Organic food food quality –
state of the art and research needs

Mikkeli, Ruralia Institute

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Sustainable Agriculture & Nutrition

• United Nations definition of sustainable consumption….

„the use of services and related products which correspond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle so as not to jeopardize the needs of future generation“

UNEP, 2005: 10
Organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system.
Organic agriculture old fashion or new inspiration?

Rockström et al., described the

The Health of the Earth:
The earth is a complex system with a self-regulatory capacity that maintains a stable environment within a relatively narrow range and that can respond to changing pressures with restoring balances, within certain thresholds.

Rockström et al., Nature 461, 472-475 (24 September 2009) |doi:10.1038/461472a;
Regulations – organic food production

EU-Regulation 834/2007 and 889/2008:

Article 2: Definitions:

- The definition of food: Reg. EU No 178/2002

Article 3 and 6:

- Products are healthy
- Products are of high quality
- Maintain the vital qualities and organic integrity of the product
- Not mislead regarding the true nature of product
Promise and expectations need clear arguments

Example non-organic food quality (TP „Food for Life“ EU)

- Sustainable food production
- Quality of life
- Well-being of the people

Example organic food quality (TP „Organics“ EU)

- Sustainable food production
- Quality of life
- Well-being of the people
The European market for organic food and drink: The countries with the highest sales 2007 and 2008 (survey date June 2009)

- **Germany**: 5.8 billion Euros (2008), 5.3 billion Euros (2007)
- **UK**: 2.65 billion Euros (2008), 2.56 billion Euros (2007)
- **France**: 1.90 billion Euros (2008), 1.97 billion Euros (2007)
- **Italy**: 0.91 billion Euros (2008), 0.79 billion Euros (2007)
- **Switzerland**: 0.81 billion Euros (2008), 0.74 billion Euros (2007)
- **Austria**: 0.60 billion Euros (2008), 0.58 billion Euros (2007)
- **Spain**: 0.537 billion Euros (2008), 0.50 billion Euros (2007)
- **Denmark**: 0.49 billion Euros (2008)

Source: Aberystwyth University, FiBL & ZMP Survey 2009
Resumee

• Organic agriculture is a natural system with certified processes

• Organic agriculture is fast growing all over the world

• Organic food market is out of the niche
Statement Organic Agriculture

Organic agriculture emphasised the world to move towards sustainable agriculture. This was one of its big innovations.

Organic agriculture is the leading system putting biodiversity, environmental protection and animal welfare together towards sustainable diets.

Examples:
Reports FAO on „Organic Agriculture and Food Security“ as well as „Biodiversity in sustainable diets“
The goal: best for human and environment
Actually discussed: market relevance

Market research results:

1. The quality question dominates the marketing of the products

2. The quality profile needs consumer understanding and acceptance

3. The quality of organic offer a „plus“ compared to non-organic
   - product oriented aspects (natural, healthy etc.)
   - process oriented aspects (animal welfare etc.)
process orientated quality

sustainability as the underlying principle of food quality

more selfish demands such as good taste, good for ones own health

society

consumer
Product quality – Different criteria of food

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Example for quality attribut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>Content of health promoting substances</td>
</tr>
<tr>
<td>Senses</td>
<td>Colour, taste, smell</td>
</tr>
<tr>
<td>Technique</td>
<td>Ripeness, shelf-life</td>
</tr>
<tr>
<td>Psychology</td>
<td>Prestige</td>
</tr>
</tbody>
</table>
Framework for Organic food quality

(Kahl et al., JSFA, 2012)

Organic milk quality

Process

Impact on
environment

Impact on
society

Soil

Atmosphere

Carbon-
foodprint

Product

Enjoyment

Vital qualities

Sensory attributes

Profile

Triangular-test

Simple description

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Quality definition of carrots in an organic baby food production chain

Quality dimensions
- Nutritional value
  - Observability
    - Nutrients
    - Composition
    - Fibre
    - Digestibility
    - Wholesomeness (total of the product)
- Sensory quality
  - Ability to prepare
    - Keepability
  - Believed health promoting constituents e.g. antioxidants
- Convenience
  - Safety
    - Absence of harmful properties
- Authenticity
  - Natural product
  - Organic
  - Safe production

Quality criteria
- How to measure
  - Consumer and processor studies
  - Studies of actual production lines (SME's)
  - Pilot plant processing studies
  - Quality analysis of critical control points (QACCP)
  - Chemical analyses
  - Sensory analyses
  - Impact on health studies
  - Animal feeding studies

Coopo organic, Project no. 2006-1885, Quality analysis of critical control points within the whole food chain and their impact on food quality, safety and health (QACCP)
Resumee Organic Food Quality

