2004 |
| Tomatoes | 10,4 | 16,4 | -36,59 | -36,59 | [illegible] 2000 |
| Tomatoes | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 2005 |
| Tomatoes | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 2006 |
| Red pepper | 152,18 | 113,89 | +33,79 | +28,83 | [illegible] 2006 |
| Red pepper | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] 2007 |
| Apples | 7,37 | 5,47 | +32,91 | +28,30 | [illegible] 2000 |
| Oranges | [illegible] | [illegible] | +11,38 | +11,38 | [illegible] 2003 |
| **Mean:** | | | **+ 32,21** | **+23,9** | |

Two calculation systems: according to Worthington* and Lockeretz**

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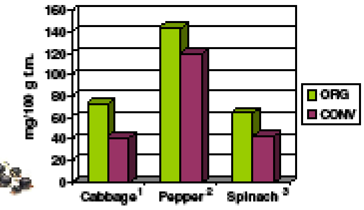
## Vitamin C content in organic (ORG) and conventional (CONV) vegetables and fr




[1] Schuphan 1974
[2] Hallmann 2006, Hallmann et al. 2007
[3] Schuphan 1974, Vogtmann et al. 1984

## Total sugars in organic (ORG) and conventional (CONV) vegetables and fruit

| Plants | Sugars content (g/100g f.m.) | | Difference in the content of chosen compounds in favour of the organic product* | Difference in the content of chosen compounds in favour of the organic product** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Beetroot | 8,44 | 8,38 | +0,73 | +0,71 | Abele 1987 |
| Potatoes | 1,1 | 1,11 | -0,90 | -0,90 | Abele 1987 |
| Carrot | 6,04 | 6,01 | +0,50 | +0,50 | Abele 1987 |
| Beetroot | 16,5 | 16,5 | +0,45 | +0,25 | Zadoks 1989 |
| Carrot | 7,53 | 6,57 | +14,61 | +12,82 | Rembiałkowska 1999 |
| Apples | 10,91 | 10,30 | +6,31 | +4,09 | Rembiałkowska et al. 2004 |
| Potatoes | 0,98 | 0,41 | +139,02 | +58,01 | Cachoński, Rembiałkowska et al. 2006 |
| Tomatoes | 5,04 | 4,35 | +15,87 | +13,65 | Rembiałkowska et al. 2006 |
| Onion | 3,32 | 1,7 | +91,76 | +48,08 | Hallmann and Rembiałkowska 2006 |
| Red pepper | 6,08 | 3,9 | +61,11 | +38,18 | Hallmann et al. 2007 |

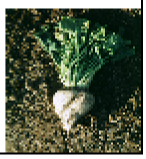
**Mean:** +31,7% +22,2%

Two calculation systems: according to Worthington* and Lockeretz**

## Sugar content in sugar beets [% f.m.]

| | Farm | | |
|---|---|---|---|
| Year | Conventional | Integrated | Organic |
| 1980 | 16,4 | 16,2 | 16,4 |
| 1981 | 15,7 | 15,7 | 16,1 |
| 1982 | 16,2 | 16,7 | 17,3 |
| 1983 | 15,8 | 15,9 | 16,5 |
| 1984 | 13,6 | 15,8 | 16,3 |
| Mean | 15,5 | 16,1 | 16,5 |

Zadoks, 1989



## Reducing sugars' content in organic (ORG) and conventional (CONV) vegetables and fruit

| Plants | Reducing sugars (g/100g f.m.) | | Difference in the content of chosen compounds in favour of the organic product* | Difference in the content of chosen compounds in favour of the organic product** | Author |
|---|---|---|---|---|---|
| | ORG | CONV | | | |
| Beetroot | 0,27 | 0,23 | +17,39 | +16,00 | Abele 1987 |
| Potatoes | 0,32 | 0,33 | -3,03 | -3,03 | Abele 1987 |
| Carrot | 3,71 | 3,7 | +0,27 | +0,27 | Abele 1987 |
| Apples | 8,48 | 8,4 | +1,41 | +1,40 | Rembiałkowska et al 2006 |
| Potatoes | 0,25 | 0,1 | +150,00 | +60,71 | Cachoński, Rembiałkowska et al 2006 |
| Tomatoes | 3,86 | 4,41 | -12,56 | -14,35 | Rembiałkowska et al 2006 |
| Onion | 0,48 | 0,21 | +128,57 | +71,29 | Hallmann and Rembiałkowska 2006 |
| Red pepper | 3,50 | 2,4 | +45,00 | +32,00 | Hallmann et al 2007 |

**Mean:** +93,3% +55,1%

Two calculation systems: according to Worthington* and Lockeretz**

## Mineral compounds in organic and conventional vegetables

(Worthington 2001)

| Vegetable | Mineral compounds* | | | |
|---|---|---|---|---|
| | Vitamin C | Iron | Magnesium | Phosphorus |
| Lettuce | +17 | +17 | +29 | +14 |
| Spinach | +52 | +25 | -13 | +14 |
| Carrot | -6 | +12 | +69 | +13 |
| Potatoes | +22 | +21 | +5 | 0 |
| Cabbage | +43 | +41 | +40 | +22 |

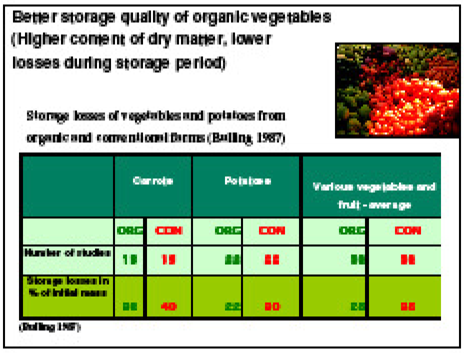
*„+" and „-" determine % differences in the content of each compound in organic vegetable in comparison with conventional vegetable.

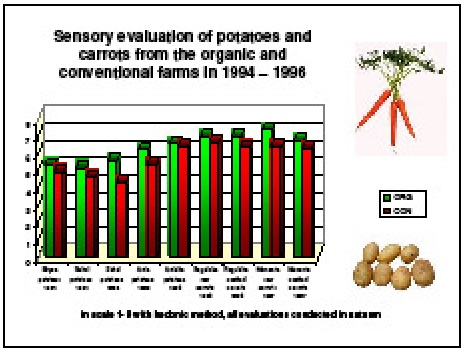
## Dry matter content in organic and conventional vegetables

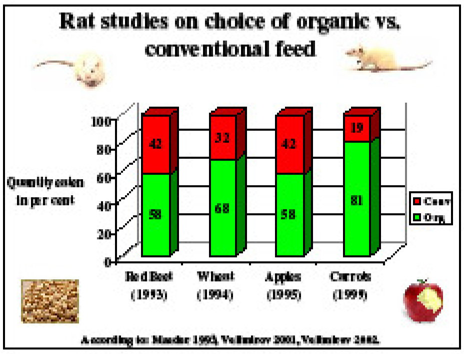
(Rembiałkowska 2000)

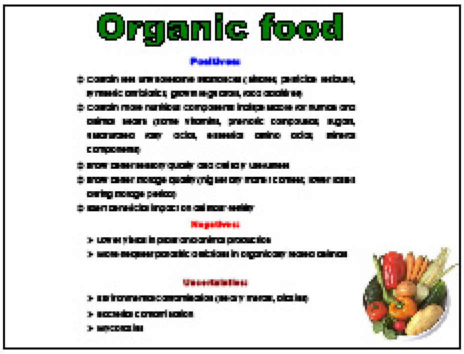
| VEGETABLE | CULTIVAR | YEAR | ORGANIC | CONVENTIONAL |
|---|---|---|---|---|
| Potatoes | different cultivars, mixed | 1991 - 1992 | 22.4 ± 2.09 a[1] | 21.1 ± 2.25 b[1] |
| Potatoes | Bryza | 1994 | 21.43 ± 1.39 a[1] | 20.21 ± 1.96 a[1] |
| Potatoes | Sokół | 1994 | 20.64 ± 1.86 a | 20.79 ± 2.00 a |
| Potatoes | Sokół | 1995 | 21.93 ± 1.61 a | 20.21 ± 1.89 a |
| Potatoes | Asia | 1995 | 24.12 ± 1.61 a | 21.60 ± 2.79 b |
| Potatoes | Aniela | 1996 | 24.3 ± 1.2 a | 23.3 ± 1.5 b |
| Carrot | Regulska | 1996 | 15.32 ± 1.26 a | 14.11 ± 0.81 a |
| Carrot | Morana | 1997 | 11.87 ± 0.84 a | 11.30 ± 0.89 a |
| Cabbage | Alris F1 | 1997 | 8.37 ± 0.51 a | 7.25 ± 0.48 b |
| Red beet | * | 1997 | 16.76 ± 0.58 a | 13.06 ± 1.39 b |
| Carrot | * | 1997 | 11.78 ± 1.43 a | 11.42 ± 1.42 a |
| Potatoes | * | 1997 | 18.08 ± 0.91 a | 16.05 ± 1.55 b |

[1] (a – a) = difference statistically insignificant, (a – b) = difference statistically significant
* Vegetables from organic shops (cultivars not known)


Better storage quality of organic vegetables
(Higher content of dry matter, lower
losses during storage period)
Storage losses of vegetables and potatoes from
organic and conventional farms (Bulling, 1987)
Carrots
Potatoes
Various vegetables and fruit - average
ORG
CON
Number of studies
Storage losses in % of initial mass
40


Sensory evaluation of potatoes and
carrots from the organic and
conventional farms in 1994 – 1996


Rat studies on choice of organic vs.
conventional feed
Quantity eaten in per cent
100
80
60
40
20
0
42
58
32
68
42
58
19
81
Red Beet (1993)
Wheat (1994)
Apples (1995)
Carrots (1999)
Conv
Org
According to: Mader 1993, Velimirov 2001, Velimirov 2002.


Organic food


THANK YOU

# 5 *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*

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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 practises, 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)**

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

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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 (LIminusP), (2) low input of fertilizer and high input of pesticides (LIplusP), (3) and high input of fertilizers and high input of pesticides (HIplusP) 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 etal., 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 outmost 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**

Jørgensen, H., Brandt, K., and Lauridsen, C. 2008. Year rather than farming system influenced protein utilisation and energy value of vegetables when measured in a rat model. Nutr. Res. 28, 866-878.

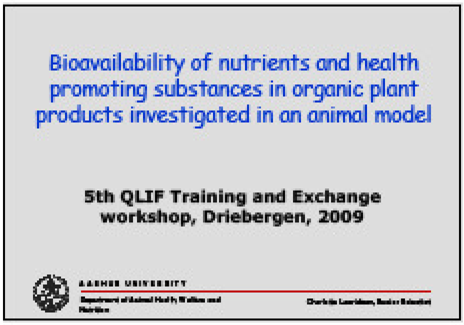
Kristensen, M., Østergaard, L.F., Halekoh, U., Jørgensen, H., Lauridsen, C., Brandt, K., and Bügel, S. 2008. Effect of plant cultivation methods on content of major and trace elements in foodstuffs and retention in rats. J. Sci. Food Agric. 88, 2161-2172.

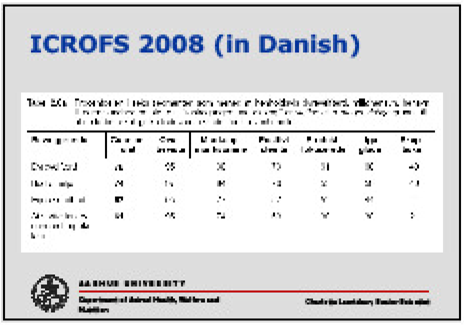
Lauridsen, C, Yong, C., Halekoh, U., Bügel, S. H., Brandt, K., Christensen, L.P., and Jørgensen, H. 2008. Rats show differences in some biomarkers of health when eating diets based on ingredients produced with three different cultivation strategies. J. Sci. Food Agric. 88, 720-732.

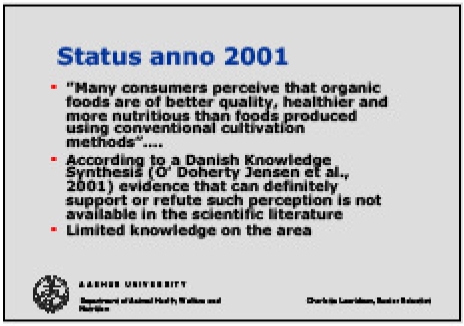
O’Doherty Jensen, K., Larsen, H.N., Mølgaard, J.P., Andersen, J.O., Tingstad, A., Marckmann, P. and Astrup, A. 2001. Økologiske fødevarer og menneskets sundhed. FØJO rapport nr. 14, 130 pp.

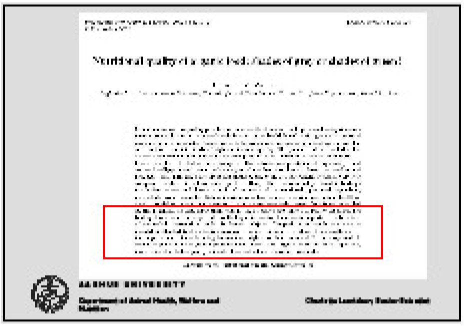
Yong, C., Halekoh, U., Jørgensen, H., and Lauridsen, C. 2005. Dependent on dietary treatments of mothers, rats showed individual preference of diets containing ingredients produced with different cultivation strategies. J. Anim. Feed. Sci., 14, 715-726.

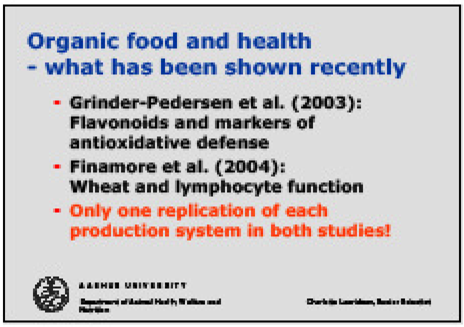
# Presentation

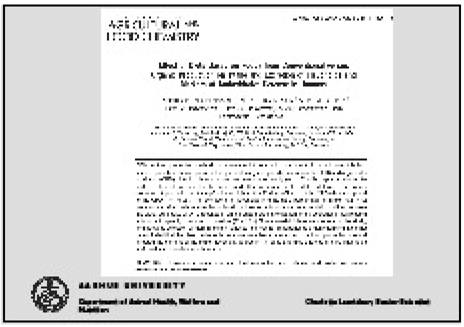




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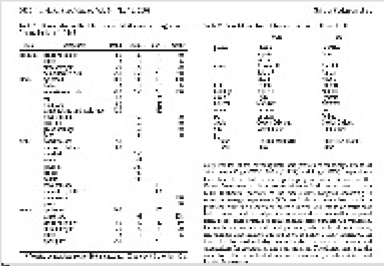


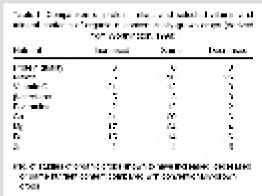
The question
"if organic food is better for health than conventional foods"
is very complex……..

- Nutritive value
  ⇩ ?
- Health-promoting effects
  ⇩ ?
- Health-responses – what is "health"?

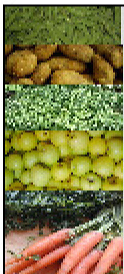
## Nutritive value

- Chemical composition } Primary nutrients
- Bioavailability }
- Secondary metabolites
- Unwanted residues

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

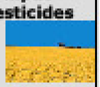


Williams, 2002. Proceedings of the Nutrition Society, 61, 19-24

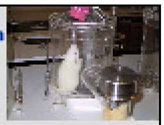


## Three cultivation methods

- "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



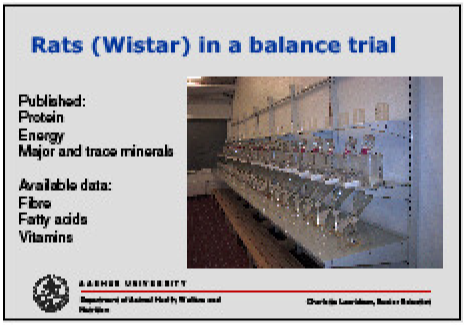
## Impact of cultivation method on content of primary nutrients

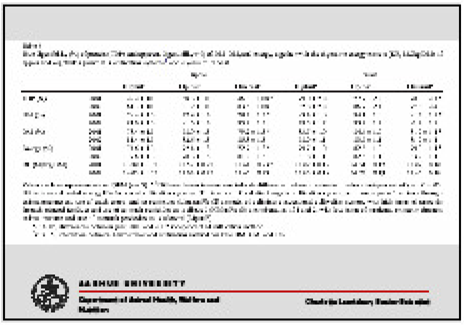


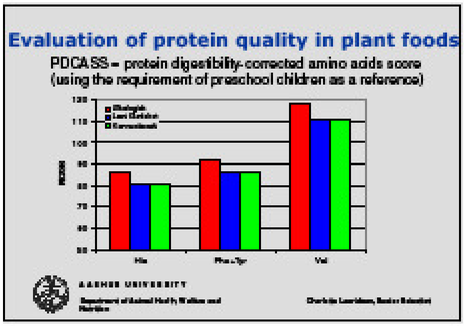
- Dry matter, protein, amino acids, carbohydrates, fatty acids, minerals: NS (few exceptions)
- Harvest year: Effect on several nutrients, although little when considering absolute values

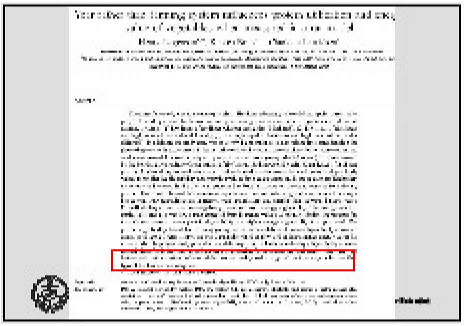
What about bioavailability?

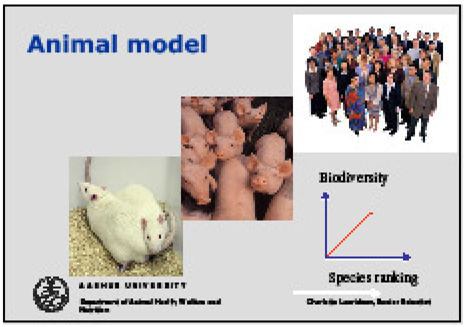
1

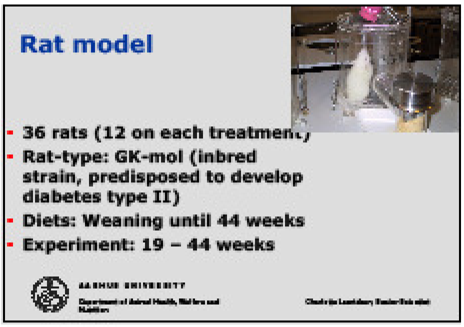

Rats (Wistar) in a balance trial
Published:
Protein
Energy
Major and trace minerals
Available data:
Fibre
Fatty acids
Vitamins




Evaluation of protein quality in plant foods
PDCASS = protein digestibility-corrected amino acids score
(using the requirement of preschool children as a reference)
120
110
100
90
80
70
60
50
PDCAAS
His
Phe+Tyr
Val




Animal model
Biodiversity
Species ranking


Rat model
36 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

1

## Dietary Composition

| | Organically | Minimally fertilized | Conventionally |
|---|---|---|---|
| Potatoes | 300,0 | 300,0 | 300,0 |
| Carrots | 50,0 | 50,0 | 50,0 |
| Peas | 472,4 | 472,4 | 472,4 |
| Green kale | 10,0 | 10,0 | 10,0 |
| Apples | 10,0 | 10,0 | 10,0 |
| Rapeseed oil | 130,0 | 130,0 | 130,0 |
| DL-methionine | 6,4 | 6,4 | 6,4 |
| $CaCO_3$ | 12,5 | | |
| Salt | 0,7 | | |
| Vitamin/ Mineral mixture | 8,0 | | |

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Department of Animal Health, Welfare and Nutrition

Effect of plant cultivation methods on content of major and trace elements in foodstuffs and retention in rats

## Content of nutrients and health-promoting substances

| | Organic | Minimal fertilised | Conventional |
|---|---|---|---|
| Energy, MJ/kg DM | 21 | 21 | 21 |
| Protein, g/kg DM | 161 | 161 | 161 |
| Fat, g/kg DM | 157 | 155 | 159 |
| Vitamin E, mg/kg DM | 32 | 19 | 32 |
| Sat. FA, % | 8 | 7 | 8 |
| Monouns. FA, % | 62 | 72 | 60 |
| PUFA, % | 30 | 21 | 29 |

No pesticide residues could be measured

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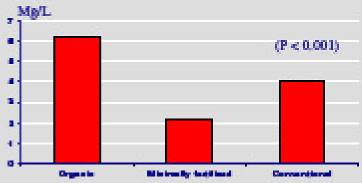
Department of Animal Health, Welfare and Nutrition
Charlotte Lauridsen, Senior Scientist

## Vitamin E in plasma




- No difference in vitamin E content of tissues and organs
- No difference regarding other measured antioxidant

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Charlotte Lauridsen, Senior Scientist

## Effect of rapeseed oil

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

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Department of Animal Health, Welfare and Nutrition
Charlotte Lauridsen, Senior Scientist

## Measurement of rats' health

- Balance experiment
- Energy metabolism
- Activity
- Organ function
- Intestinal function
- Analyses of blood and tissue
  - Antioxidants
  - Immune substances
  - Nutritional status

*In vivo*

*Post mortem*

Preference test

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Charlotte Lauridsen, Senior Scientist

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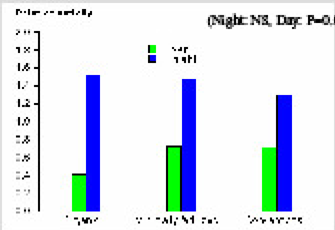
## *In vivo* results

- All rats ate the feed during the entire experiment
- No changes in weight
- No clinical signs of disease
- No notable difference between diets regarding utilization and metabolism of nutrients

## Activity and energy metabolism

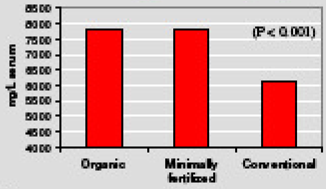
## Relative activity of rats




## Evaluation of well-being

## Accumulation of body fat

## Effect on IgG
## (no effect on IgM and IgA)

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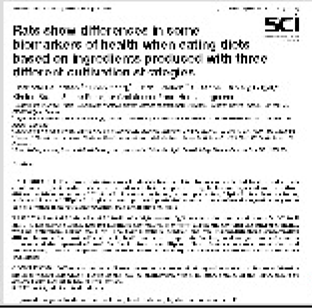
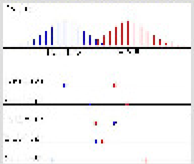
## Conclusion

- 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



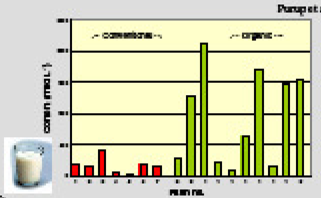
Experiments with crops based on one experimental unit (= field)

Sørensen & Højgaard, 2005

## Results from a pilot study

Equol (phytoestrogen) in bulk milk from 17 farms

Purup et al., 2005




## 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)

VEGQURE:
3 cultivation-systems
1 localisation
2 years
2 replications

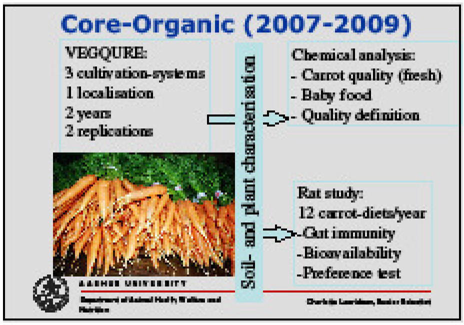
CROPSYS:
3 cultivation-systems
3 localisations
2 years
2 replications

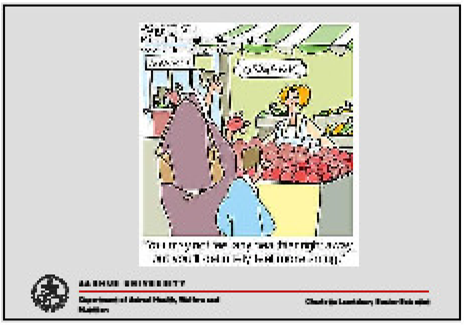
Soil- and plant characterisation

Human intervention study:
6 complete diets/year
1 localisation
Bioavailability (trace-minerals, sec. metabolites

Rat study:
18 diets/year
3 localisations
Biomarkers of health
Immune system

1


Core-Organic (2007-2009)
VEGQURE:
3 cultivation-systems
1 localisation
2 years
2 replications
Soil- and plant characterisation
Chemical analysis:
- Carrot quality (fresh)
- Baby food
- Quality definition
Rat study:
12 carrot-diets/year
-Gut immunity
-Bioavailability
-Preference test



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# 7 Consumer perception of the sensory quality of products

*Bob Cramwinckel*

*Centre of Taste Research, Agro Business Park 34, 6708 PW Wageningen, The Netherlands*

*E-mail: smaak@wxs.nl*

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.

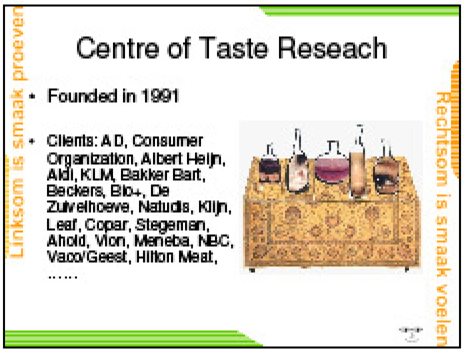
In order to improve the taste quality of organic food, it is necessary to improve the original taste and to combine it with the attractive story of the biological production.

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.

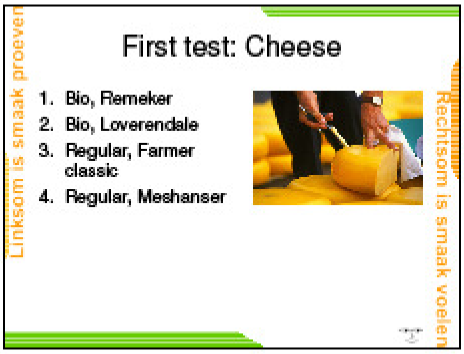
This will be a long way. Not only the biological growing conditions influence the taste but also the genetic properties. So, beside the optimal biological growing conditions also the best genetic variants for that conditions must be found. Only the combination of a good feeling of the organic food production 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.

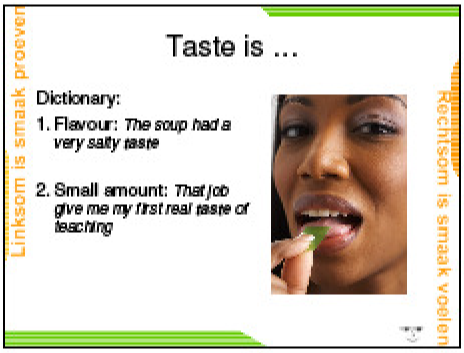
## *Presentation*

+






## The start of CSO

Linksom is smaak proeven

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

Rechtsom is smaak voelen

## Example: test of lager & beer

Linksom is smaak proeven

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

Rechtsom is smaak voelen

## Answer

Linksom is smaak proeven

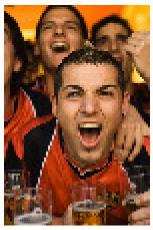
- Beer!
- But… which one is the best selling product?

Rechtsom is smaak voelen

## Conclusion

Linksom is smaak proeven

- The result of a (blind) taste test gives no prediction of a success in the market
- Reason: In a blind test the values or feelings are ignored
- Values of lager = pleasure, friendship and easy to drink!