1. Organic food quality is defined through the principles of organic farming and food production

2. Organic food quality is defined through process and product related aspects

3. Evaluation of organic food quality is performed through criteria, indicators and parameters, these can be organic specific

Kahl et al., FT, 2010
Kahl et al., JSFA, 2012
Factors affecting organic food quality

- No mineral N-fertilization
- Prohibition of synthetic pesticides, fungicides, herbicides
- Prohibition of GMO
- Limitation of food additives
- Certification process
Newest research results

• Dangour et al. 2009 (meta-analysis)
• Lairon 2009 (qualitative analysis)
• Brandt et al. 2011 (meta-analysis)
• Palupi et al. 2012 (meta-analysis)

Results:
1. Organic food quality is different from non-organic (evidence)
2. The difference depends on the quality criteria/indicator
3. The difference can not be guaranteed (other factors)
Organic milk quality

Palupi et al. JSFA, 2012
Organic food and health

• A few studies show a positive health effect of organic feed on animals, although sometime there was no difference in the compounds of the fodder

• A few human epidemiological studies indicate an effect, but this is strongly connected to co-factors (life style etc.)

• Organic food consists significant less amounts of undesired compounds (residues from pesticides, antibiotics etc.)

• Yet there is no scientific evidence, that organic food is healthier. We have questions how to design a human intervention study in order to give scientific evidence
Research questions

• How to compare organic to non-organic?

• Is the single compound paradigm fitting with organic?

• Is organic sufficient to cover future expectations from consumer on high quality food?
From glass-house to reality

\[ R^2 = 0.5447 \]
\[ R^2 = 1 \]
\[ R^2 = 0.0837 \]
Quality aspects of plants

Phenotyp (Morphology)

Genotyp (Variety)

Physiotyp (substances)

Soil (water, mobility of substances, manure)

Climate (temperature, light, rain fall)

Fertilisation (mineral, organic)

Year

Pest control

Cultivate (rotation, technique)
What’s defining an “organic” sample and can food be determined as “organic”?
Food quality determination

Basis: LFGB, §35 Methods: Energy and single compounds

Analysis

- ca. 85% Water
- ca. 15% Dry matter
- N-containing compounds
- Carbohydrates
- Ash
Food quality – Change of paradigms in nutrition

<table>
<thead>
<tr>
<th>Phase</th>
<th>Quality aspect (vegetables)</th>
</tr>
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<tbody>
<tr>
<td>I (until 1960)</td>
<td>Energy, Potassium</td>
</tr>
<tr>
<td>II (until 1980)</td>
<td>Potassium, Vitamine C</td>
</tr>
<tr>
<td>III (until 1995)</td>
<td>K, Vitamine C, ß-Carotene</td>
</tr>
<tr>
<td>IV (from 1995)</td>
<td>Carotinoids, Flavonoids, Fatty acids</td>
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</tbody>
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Do we catch the right substance?

The lycopene story:

Rao et al. 2000
Lycopene literature review, 70 papers
Result: Lycopene against prostate cancer: model fits, some clinical studies not

Gitenay et al. 2007
Tests on rats, tomato powder with low lycopene, lycopene only
Oxidative stress
Results: Effect with tomato powder but NOT with lycopene

Gitenay et al. 2007
Cancer (cells)
Tomato powder and lycopene
Results: Effect with tomato powder, NOT with lycopene
Carotinoids – Metabolism

- 50% cis-β-Carotene
- 50% trans-β-Carotene

- S. Intestine

- Lymph.

- Blood

- 5% cis-β-Carotene
- 95% trans-β-Carotene

- 50% cis-Lycopene
- 50% trans-Lycopene

- 40% cis-Lycopene
- 60% trans-Lycopene
Organic food – structural aspects – choice of methods

Level 6: carrot as a living whole

„fundamental leap“

Level 5: macroscopic structure

Level 4: protein-structure

Level 3: proteins

Level 2: amino acids

Level 1: nitrogen

sensory analysis

order / organisation

Kusche et al., BAH, 2010
FQH Conferences 2011, 2013, 2015

First International Conference on Organic Food Quality and Health Research

18 - 20 May, 2011

Diplomat Hotel Conference Centre ● PRAGUE ● CZECH REPUBLIC
Results from FQH on Organic food and....

- Values-based food systems (regional, traditional)
- Careful/minimal processing
- System approach
- Best practices
- Sustainable diets
Guideline for organic food quality

„The birthright of living things is health. This law is true for soil, plant, animal and mass: the health of these four is one connected chain. Any weakness or defect in the health of any earlier link is passed on to the next and succeeding links, until it reaches the last, namely, man“

Sir Albert Howard, 1947
Thank you for your attention!