Rechtsom is smaak voelen

## **S**timulus and the **R**esponse

Linksom is smaak proeven

- The surroundings dominate the consumers behavior

***or***

- The consumer dominates his surroundings

Rechtsom is smaak voelen

## 'Ground' taste

Linksom is smaak proeven

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

Rechtsom is smaak voelen

## 'Ground' taste

Linksom is smaak proeven
Rechtsom is smaak voelen

- Three samples of tilapia: sample A, sample B and tilapia from the supermarket

## Tilapia test

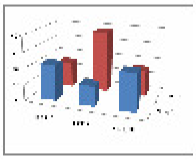
Linksom is smaak proeven
Rechtsom is smaak voelen

| | 1. Tilapia [illegible] | 2. Tilapia [illegible] | 3. Tilapia [illegible] | Significant |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | *** |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | n.s. |
| [illegible] | [illegible] | [illegible] | [illegible] | n.s. |
| Juicy | [illegible] | [illegible] | [illegible] | n.s. |
| Tender | [illegible] | [illegible] | [illegible] | ** |
| Ground taste | [illegible] | [illegible] | [illegible] | [illegible] |
| Total judgement | [illegible] | [illegible] | [illegible] | n.s. |
| [illegible] | [illegible] | [illegible] | [illegible] | |

## Ground taste

Linksom is smaak proeven
Rechtsom is smaak voelen

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



## Different type of taste research

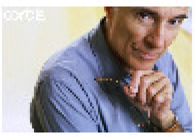
Linksom is smaak proeven
Rechtsom is smaak voelen

1. First form target groups
2. Explain the goal of the experiment
3. Explain the value of a personal judgment

## Understanding taste

Linksom is smaak proeven
Rechtsom is smaak voelen

- Attention for the feelings for a product
- But, how to do that?



## First feelings

Linksom is smaak proeven
Rechtsom is smaak voelen

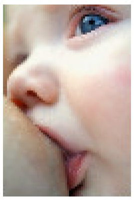
- An empty stomach (very bad feeling) becomes a filled stomach (very good feeling)
- The taste of human milk (37 °C) is sweet and creamy
- Learning process: products with a sweet and creamy taste gives me positive feelings

Linksom is smaak proeven

Rechtsom is smaak voelen

## What's next?

- After the period of human milk, new products are discovered
- New tastes are learned
- New good feelings are developed.



Linksom is smaak proeven

Rechtsom is smaak voelen

## Four laws

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

Linksom is smaak proeven

Rechtsom is smaak voelen

## Blind test: Cheese

1. Sample 1
2. Sample 2
3. Sample 3
4. Sample 4

Linksom is smaak proeven

Rechtsom is smaak voelen

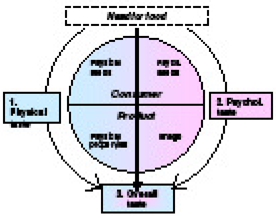
## Codes

1. Bio, Remeker – as branded test nr. 1
2. Regular, classic – as branded test nr. 3
3. Bio, Loverendale – as branded test nr. 2
4. Regular, Meshanser – as branded test nr. 4

Linksom is smaak proeven

Rechtsom is smaak voelen

The 3-Taste Model

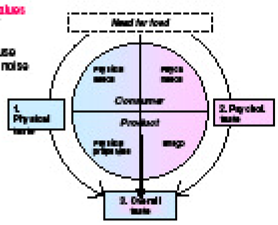


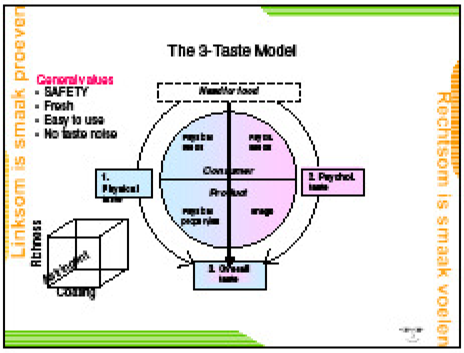

Linksom is smaak proeven

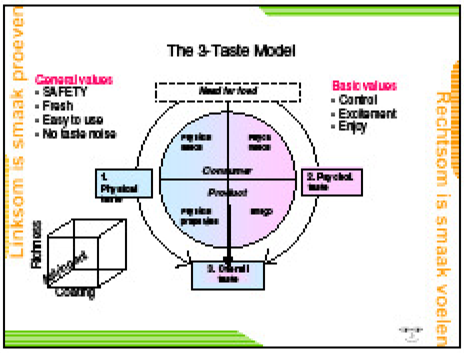
Rechtsom is smaak voelen

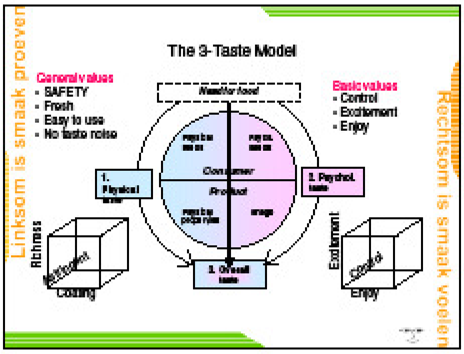
The 3-Taste Model

General values
- SAFETY
- Fresh
- Easy to use
- No taste noise




The 3-Taste Model
General values
- SAFETY
- Fresh
- Easy to use
- No taste noise
Need for food
Consumer
Product
1. Physical
2. Psychol.
3. Overall
Richness
Coating
Linksom is smaak proeven
Rechtsom is smaak voelen


The 3-Taste Model
General values
- SAFETY
- Fresh
- Easy to use
- No taste noise
Basic values
- Control
- Excitement
- Enjoy
Need for food
Consumer
Product
1. Physical
2. Psychol.
3. Overall
Richness
Coating
Linksom is smaak proeven
Rechtsom is smaak voelen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General values
- SAFETY
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Need for food
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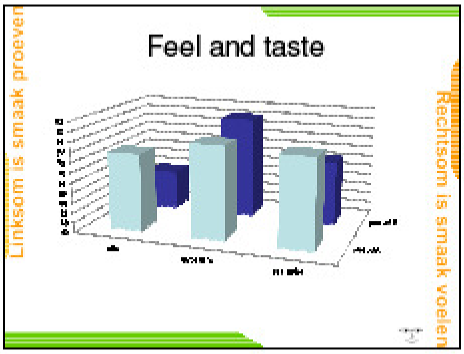
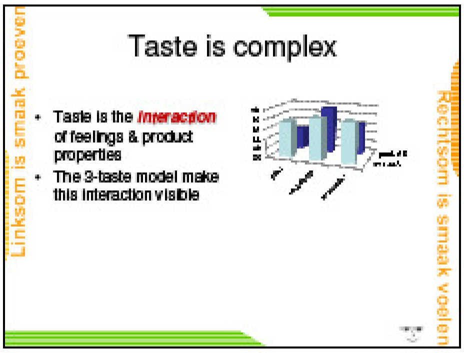
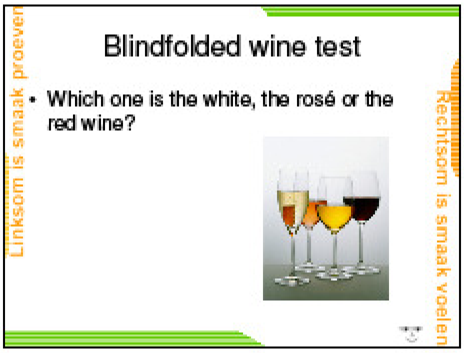
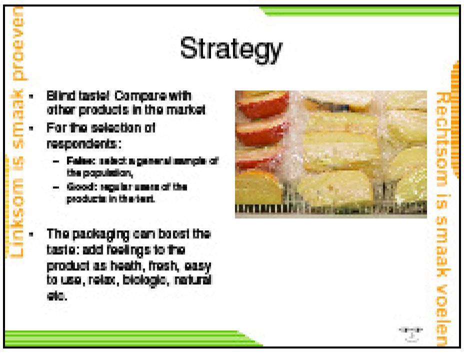
Richness
Coating
Excitement
Control
Enjoy
Linksom is smaak proeven
Rechtsom is smaak voelen

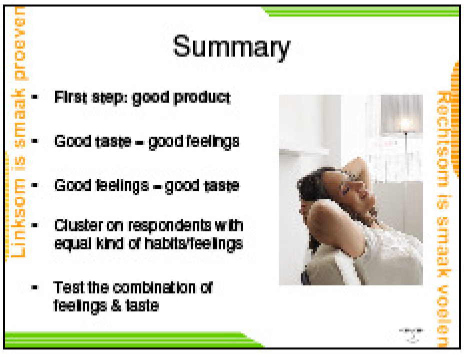

Feel and taste
Linksom is smaak proeven
Rechtsom is smaak voelen


Taste is complex
• Taste is the interaction of feelings & product properties
• The 3-taste model make this interaction visible
Linksom is smaak proeven
Rechtsom is smaak voelen


Blindfolded wine test
• Which one is the white, the rosé or the red wine?
Linksom is smaak proeven
Rechtsom is smaak voelen


Linksom is smaak proeven
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.
Rechtsom is smaak voelen


Linksom is smaak proeven
Strategy
Blind taste! Compare with other products in the market
For the selection of respondents:
– False: select a general sample of the population,
– Good: regular users of the products in the test.
The packaging can boost the taste: add feelings to the product as health, fresh, easy to use, relax, biologic, natural etc.
Rechtsom is smaak voelen

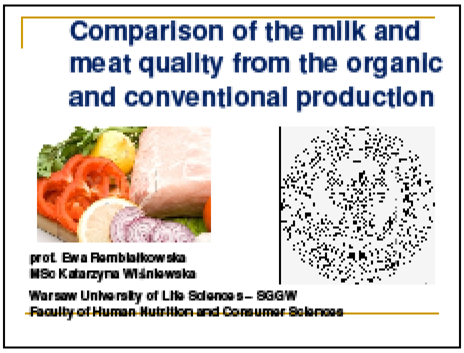

Linksom is smaak proeven
Summary
First step: good product
Good taste = good feelings
Good feelings = good taste
Cluster on respondents with equal kind of habits/feelings
Test the combination of feelings & taste
Rechtsom is smaak voelen

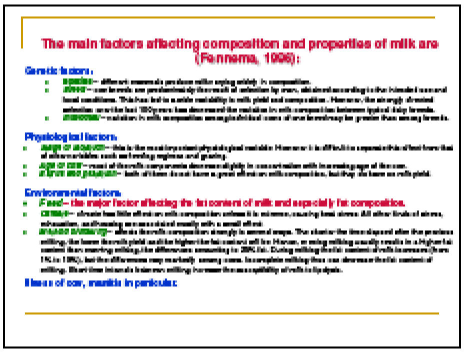

Linksom is smaak proeven
End
Rechtsom is smaak voelen

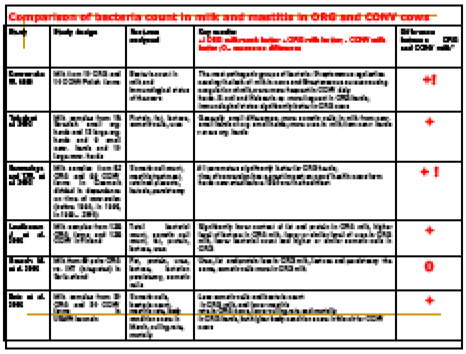
# *8 Quality of animal products*

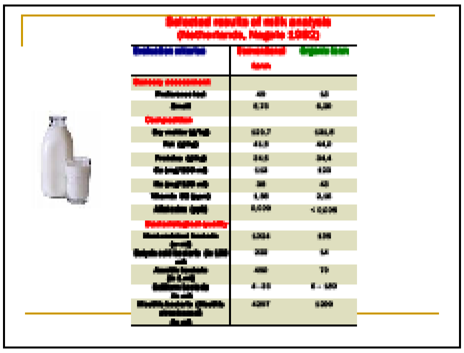
*Ewa Rembiałkowska*
*Warsaw Agricultural University, Faculty of Human Nutrition and Consumer Sciences, Organic Foodstuffs Division, Nowoursynowska 159 C, 02 – 776 Warszawa, Poland*

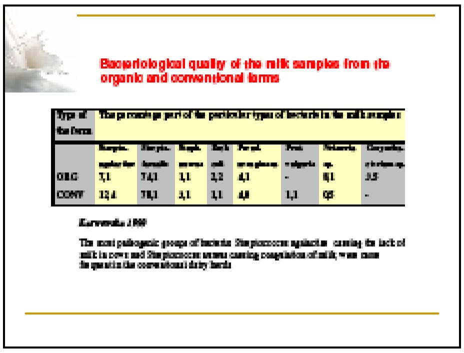
Farm animals from organic herds show less metabolic diseases like ketosis, lipidosis, arthritis, abscesses, mastitis and milk fever. The level of the somatic cells is similar in cow milk from the organic and conventional husbandry, but the level of heavy mastitis cases is significantly lower in the organic 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
prof. Ewa Rembiałkowska
MSc Katarzyna Wiśniewska
Warsaw University of Life Sciences – SGGW
Faculty of Human Nutrition and Consumer Sciences


The main factors affecting composition and properties of milk are (Fennema, 1996):
Genetic factors:
Physiological factors:
Environmental factors:
Illness of cow, mastitis in particular.


Comparison of bacteria count in milk and mastitis in ORG and CONV cows


Selected results of milk analysis
(Netherlands, Nagele 1992)


Bacteriological quality of the milk samples from the organic and conventional farms
Karwowska 1999

**Comparison of the health status of the dairy cows from the organic and conventional farms**

*Kur nowska, 1999*

## Conclusions

1. The clinic observations and analytical results indicate that the mastitis disease occurs in the studied herds of cows.
   In the winter season 34 % of the conventional cows and only 7 % organic cows were ill with heavy mastitis.
2. The cows from the conventional farms had smaller possibilities to fight against the infection development. Their leucocytes had lower phagocytosis capability, small possibility to decompose the phagocyted compounds and lower reactivity to mitogens.
3. Comparison of the clinic studies and haematological, biochemical and immune indexes showed better health status of the cows form the organic farms compared to the conventional farms.

**Pollutant content in organic (ORG) v.s. Conventional (CONV) farm-gate milk in pilot study in UK (Ellis et al. 2005)**

| | *Farm-gate* | | *Processed* | |
|---|---|---|---|---|
| Variable | Mean (SD) | | | |
| | ORG | CONV | ORG | CONV |
| Ortho PCBs (µg/kg fat) | 8,22 (18,28) | 5,06 (7,01) | 4,04 | 21,45 |
| Non-ortho PCBs (ng/kg fat) | 5,45 (3,62) | 8,06 (6,08) | 8,58 | 12,13 |
| Dioxins (ng/kg fat) | 2,90 (0,91) | 9,88 (12,57) | 2,77 | 2,38 |
| PBDEs (µg/kg fat) | 1,09 (0,21) | 0,91 (0,51) | 1,93 | 1,88 |
| TEQ (ng/kg fat) | 0,98 (0,21) | 0,91 (0,52) | 1,44 | 1,05 |

**COMPOSITION OF FARM-GATE MILK IN PILOT STUDY IN UK (Ellis et al. 2005)**

| Parameter | Average parameter value in each farming system for 3-month period | |
|---|---|---|
| | Organic n=7 | Conventional n=5 |
| | Mean (SD) | Mean (SD) |
| Somatic cells count ('000s/ml) | 330a (202) | 109b (17) |
| Total bacteria count ('000s/ml) | 39(16) | 64 (48) |
| % fat | 4.32 (0.40) | 3.88 (0.10) |
| % protein | 3.32 (0.18) | 3.28 (0.08) |
| Herd size (no. cows) | 98 (27) | 132 (73) |
| Av. yield / cow/ lactation | 5535 (998) | 6471 (741) |

[a,b] different superscripts indicate significant difference when p < 0.05

**Main factors influencing FA profile in milk:**

- Increased proportion of the fresh herbage in the diet results in increased proportion of rumenic acid in milk fat
- Nitrogen fertilization may have a positive influence on FA levels in the fresh herbage
- Plant composition of fresh herbage is significant
- Seasonal changes in FA profile of fresh herbage are typical
- Frequent cutting (grazing) – interruption of process from initiation of flowering to inflorescence emergence
- Weather is significant factor (temperature, light intensity and precipitation)
- Irrigation is a very important management tool

## CLA

Rumenic acid
*cis*-9, *trans*-11 CLA

- Isomers of linoleic acid (C18:2) with conjugated double bonds in several position and confirmations
- 75-90% *cis*-9, *trans*-11 CLA
- Supposed beneficial health effects of rumenic acid:
  - Prevention of cancer
  - Suppression of atherosclerosis
  - Anti-inflammatory properties

**Effect of pasture season on milk yield, milk composition and pools of fatty acids in milk fat (Skeiewski et al. 2005)**

| Item | Season (pasture versus indoor) | month (within season) | LSM | |
|---|---|---|---|---|
| | | | pasture season | indoor season |
| Milk (kg/day) | * | *** | 18.5 | 14.8 |
| Fat (%) | *** | *** | 3.90 | 4.32 |
| Protein (%) | * | *** | 3.32 | 3.42 |
| SFA (g/100 g fat) | ns | *** | 59.39 | 61.6 |
| MUFA | ns | *** | 15.8 | 18.6 |
| PUFA | * | ns | 2.90 | 2.50 |
| Short | ns | *** | 9.85 | 9.80 |
| Medium | ** | *** | 31.4 | 34.2 |
| Long | ns | *** | 23.2 | 27.0 |

LSM – least square means

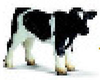
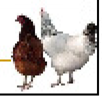
## Effect of pasture season on pools of fatty acids in milk fat (Skoniewski et al. 2005)

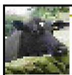
| Fatty acid | Season (pasture versus indoor) | Month (within season) | LSM g/100g fat: pasture season | LSM g/100g fat: indoor season |
|---|---|---|---|---|
| C4 | ns | ** | [illegible] | [illegible] |
| C6 | ** | ns | [illegible] | [illegible] |
| C8 | ns | ** | [illegible] | [illegible] |
| C10 | ** | ** | [illegible] | [illegible] |
| C10:1 | * | ** | [illegible] | [illegible] |
| C12 | ** | ** | [illegible] | [illegible] |
| C12:1 | * | ** | [illegible] | [illegible] |
| C14 | * | ns | [illegible] | [illegible] |
| C14:1 | ** | ** | [illegible] | [illegible] |
| C15 | ** | * | [illegible] | [illegible] |
| C16 | ** | * | [illegible] | [illegible] |
| C16:1 | ** | ** | [illegible] | [illegible] |
| C17 | * | ** | [illegible] | [illegible] |
| C18 | * | * | [illegible] | [illegible] |
| C18:1 | ** | * | [illegible] | [illegible] |
| C18:1 | ns | ** | [illegible] | [illegible] |
| C18:2 | ** | ns | [illegible] | [illegible] |
| C18:2 + CLA | *** | *** | [illegible] | [illegible] |
| C18:3 | ** | ns | [illegible] | [illegible] |
| C20:4 | ns | ** | [illegible] | [illegible] |
| C20:5 | ** | ns | [illegible] | [illegible] |
| C22:5 | ** | * | [illegible] | [illegible] |
| C22:6 | * | ns | [illegible] | [illegible] |

## Conditions of animal breeding in organic agriculture according to EEC Regulation No. 1804/1999 compared to general ordinances

| Farm animals | | EU-Ordinances on the keeping of farm animals | EEC-Regulation on Organic Livestock Farming |
|---|---|---|---|
| Dairy cows | Locomotion area*<br>Floor characteristics<br>Husbandry conditions | No ordinance | 6,0 m² indoors + 4,5 m² outdoors<br>Lying area with litter bedding<br>Keeping tethered is forbidden |
| Calves | Locomotion area *<br>Floor characteristics<br>Husbandry conditions | 1.5 m²<br>Dry litter bedding***<br>Group penning after 8th week | 1.5 m² indoors + 1.1 m² outdoors<br>Dry litter bedding<br>Generally group penning |
| Sows with piglets | Locomotion area *<br>Floor characteristics | No ordinance<br>Isolated, non-perforated floor | 7,5 m² indoors + 2,5 m² outdoors<br>Dry litter bedding |
| Fattening pigs | Locomotion area *<br>Floor characteristics<br>Husbandry conditions | 0,65 m²**<br>Slatted floors<br>Tools for occupation > 1h | 1,3 m² indoors** + 1,0 m² outdoors<br>Dry litter bedding<br>No tail-docking and tooth-clipping |
| Laying hens | Locomotion area | 450 cm² | 1600 cm² indoors + 4 m² outdoors |

* area per animal  ** up to 110 kg live-weight  *** for calves up to 2 weeks of age



## Norwegian study comparing the organic and conventional dairy herds 1994 – 1997

*Hardeng and Edge 2001*

| | Organic cow herds | Conventional cow herds |
|---|---|---|
| Number of studied herds | 31 | 93 |
| Feeding regime | 40 % concentrates and silage; hay, pasture and root crops were important | 70% concentrates and silage |
| Management regime | At least 30 min daily exercise outdoors during winter | Exercise outdoors - very rare practice |
| Mean lactation age | 2.87 | 2.5 |
| Spring calving | Larger proportion | Lower proportion |
| Milk yield (kg / cow / year) | 4754 | 6123 |
| Breed composition | More complex, more indigenous breeds | Less complex |
| Ketosis | Significantly less frequent | Significantly more frequent |
| Mastitis | Significantly less frequent | Significantly more frequent |
| Milk somatic cells | No significant difference | |
| Milk fever | Significantly less frequent | Significantly more frequent |

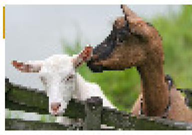
## Comparison of carcass quality from the organically and conventionally reared animals

HANSSON I et al 2000

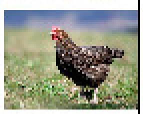
### Conclusions

1. There was a significant difference at the postmortem inspection of growing-fattening pigs: 28% of the conventional and 17% of the organic pigs had one or more registered lesions
2. In cattle, 25 % of the organic and 27% of the conventional animals had registered abnormalities
3. Parasitic affections were more prevalent in organic herds
4. Eosinophylic myositis was more frequent in organically reared cattle
5. Cows and heifers from organic herds showed significantly lower incidences of abscesses, arthritis, mastitis, and liver diseases such as lipidosis
6. Pathological finding in sheep were low both for conventional (10%) and organic (9%) animals.

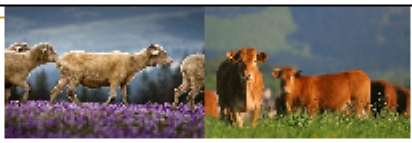
The study involved 3494 organically reared pigs, 4949 cattle and 4997 sheep, and 3.3 million conventionally reared pigs, 578 000 cattle and 188 000 sheep.


Organic principles strive to enhance the naturalness of the lives of the stock, and the harmony between individuals in the flock or herd and the physical, climatic and human environments in which they are kept.



Source: www.sac.ac.uk



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.sac.ac.uk*

## ORGANIC FARMING IN EU LEGISLATION

The basic law on organic farming and processing, applying in the UE is **Council Regulation (EEC) No 2092/91 of 24 June 1991** ***on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs*** (**in force till 31 XII 2008**).

## ORGANIC FARMING IN EU LEGISLATION

- In August 1999 **rules on production, labelling and inspection of the most relevant animal species** (cattle, sheep, goats, horses and poultry) were also agreed – **Council Regulation (EC) No 1804/1999 of 19 July 1999.**

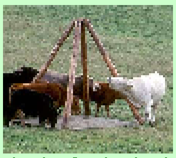
  => This agreement covers such issues as animal breeding, housing conditions, animal nutrition, disease prevention and veterinary treatment, animal welfare, husbandry practices and the management of manure as well as labeling of products.

## ORGANIC FARMING IN EU LEGISLATION

- Since 1 January 2009 **Council Regulation (EC) No 834/2007** of 28 June 2007 **on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91** will be in force.
- More detailed rules are included in the **IFOAM Basic Standards and Accreditation Criteria**

## Organic livestock production standards

Use of antibiotics, growth-promoters, GMO-s is prohibited
=> except for situation when saving animal life 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 where the animals were kept or from other organic holdings in the same region.

## Organic livestock production standards

- The livestock shall have permanent access 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.

## Organic livestock production standards

- Rearing and maintenance conditions in organic farms must answer species behavioural needs (roosts for poultry; access to water basins for waterbirds etc.)
- Optimal stocking level is **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, poaching 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.

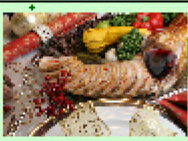
## Changes according to new Council Regulation (EC) No 834/2007 of 28 June 2007

- **Organic livestock shall be born and raised on organic holdings.** Non-organically raised 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 case of herbivorous animals not more than 5% of feed may come from middle intensive conventional farms and up to 15% in case of other species (in force only till 31 XII 2008)*



- According to the results of the studies surveyed among organic food consumers, they are of the opinion that this food is "safer" and that practices applied in the organic farms are more beneficial to environment and well-being of animals.

*Source: Sylvander 1999*

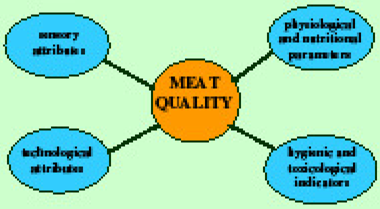
- Last food scares caused by BSE or hoof-and-mouth disease resulted in the loss of consumer trust in many EU countries and increase of the demand on meat from husbandry that is consistent with organic farming standards. That is especially justifiable in case of BSE, because in organic livestock production use of animal meals as additive to feed is prohibited.



The consumer's decision to purchase a specific food, especially in developed countries is greatly influenced by perception of the food 'healthiness', which in the case of meat is largely related to its **fat content** and its **fatty acid composition**, namely the **polyunsaturated fatty acids** (PUFA), **monounsaturated fatty acids** (MUFA) and **saturated fatty acids** (SFA) contents.

*Source: Dias et al. 2008*

## MEAT QUALITY ASPECTS




*Source: Jurczak 2005*

**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, burn and chilling of carcasses.

➢ **Organic meat quality parameters differ depending on animal species.**

*Source: Troy 1995; Karry et al. 2000*

## Quality attributes of organic bovine meat and mutton

- Organic meat has different sensory quality that is preferred by most surveyed consumers
- higher marbling
- lower total fat content
- higher intramuscular fat content
- darker colour of organic mutton
- different FA quota:
  - ➢ **higher content of PUFA, especially linoleic acid**
  - ➢ **reduced ratio of n-6:n-3 PUFA**
  - ➢ **lower content of SFA.**

*Enser et al. 1998; Woodward & Fernandez 1999; Pastushenko et al.; Fisher et al. 2000*

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

| | Soya ORG | Suffolk ORG | Suffolk CON | |
|---|---|---|---|---|
| Carcass weight [kg] | 10,9 | 18,3 | 20,0 | - |
| Intramuscular fat [%] | 5,4 | 9,2 | 8,6 | + |
| Subcutaneous fat [%] | 1,4 | 3,3 | 5,3 | + |
| Fat-free body weight [%] | 66,3 | 59,7 | 58,0 | + |

*Fisher et al. 2000*

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

Organic mutton of Suffolk breed showed **higher intramuscular fat content** and **higher share of fat-free body weight** when 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.

*Fisher et al. 2000*

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

- When comparing n-6:n-3 ratio in meat samples it was found that the ratio is the most favourable in meat obtained from Soya sheep that was pastured. This specific British breed (Ovis aries L.) is told to be the oldest from currently occurred, the closest to sheep from Neolithic period (Ryder, 1984). Meat of this breed had the most beneficial ratio of polyunsaturated acids to saturated fatty acids (P/S).

*Fisher et al. 2000*

## 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 and organically-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*

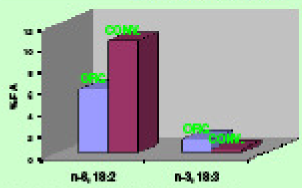
## Fatty acid composition and eating quality in organic vs. conventional lamb

=> the increased flavour (preferred by UK consumers) can be attributed to differences in fatty acid composition, in particular a higher level of linolenic acid (18:3) and total n-3 PUFA in organic chops (derived from grass feeding).

- Conventional chops had a higher percent of linoleic acid (18:2) – indicating more concentrate feeding.
- Both types of chop had favourable n-6:n-3 ratio.
- There was a modest price differential between the two production systems of no more than £1.88 per kg.

*Angood et al. 2007*

## Essential fatty acid content in organic and conventional beef




n-6, 18:2- linoleic acid (basic form of n-3 PUFA)

n-3, 18:3- α-linolenic acid (basic form of n-6 PUFA)

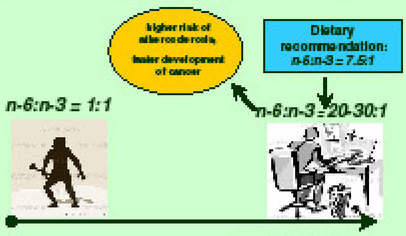
*Pastushenko et al. 2000; Enser et al. 1998*

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

| | The ratio of n-6:n-3 EFA |
|---|---|
| Organic beef | 4.6 : 1 |
| Conventional beef | 29.2 : 1 |

*Pastushenko et al. 2000; Enser et al. 1998*

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




*Bantsch-Hempen 1995*

## 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 currant livestock production. In the diet of persons 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 20-30: 1.
- It is due to the fact that industrial production of animal feed abounding in grains rich in n-6 fatty acids, leads to predominance of n-6 fatty acids in meat and not enough amount of n-3 polyunsaturated fatty acids.

*Bartsch-Hampen 1995*

## Comparison of organic and conventionally reared steers

- According to study by Walshe et al. (2005) **organic samples (O)** were significantly **higher in fat content** and therefore significantly **lower in moisture content** than **conventional samples (C)**.
- No significant differences were observed between C and O samples for protein, ash, β-carotene, alpha-tocopherol, retinol, as well as fatty acid content.
- C samples outperformed O samples with respect to **shelf life stability**

=> C samples proved to have grater colour and lipid stability while stored under retail conditions => due to the greater fat content of O samples => increased oxidation of O samples even though O samples contained greater levels of α-tocopherol.

*Walshe et al. 2005*

## Quality attributes of organic pork

- Meat quality is strongly influenced by feed composition, in case of pork that is percent share of organic concentrates and silage.

Carcasses from organic husbandry (animals were fed on concentrates in 70% and silage in 30%) had in comparison to conventional carcasses:

➢ lower total weight, but higher fat-free weight

➢ lower percent of intramuscular fat

➢ similar weight of loin and ham (significant from the technological point of view)

*Hansen et al. 2006*

## Quality attributes of organic pork

In case of feed consisted only from organic concentrates, weight gains and fat-free body weight were similar as in conventional group (Hansen et al., 2006).

- According to Sundrum et al. (2000) and Millet et al. (2003), meat of fattening pigs from organic husbandry had considerably higher intramuscular fat content in comparison to meat from conventional husbandry (2.9% vs. 1.2%) – opposite results to those obtained by Hansen et al. (2006).

=> **Higher intramuscular fat content results in higher technological value and better taste.**

Sows of Pulawska breed

*Sundrum et al. 2000, Millet et al. 2003, Hansen et al. 2006*

## Quality attributes of organic pork

- Conventional pork is in general more tender than organic pork. There is the hypothesis that it is caused by lower daily weight gain in pigs from organic husbandry and as a consequence drop in proteolytic potential in muscles during slaughter.
- Organic pork (animals were fed on concentrates in 70% and silage in 30%) had higher hardness and lower tenderness and its chewing last longer when compared to meat from animals fed on fodder concentrates.

⇒ Organic pork, alike other kinds of meat from organic husbandry, has higher PUFA levels than conventional meat, but on the other hand reduced SFA levels.

*Danielsen 2000; Sundrum et al. 2000; Millet et al. 2003; Hansen et al. 2006*

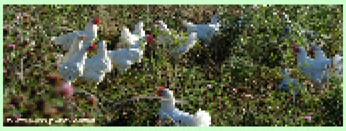
## Quality attributes of organic pork

- **Vitamin E** content is higher in organic pork (from free-range rearing with access to pasture) than in conventional meat. However high level of this antioxidant is not enough to compensate higher susceptibility of this meat for lipid oxidation (higher TBARS value) in organic pork that results in **inferior shelf life stability.**
- Carcasses from organic husbandry have **higher percent of fat-free body weight** and their value is evaluated higher due to heavier elements such as: **sirloin** and **ham** in comparison to carcasses from conventional husbandry.

*Hansen et al. 2000; Nilzen et al. 2001, Sundrum et al. 2000; Bee et al. 2004, Sather et al. 1997*

## Quality attributes of organic poultry and rabbit meat

- Higher colour intensity in rabbit meat from organic husbandry
- Higher iron content in organic poultry
- Lower fat content in poultry and rabbit meat from organic husbandry
- Higher juiciness of organic poultry (found in the sensory panel)
- Organic poultry was more accepted by the respondents of the sensory panel.



*Castellini et al. 2001; Combes et al. 2003*

## Quality attributes of organic poultry meat

- Elevated TBARS levels in organic poultry in comparison to conventional poultry => indicating intensive oxidation
- Different FA quota of organic meat: higher content of SFA and PUFA and lower MUFA
- Lower weight gains and lower final weight of rabbits and chickens in organic husbandry
  => as the effect of higher activity of organic chickens proved in behavioural observations and higher energy expenses connected with thermoregulation
- Lower stomach fat and better development of breast and thigh muscles in carcasses from organic husbandry (features that significantly increase commercial productivity).

*Castellini et al. 2001; Combes et al. 2003*

## Conclusions:
### positive attributes of meat from organic livestock production

- lower content of total fat in carcasses
- higher intramuscular fat content => higher marbling
- different quota of fatty acids:
  - lower level of SFA
  - n-6/n-3 EFA ratio could be up to nine-times lower than in conventional meat
- higher weight of breast and thigh muscles in poultry carcasses, and sirloin and ham in pork carcasses
- in most cases better sensory quality (+/-).

## Conclusions:
### 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
- lower tenderness in case of organic pork

## Thank you for your attention!

# 9 Relationship between grassland management and bovine milk quality

*Håvard Steinshamn[1], Steffen Adler[1], Søren Krogh-Jensen[2], Stig Purup[2] and Jens Hansen-Møller[2]*

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**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.*

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

**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 equol 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.*

| | **Farming and grassland system** | | | | **SED** | **Significance, P-value** | | |
|---|---|---|---|---|---|---|---|---|
| | **OS** | **OL** | **CS** | **CL** | | **F** | **G** | **F × G** |
| Number of farms | 9 | 7 | 9 | 7 | | | | |
| *Milk yield, kg/day | 19.8 | 16.3 | 21.3 | 19.9 | 1.65 | 0.03 | 0.11 | 0.33 |
| Milk fat, g/kg | 41.3 | 38.9 | 41.4 | 40.8 | 0.82 | 0.07 | 0.05 | 0.09 |
| Milk protein, g/kg | 34.6 | 32.8 | 34.4 | 33.4 | 0.47 | 0.47 | 0.005 | 0.17 |
| Fatty acids, g/100 g FAME | | | | | | | | |
| C12:0 | 3.82 | 3.24 | 3.21 | 3.03 | 0.156 | 0.004 | 0.016 | 0.051 |
| C14:0 | 12.5 | 11.8 | 11.1 | 10.8 | 0.32 | < 0.001 | 0.116 | 0.335 |
| C16:0 | 30.7 | 30.9 | 27.6 | 27.7 | 0.84 | < 0.001 | 0.879 | 0.946 |
| C18:0 | 10.1 | 10.5 | 13.0 | 13.4 | 0.48 | < 0.001 | 0.234 | 0.961 |
| C18:1c9 | 21.6 | 22.8 | 25.5 | 25.5 | 0.88 | < 0.001 | 0.417 | 0.358 |
| C18:1t11 | 1.07 | 1.06 | 1.01 | 0.89 | 0.101 | 0.209 | 0.364 | 0.442 |
| C18:2c9,t11 | 0.69 | 0.83 | 0.72 | 0.64 | 0.085 | 0.196 | 0.579 | 0.074 |
| C18:2c9,c12 n-6 | 1.85 | 1.73 | 2.04 | 1.87 | 0.100 | 0.030 | 0.065 | 0.727 |
| C18:3c9,c12,c15 n-3 | 0.73 | 0.77 | 0.57 | 0.62 | 0.045 | < 0.001 | 0.146 | 0.838 |
| C20:5 n-3 | 0.096 | 0.087 | 0.065 | 0.075 | 0.005 | < 0.001 | 0.922 | 0.009 |
| C22:5 n-3 | 0.105 | 0.100 | 0.076 | 0.088 | 0.005 | < 0.001 | 0.520 | 0.010 |
| C22:6 n-3 | 0.098 | 0.063 | 0.011 | 0.013 | 0.009 | < 0.001 | 0.018 | 0.489 |
| Saturated FA | 69.8 | 68.5 | 66.5 | 66.9 | 1.03 | 0.003 | 0.549 | 0.267 |
| Monounsaturated FA | 26.3 | 27.4 | 29.6 | 29.4 | 0.94 | 0.001 | 0.503 | 0.306 |
| Polyunsaturated FA | 3.96 | 4.07 | 3.94 | 3.77 | 0.169 | 0.204 | 0.839 | 0.261 |
| n-6/n-3 FA | 1.98 | 1.85 | 3.18 | 2.65 | 0.220 | < 0.001 | 0.044 | 0.206 |
| Vitamins and carotenoids, μg/mL | | | | | | | | |
| α-tocopherol | 0.60 | 0.71 | 0.69 | 0.70 | 0.049 | 0.186 | 0.167 | 0.118 |
| β-carotene | 0.18 | 0.19 | 0.21 | 0.21 | 0.013 | 0.004 | 0.802 | 0.281 |
| Retinol | 0.53 | 0.51 | 0.49 | 0.49 | 0.029 | 0.195 | 0.617 | 0.736 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Phytoestrogens, µg/L | | | | | | | | |
| Equol | 286.9 | 86.0 | 56.0 | 50.2 | 42.3 | < 0.001 | 0.002 | 0.003 |
| Enterolactone | 130.2 | 96.4 | 83.4 | 80.4 | 18.6 | 0.015 | 0.319 | 0.173 |
| Micro-mineral, µg/100mL | | | | | | | | |
| Selenium | 2.18 | 1.87 | 1.83 | 1.66 | 0.145 | 0.01 | 0.05 | 0.49 |

F = Farming system, G =Grassland management

**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.

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## Relationship between grassland management and bovine milk quality

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## Introduction

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

  than conventional produced milk (Bergamo et al., 2003; Butler et al., 2008; Collomb et al., 2008; Ellis et al., 2006; Hoikkala et al. 2008; Jahreis 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 (Leiber et al., 2005; Lourenco et al., 2005)

## Introduction (cont.)

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

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

| Source | Grass | WC | RC | Grass vs. clover | WC vs. RC |
|---|---|---|---|---|---|
| *Milk* | | | | | |
| Dewhurst et al. 2003 | 0.40 | 0.96 | 1.28 | *** | *** |
| Al Mabruk et al. 2004 | 0.47 | - | 0.96 | *** | - |
| Vanhatalo et al. 2007 | 0.39 | - | 1.11 | *** | - |
| Van Dorland et al. 2008 | 0.90 | 1.14 | 1.04 | (*) | ns |
| Steinshamn and Thuen 2008 | - | 0.73 | 0.87 | - | *** |
| | | | | | |
| *Meat (lamb)* | | | | | |
| Fraser et al. 2004 | 2.07 | - | 2.86 | ** | - |

## Introduction (cont.)

- 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)

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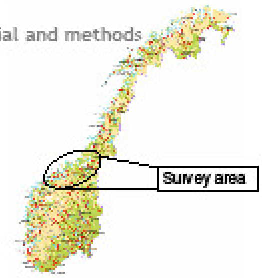
## Introduction (cont.)

- 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




## Material and methods (cont.)

- Farming system
  - O = Organic (16)
  - C = Conventional (16)
- Grassland management
  - S = Short-term grassland (18)
  - L = Long-term grassland (14)
- Organic farms were paired with conventional farms with similar grassland management and calving pattern

## Material and methods (cont.)

- Bulk-tank milk samples collected every second month (Feb - Dec in 2007 and 2008) from each farm (14 days periods)
- Other data collected:
  - Interviews
  - Norwegian Dairy Herd Recording System (TINE)

## Material and methods (cont.)

| Data from 2007 | Farming and grassland system | | | |
|---|---|---|---|---|
| | OS | OL | CS | CL |
| Farms | 9 | 7 | 9 | 7 |
| Total area per farm, ha | 41.2 | 32.4 | 35.2 | 22.3 |
| Annual crops, proportion of total area | 0.14 | 0.01 | 0.19 | 0.00 |
| Average age of leys, years | 2.9 | 11.4 | 2.6 | 9.9 |
| Lactating dairy cows per farm | 19.7 | 12.5 | 19.0 | 14.5 |
| Average number of lactation per cow | 2.2 | 2.1 | 2.2 | 2.3 |
| Concentrate, FEm/day (= kg/day) | 5.5 | 4.4 | 6.6 | 7.2 |

OS = Organic short-term grassland; OL = Organic long-term grassland
CS = Conventional short-term grassland; CL = Conventional long-term grassland

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## Material and Methods

- Chemical analysis
  - Standard (fat, protein, lactose, urea, FFA)
  - Fatty acid methyl esters
  - α-tocopherol (vitamin E)
  - β-carotene (vitamin A precursor)
  - Retinol (vitamin A)
  - Phytoestrogens
  - Selenium

## Material and Methods

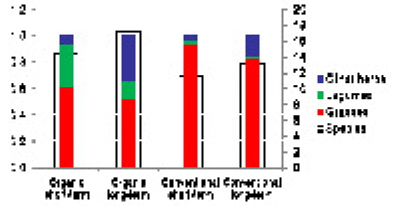
- Statistical model

  $y_{ijk} = \mu + F_i + G_j + Month_k + e_{ijkl}$

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

## Results from 2007

## Grassland botanical composition, cut swards



## Organic short-term grassland

Photo: Steffen Adler

## Organic long-term grassland

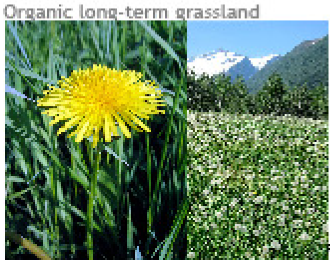


Photo: Steffen Adler

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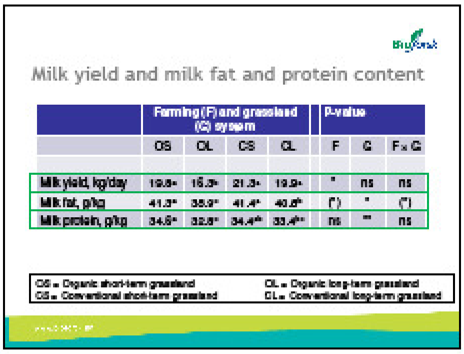
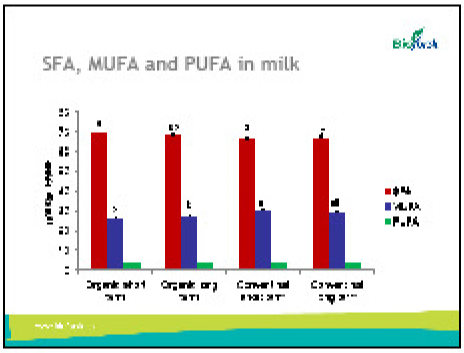
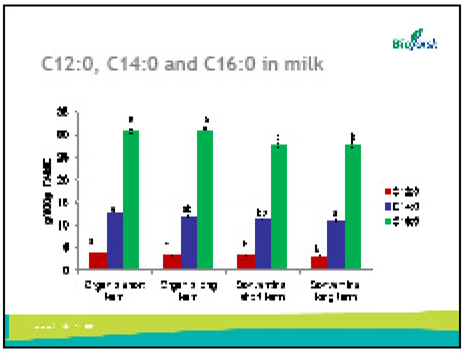


Milk yield and milk fat and protein content

| | Farming (F) and grassland (G) system | | | | P-value | | |
|---|---|---|---|---|---|---|---|
| | OS | OL | CS | CL | F | G | F x G |
| Milk yield, kg/day | 19.8a | 16.3b | 21.3a | 19.9a | * | ns | ns |
| Milk fat, g/kg | 41.3a | 38.9b | 41.4a | 40.8a | (*) | * | (*) |
| Milk protein, g/kg | 34.6a | 32.8b | 34.4ab | 33.4b | ns | ** | ns |

OS = Organic short-term grassland
OL = Organic long-term grassland
CS = Conventional short-term grassland
CL = Conventional long-term grassland

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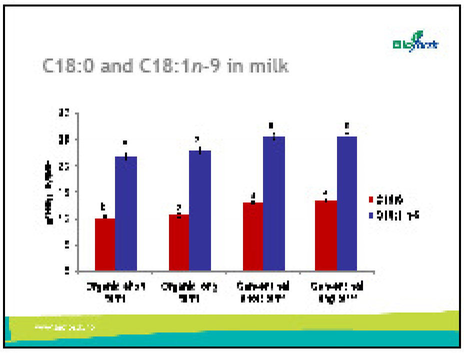
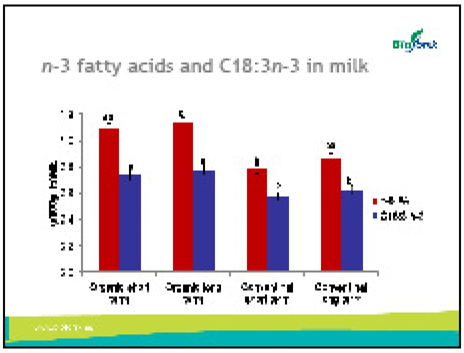
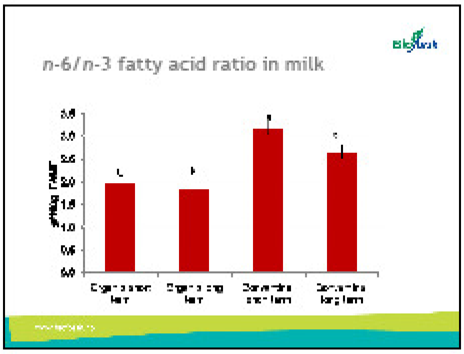
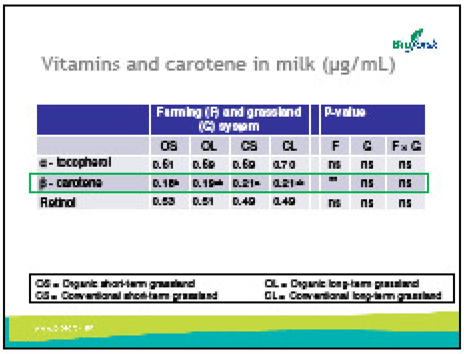


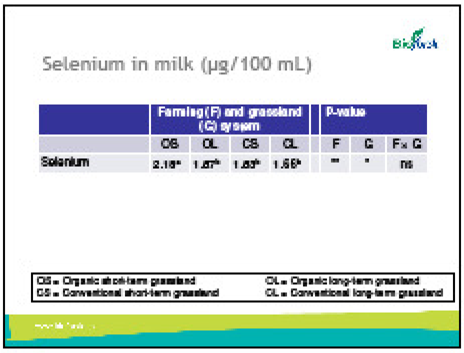





Vitamins and carotene in milk (µg/mL)

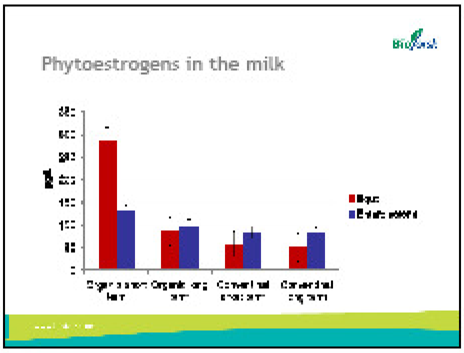
| | Farming (F) and grassland (C) system | | | | P-value | | |
|---|---|---|---|---|---|---|---|
| | OS | OL | CS | CL | F | G | F x G |
| α - tocopherol | 0.61 | 0.69 | 0.69 | 0.70 | ns | ns | ns |
| β - carotene | 0.18* | 0.19** | 0.21* | 0.21** | ** | ns | ns |
| Retinol | 0.53 | 0.51 | 0.49 | 0.49 | ns | ns | ns |

OS = Organic short-term grassland; OL = Organic long-term grassland
CS = Conventional short-term grassland; CL = Conventional long-term grassland


Selenium in milk (µg/100 mL)

| | Farming (F) and grassland (C) system | | | | P-value | | |
|---|---|---|---|---|---|---|---|
| | OS | OL | CS | CL | F | G | F x G |
| Selenium | 2.16a | 1.67b | 1.63b | 1.66b | ** | * | ns |

OS = Organic short-term grassland; OL = Organic long-term grassland
CS = Conventional short-term grassland; CL = Conventional long-term grassland

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## In summary

- Farms with long-term grassland had more plant species and higher proportion of non-clover herbs 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 poportion of *n*-3 FA and in particular C18:3*n*-3 (α-linolenic)

## In summary (cont.)

- Milk β-carotene content was higher on conventional than on organic farms
- Milk phytoestrogen 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 equol (phytoestrogen) content was likely due to differences in grassland red clover content
- 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 was likely due to differences in concentrate content of fish meal

## Financial support

- Møre and Romsdal County
- TINE Midt
- TINE R&D

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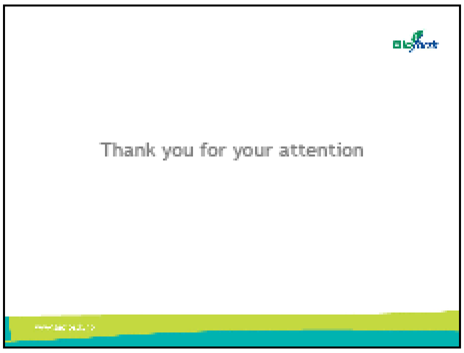


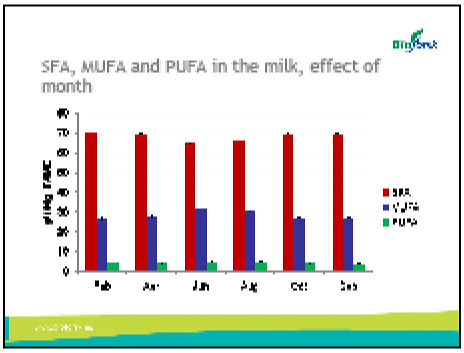


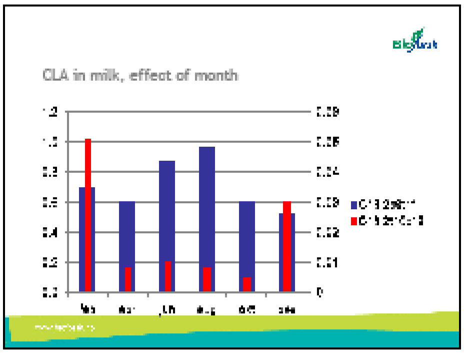


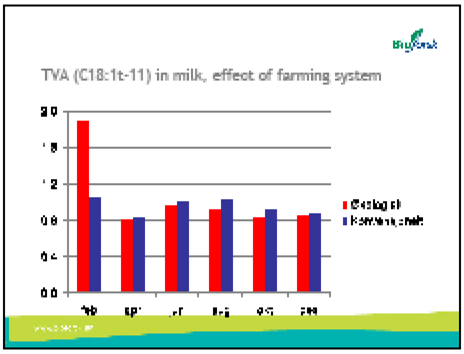


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# 10 Implications of a calmative handling procedure for cattle preliminary to transport and slaughter and the implications on animals behaviour, blood parameters and meat quality

*Johanna Probst*

*FiBL, Switzerland*

*E-mail: johanna.probst@fibl.org*

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.

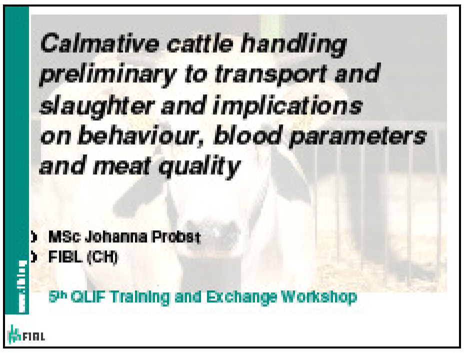
Blood samples from 'vena caudalis' were taken from all animals before the first handling session began and one day before slaughtering. During exsanguinations a blood sample from each animal was taken. All blood samples where analysed for cortisol-, lactate- and glucose concentrations. Cortisol concentration 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.

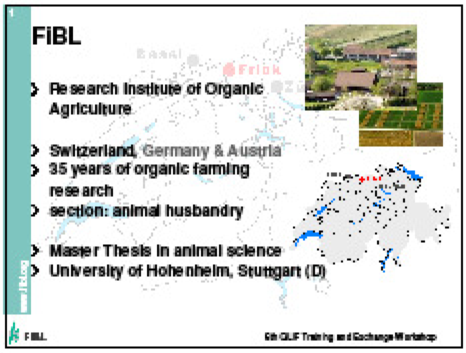
Meat quality was evaluated by measuring cooking loss, shear force, color and pH-value after 25 days maturation in m. longissimus dorsi. Control animals showed higher cooking losses than animals of the handling group.

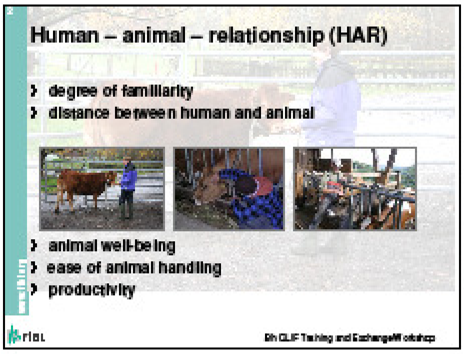
The results of this study imply that a calmative handling in the forefront of slaughtering can decrease stress reactions of beef cattle. Additionally the importance of a positive human-animal-relationship becomes considerable.

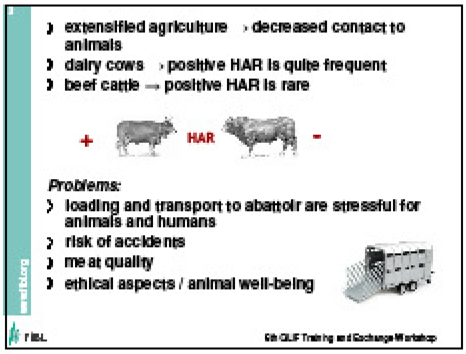
*Presentation*

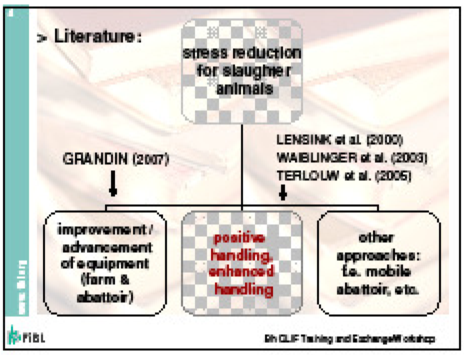
FiBL 02.02.2009

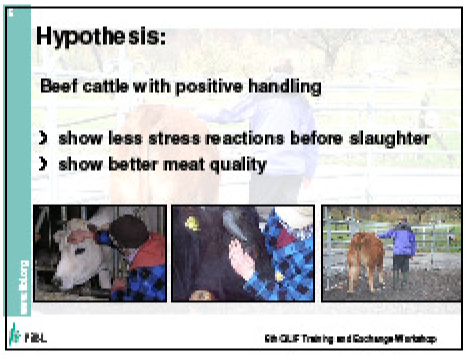
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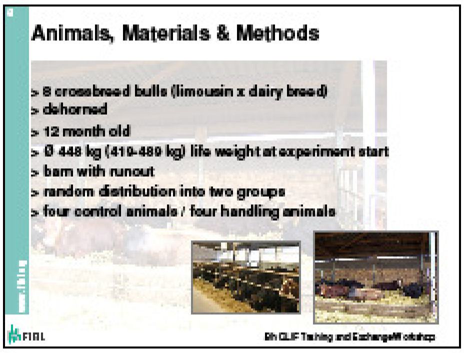
Animals, Materials & Methods
> 8 crossbreed bulls (limousin x dairy breed)
> dehorned
> 12 month old
> Ø 448 kg (419-489 kg) life weight at experiment start
> barn with runout
> random distribution into two groups
> four control animals / four handling animals
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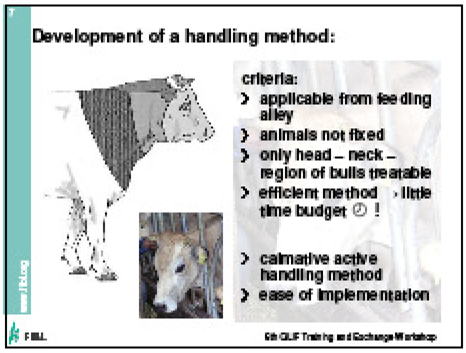
Development of a handling method:
criteria:
applicable from feeding alley
animals not fixed
only head – neck – region of bulls treatable
efficient method little time budget !
calmative active handling method
ease of implementation
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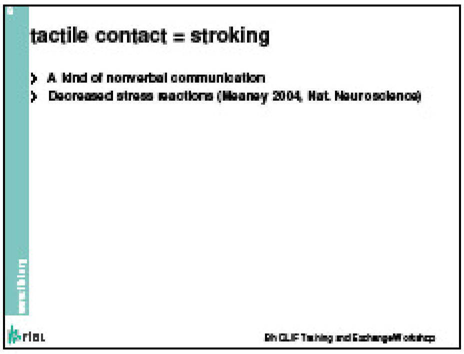
tactile contact = stroking
A kind of nonverbal communication
Decreased stress reactions (Meaney 2004, Nat. Neuroscience)
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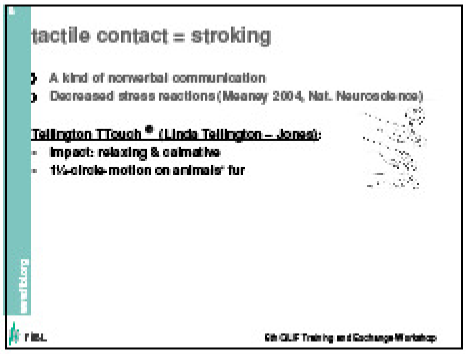
tactile contact = stroking
A kind of nonverbal communication
Decreased stress reactions (Meaney 2004, Nat. Neuroscience)
Tellington TTouch ® (Linda Tellington – Jones):
- Impact: relaxing & calmative
- 1¼-circle-motion on animals' fur
FiBL
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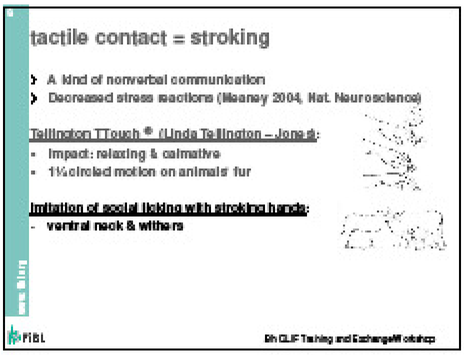
tactile contact = stroking
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Tellington TTouch ® (Linda Tellington – Jones):
- Impact: relaxing & calmative
- 1¼ circled motion on animals' fur
Imitation of social licking with stroking hands:
- ventral neck & withers
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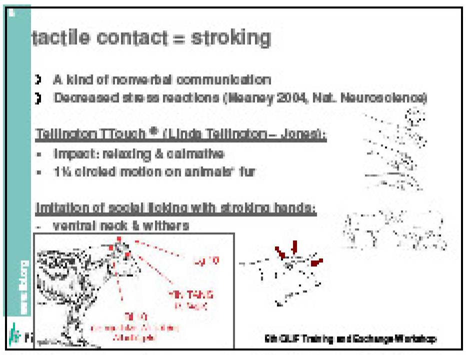
tactile contact = stroking
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Imitation of social licking with stroking hands:
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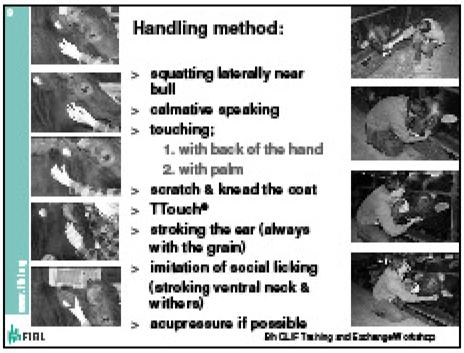
Handling method:
squatting laterally near bull
calmative speaking
touching:
1. with back of the hand
2. with palm
scratch & knead the coat
TTouch®
stroking the ear (always with the grain)
imitation of social licking (stroking ventral neck & withers)
acupressure if possible
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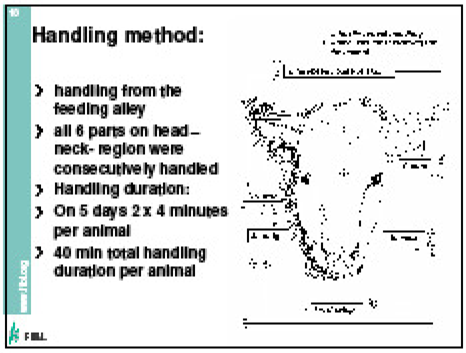
Handling method:
handling from the feeding alley
all 6 parts on head – neck- region were consecutively handled
Handling duration:
On 5 days 2 x 4 minutes per animal
40 min total handling duration per animal
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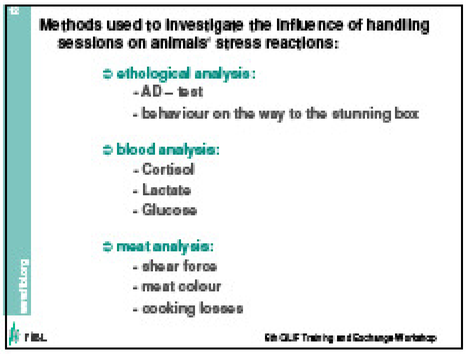
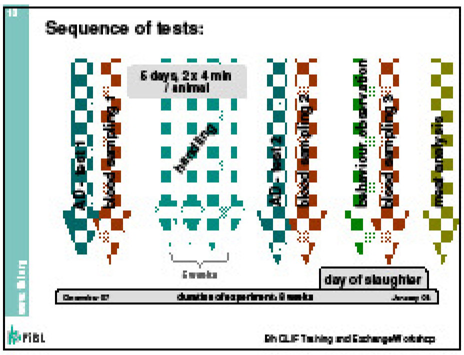

Methods used to investigate the influence of handling sessions on animals' stress reactions:
ethological analysis:
- AD – test
- behaviour on the way to the stunning box
blood analysis:
- Cortisol
- Lactate
- Glucose
meat analysis:
- shear force
- meat colour
- cooking losses
FiBL


Sequence of tests:
5 days, 2x 4 min / animal
handling
day of slaughter
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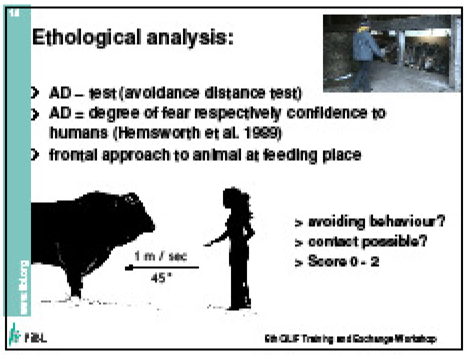
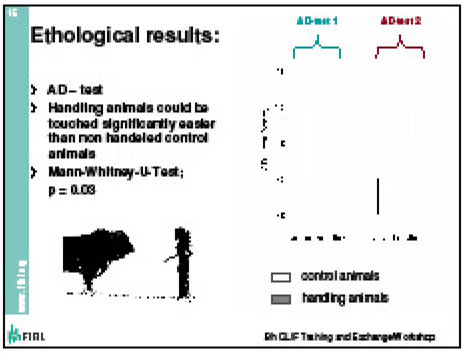

Ethological analysis:
AD – test (avoidance distance test)
AD = degree of fear respectively confidence to humans (Hemsworth et al. 1989)
frontal approach to animal at feeding place
1 m / sec
45°
> avoiding behaviour?
> contact possible?
> Score 0 - 2
FiBL


Ethological results:
AD-test 1
AD-test 2
AD – test
Handling animals could be touched significantly easier than non handeled control animals
Mann-Whitney-U-Test; p = 0.03
control animals
handling animals
FiBL
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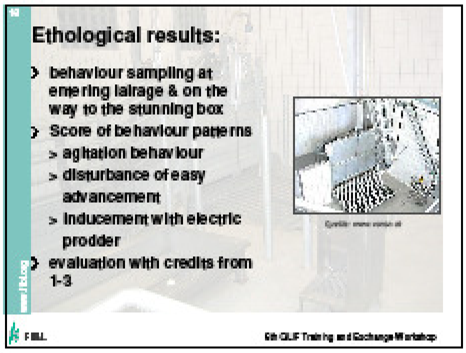
Ethological results:
behaviour sampling at entering lairage & on the way to the stunning box
Score of behaviour patterns
agitation behaviour
disturbance of easy advancement
inducement with electric prodder
evaluation with credits from 1-3
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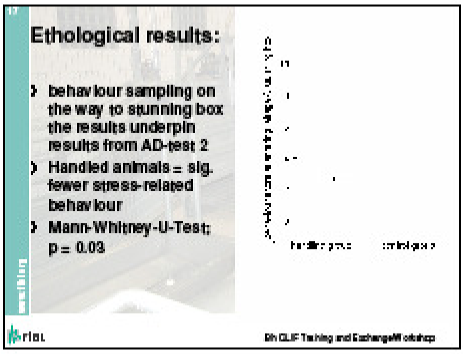
Ethological results:
behaviour sampling on the way to stunning box the results underpin results from AD-test 2
Handled animals = sig. fewer stress-related behaviour
Mann-Whitney-U-Test; p = 0.03
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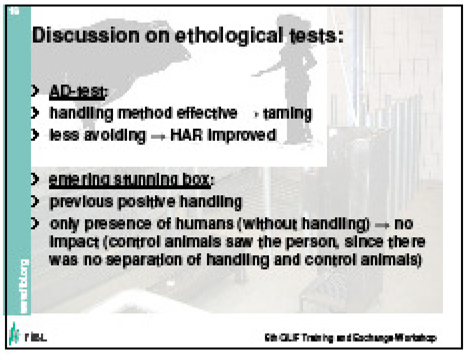
Discussion on ethological tests:
AD-test:
handling method effective → taming
less avoiding → HAR improved
entering stunning box:
previous positive handling
only presence of humans (without handling) → no impact (control animals saw the person, since there was no separation of handling and control animals)
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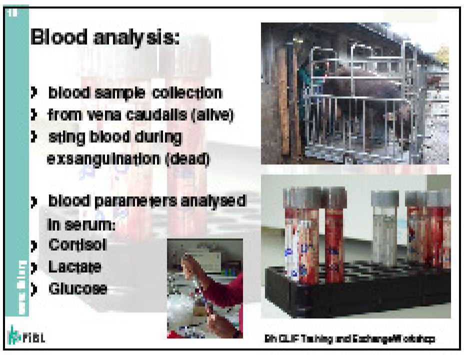
Blood analysis:
blood sample collection
from vena caudalis (alive)
sting blood during exsanguination (dead)
blood parameters analysed in serum:
Cortisol
Lactate
Glucose
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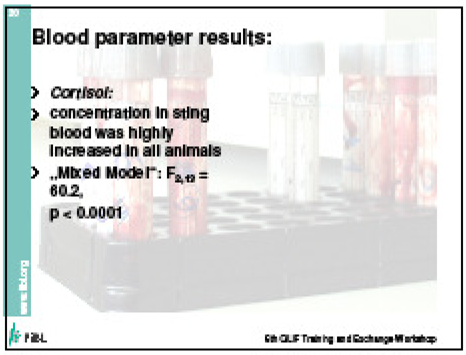
Blood parameter results:
Cortisol:
concentration in sting blood was highly increased in all animals
„Mixed Model": F2,19 = 60.2, p < 0.0001
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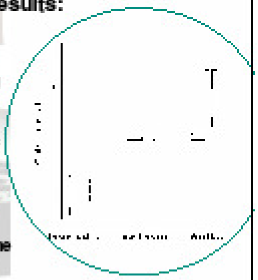
## Blood parameter results:

- *Cortisol:*
- concentration in sting blood increased in all animals
- „Mixed model": $F_{2,12}$ = 60.2, $p < 0.0001$
- *Glucose:*
- handling x point in time $F_{2,11}$ = 6.4, p = 0.014



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## Blood parameter results:

- *Lactate:*
- handling x point in time $F_{2,11}$ = 7.5, p = 0.0087
- sting blood: control animals show significantly higher concentrations than handled animals

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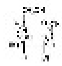
## Discussion on blood parameter results:



- *Glucose* › control animals ↑
- Catecholamines & glucocorticoides ↑ = blood glucose level ↑
- Glucocorticoides affect carbohydrate metabolism › glycogen mobilisation from liver & muscles
- Does increased glucose concentration result from deficient feeding?
- No, because all animals were fed before loading!
- reason = relative energy deficit as a result of increased need in control animals

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## Discussion on blood parameter reults:

- *Lactate* › control animals ↑
- fear › Catecholamine → rapid glycogenolysis › Lactate production ↑
- Lactate production ↑ = indication of acute stress situation
- increased anaerobic metabolic status in the musculature (before slaughter = increased physical effort)
- acute stress → transport (Kreutzer et al. 1998)
  → application of electric prodder (Warner et al. 2007)

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## Meat quality analysis:

- M. longissimus dorsi
- 25 days maturation (vakuum-packed) at 4 °C

- colour measurements (lab-method)
- shear force (warner bratzler method)
- Cooking losses (after 1 h cooking at 72 °C)

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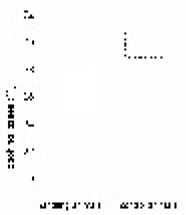
## Meat quality results:

- differences between groups, only for cooking losses
- Control animals: cooking losses ↑
- Mann-Whitney-U-Test: p=0.057



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## Discussion Meat quality results:

- *cooking losses:*
- The reason for increased cooking losses in control animals' meat is probably additional stress (Kadim et al. 2006)
- more exposure → glycogenolysis ↑ → increased laktate release
- exceeding lactate production = decreased water holding capacity
- adhesive force of water which is bounded between muscle cells is diversified by lactate

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## Conclusion:

- additional human contact decreased stress indicating reactions in beef cattle on day of slaughter
- additional human contact enhanced 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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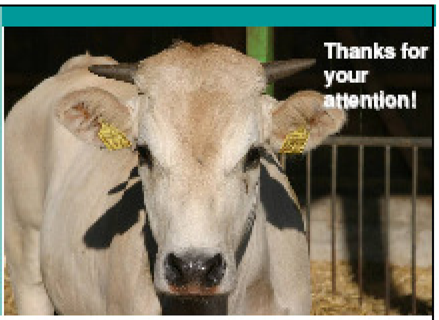


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# 11 Organic Milk Quality in the Netherlands: Distinguishable from conventional milk?

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**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, Cupper 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).*

| | **Whole year average (n=48)** | **Winter (n=14)** |
|---|---|---|
| SFA's | -2% (702 mg) | 0% (726 mg) |
| PUFA's | 15% (27,5 mg) | 6% (24,8 mg) |
| CLA | 38% (5.3 mg) | 15% (3.9 mg) |
| Omega-3 | 60% (5.8 mg) | 66% (5 mg) |
| Trans fatty acids (excl. CLA) | 20% (2,2 mg) | 3% (1.9 mg) |

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

| | **Conventional (n=20)** | **Organic (n=20)** |
|---|---|---|
| Vitamin A (total retinol) (µg/100 gr milk) | 39 | 39 |
| Vitamin E (α-tocopherol) (mg/100 gr milk). | 0,097 | 0,098 |
| B-carotene (µg/100 gr milk) | 16,5 | 16,8 |
| Luteïn (µg/100 gr milk) | 0,855 | 0,97 |
| Zeaxanthin (µg/100 gr milk) | 0,181 | 0,213 |
| B-cryptoxanthin (µg/100 gr milk) | 0,312 | 0,324 |
| Ca (mg/100 gr milk) | 120 | 123 |
| Cu (µg/100 gr) | 5 | 4,2 |
| Se (µg/100 gr) | 1,6 | 1,3 |

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

| | **Conventional (n=18)** | **Organic (n=18)** |
|---|---|---|
| Bio-crystallisation (average evaluation, scale 1-10) | 6.0 | 6.9 |
| Bio photons (*1000 counts, 100-200 sec.) | 29,9 | 31,5 |

**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.

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## Distinguishable quality of organic cow milk and strategies to improve it

J. de Wit

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## Distinguishable quality: why?

- Organic milk production involves higher costs (in most Western countries)

→How to convince consumers to pay this higher price? Problems:

- –Supporting sustainable agriculture is mainly for hard-core consumers
- –most sustainability issues relate to 'collective goods' (this means also: direct payments are option as alternative for "support via product price")

- Taste and health are important for 'light consumers'

Info is scarce; human health aspects difficult to asses.

Indication of health through food chain: children who ate mainly organic dairy products in first two years developed 30% less eczema. Kummeling et al. in British Journal of Nutrition (2008, 598-606)

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**Dutch organic milk quality research programme**

- 2004-2007: Poly-unsaturated fatty acids like CLA and omega-3, "healthy" fatty acids.
  - +2005-2006: Biocrystallisations and biophotons.
- 2008: Taste, vitamines, minerals

Mainly results from testing consumption milk samples from supermarket

In 2004-2007 also raw bulk milk samples from farms (fatty acids, biocrystallisations and biophotons).

>400 samples of 25 farms, different in many farm characteristics + deliberate feed changes

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**Difference in fatty acid composition**

(4 periods, 12 samples each; values of conventional milk between brackets in mg per g fat; all average year differences are P<0.05)

| | Year-average difference with conventional (n=48) | During winter (n=14) |
|---|---|---|
| SFA's | -2% (702 mg) | 0% (726 mg) |
| PUFA's | +15% (27,5 mg) | +6% (24,8 mg) |
| CLA | +39% (5.3 mg) | +15% (3.9 mg) |
| Omega-3 | +60% (5.8 mg) | +66% (5 mg) |
| Trans fatty acids | +20% (2,2 mg) | +3% (1.9 mg) |

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

| | Summer (n=208) | Autumn (n=78) | Winter (n=129) |
|---|---|---|---|
| CLA (mg / g milk fat) | 9.51 | 8.86 | 5.60 |
| Omega3 (mg / g milk fat) | 11,06 | 10,83 | 10.32 |
| | Percentage in ration | | |
| Concentrate | 14 | 17 | 18 |
| Fresh grass | 67 | 39 | 2 |
| Grass silage | 13 | 33 | 61 |
| Maize silage | 3 | 3 | 5 |
| Whole grain silage | 0 | 0 | 1 |
| Red clover | 2 | 7 | 10 |
| Others | 2 | 0 | 2 |
| Added oil (g/day/cow) | 38 | 50 | 78 |

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**Multilinear regression + feeding trials + literature; main conclusions:**

- Adding oil very effective (some addition might be healthy for cows), but limitedly applicable in organic (cost, milk fat depression)
- Roughage quality most important, mainly:
  - +Fresh grass (young and green)
  - +Conserved grass as 'fresh' as possible (for grass pellets, silage or hay: short field period)
  - +Minimizing maize feeding
  - +Special effects (hay, clovers, herbs) exists, but no easy tricks

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**Differences in vitamines and minerals**
(2 periods, 20 samples each; bold is significantly higher; P<0.05)

| | Conv. (n=20) | Org. (n=20) | Seasonal effect |
|---|---|---|---|
| Vitamine A | 39 | 39 | Yes (summer high) |
| Vitamine E | 0,087 | 0,096 | Season*product system interaction is significant (organic in winter lower and summer higher) |
| β-caroteen | 16,5 | 16,9 | Idem |
| Luteine | 0,855 | 0,97 | Yes (summer higher) |
| Zeaxanthine | 0,161 | 0,213 | Yes (summer higher) |
| β-cryptoxanthine | 0,312 | 0,324 | Yes (winter higher) |
| Ca (ng) | 120 | 123 | Yes (winter higher) |
| Cu | 5 | 4,2 | Yes (winter higher) |
| Se | 1,6 | 1,3 | Yes (winter higher) |

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There is more than composition….

- Taste

Two alternative parameters related to hypothesis "Structure (the 'order') of food is just as important to human health as the material composition":

- Biophotons (light counts in dark; quality to store light energy)
- Bio-crystallisation

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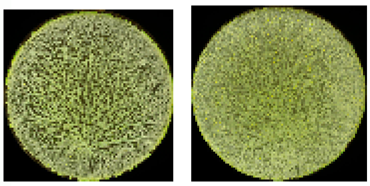
**Biocrystallisations**



Subjective qualification 1-10 of image (9 aspects plus overall) that appears after mixing milk with copper chloride

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| | Conventional | Organic | Seasonal effect |
|---|---|---|---|
| Bio-crystallisation (average evaluation) n=36 | 6.0 | 6.9 | No |
| Biophotons (*1000 counts, 100-200 sec.) n=36 | 29,9 | 31,5 | Yes (28 winter, 35 summer) |
| Taste "three alternatieves, forced choice" | No difference tasted by laymen (37 and 35% correct guess, not different from 33%); preference 47% for bio (not different from 50%) | | |

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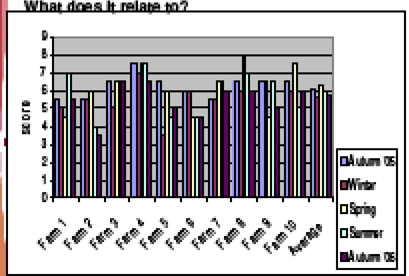
What does difference in bio-crystallisation means?
What does it relate to?




No relation with farm characteristics, season, feed, health
Also: the score of mixed sample is not equal to average of original samples!!!

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**Conclusion 1**

Dutch organic milk better than conventional?

+ Fatty acid composition
+ Some vitamins

± Better in bio-crystallisation, but meaning and scope for improvement?
± No difference in taste, some vitamins
± Lower in some minerals (but this is hardly important for human health)

- none

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## Conclusion 2

Most and main favourable differences are related to:

- Fresh grass (and hay/silage as green as possible)
- Summer

Why not base organic dairy production more on this?

- ➢Adjusting feeding ration
- ➢Seasonal (=natural) milk production.

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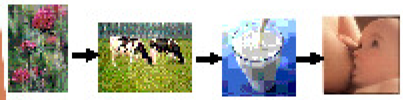
## The organic chain: tastefull products supporting human health from a healthy production system



Thank you for your attention

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

| Feed components<br>Estimated effect per kg DM (mg per g fat) | | |
|---|---|---|
| | CLA | Omega-3 |
| Fresh grass | 0.33 | Not incl. |
| Maize silage | -0.23 | -0.25 |
| Whole grain silage | Not incl. | -0.70 |
| Added oil | 9.51 | 5.71 |
| Grass pellets | 0.29 | 0.74 |
| Red clover | 0.24 | 0.21 |

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## Multiple linear regression
Explained variance and other factors

| | CLA (%) | Omega-3 (%) |
|---|---|---|
| Feed ration components | 12.0 | 15.1 |
| Sampling date (calendar week number) | 48.3 | 11.7 |
| Farm effect | 38.2 | 68.9 |
| Total explained variance | 74.5 | 62.1 |

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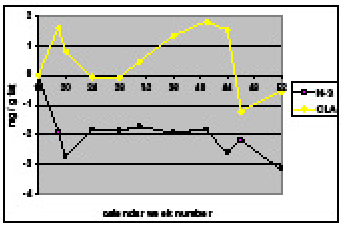
## Seasonal effects




Most seem related to grass quality

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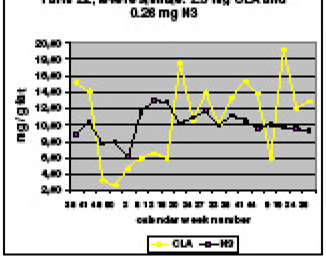
## Farm effects, individualised examples

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## No clear breed effects

| Farm number | CLA level estimate | N3 level estimate |
|---|---|---|
| 12 | -3.10 | 2.94 |
| 4 | 0.99 | -0.19 |

Literature: within breed variation high; daughter groups differences are considerable (van Arendonk et al)

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# 12 *Effect of organic and conventional feed on potential biomarkers of health in a chicken model*

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*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, $NaCO_3$ 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 Lauridsens (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 putts 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**

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Lauridsen, C., Yong, C., Halekoh, U. et al. (2008); Rats show differences in some biomarkers of health when eating diets based on ingredients produced with three different cultivation strategies. J.Sci.Food Agric. 88, 720-732.

# 13 Product quality - The alpha and omega for further development of organic agriculture – part2: Conclusions

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(For the PowerPoin presentation a few slides from Søren Husted were used)

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**

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## Product Quality

The alpha and omega for further development of organic agriculture
Part 2: Conclusions

Geert-Jan van der Burgt

QLIF Workshop, January 2009

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**Defenition:**

***Any property of a product that is related to a desired aspect of this product***
***Product and process quality***

***Fitness for use***
***Product quality***

***Consumers' expectations:***

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***Consumers' expectations:***

***How to choose my meal?***

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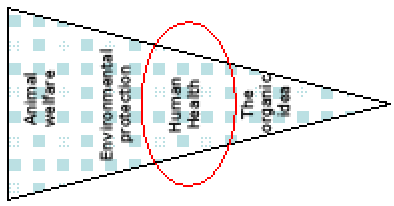
## DK consumer expectations:
### *- Consumer survey 2007*

Four important reasons to buy organic products:

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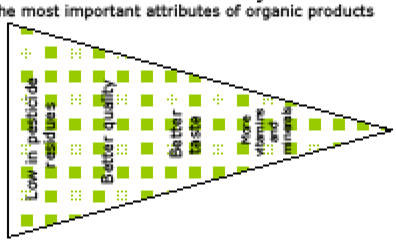
## DK consumer expectations:
### *- Consumer survey 2007*

The most important attributes of organic products

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**Most contributions:**
- Product quality: measurable in the product
- With some links to process
- About comparison conv - org

**Nothing about:**
- Size, weight
- Colour, shape
- In other words: simple marketing arguments

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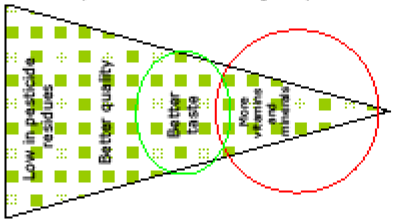
# DK consumer expectations:

*- Consumer survey 2007*

The most important attributes of organic products




*1. The organic standards are exclusively focussing*
*• on process quality parameters*
*• in the agronomic part of the process*

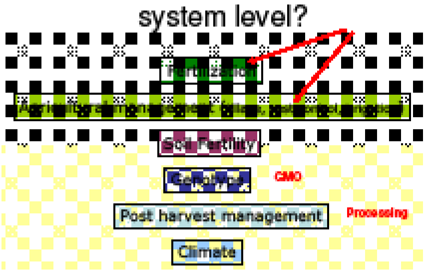
Just select some product parameters, set minimum or maximum levels, finished.

But remember: about 75.000 secondary metabolites

Alternative: Creating (= process) quality-related properties (= measurable components)

What to do?

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



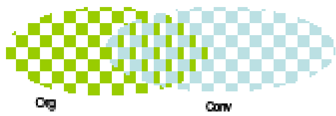

Research setup: comparison and in-depth

| | Manure org | Manure conv |
|---|---|---|
| PM org | Organic | Low input |
| PM conv | Low input | Conventional |

*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*




*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?

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Critical factor, key factor:

- Nitrogen
- Light
- Time (ripening)

Is there an overall concept?

Can we order all the results?

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Comparison: adequate set-up

Taste

Mechanism; key-factors

Health aspects

Concept building

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