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The content of secondary plant compounds in organically produced food

Dr. habil. Bernhard Watzl

Federal Research Centre for Nutrition and Food, Karlsruhe, Germany

Contact: Bernhard.Watzl@bfel.de

Evidence from epidemiological as well as experimental studies consistently suggests that a plant-based diet is associated with a lower risk for cardiovascular diseases as well as for cancer. Plant foods are a rich source of essential nutrients, dietary fiber and secondary plant compounds which are also called phytochemicals. Phytochemicals include chemically different groups such as carotenoids, flavonoids and phenolic acids, glucosinolates and others. Recent studies indicate that phytochemicals present in plant foods offer health benefits beyond basic nutrition by modulating molecular and cellular processes associated with cardiovascular diseases and cancer.

Environmental factors play an important role in the synthesis of phytochemicals suggesting that organically produced plant foods may provide higher quantities of phytochemicals compared with conventionally produced products. Until now, however, few well-designed studies have investigated the impact of agricultural production systems on the content of phytochemicals in plant foods. Further, characterization of conventional and organic farming systems as well as plant varieties investigated in such studies often is inadequate. Overall, there is no clear conclusion whether differences occur in the phytochemical content among organically and conventionally produced products. This prompted us to investigate the impact of the agricultural production system on the content of carotenoids and flavonoids in apples and carrots as well as on their antioxidative potential.

We investigated two varieties of apples produced and harvested under standardized conditions. No differences in the content of flavonoids and phenolic acids were observed between organically and conventionally produced apples. Further, for both varieties no differences in the antioxidative potential was detected. In contrast, carotenoid content in carrots of two carrot varieties was significantly lower in conventionally produced carrots. Currently, human intervention studies are ongoing to investigate whether the intake of carrots or apples from organic and conventional production differentially modulate blood phytochemical concentrations and antioxidant status. In conclusion, present data from the literature as well as our own data reveal minor differences in the content of phytochemicals in organically or conventionally produced plant foods.

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Strategies for handling pesticide contaminations in organic operations

Gabriela S. Wyss
Research Institute of Organic Agriculture, Ackerstrasse, CH-5070 Frick
Contact: gabriela.wyss@fibl.org

Production, processing, transport and trading of organic foods pose big challenges for the operator and are based on sustainable, precautionary and cyclical principles. Handling must be carried out with special care and attention using gentle and often traditional methods. This holistic concept also should include a proper strategy for handling food contaminations of all sources, especially pesticide contaminations in organic operations. Organic farming largely excludes the use of synthetically compounded pesticides, and plant protection substances may only be applied if all preventive cultivation techniques have been exploited and a case of immediate threat occurs. Organic agriculture, however, makes no claims concerning environmental background contamination or persistent compounds in soils that were applied twenty to thirty years ago.

The absence of pesticide residues is viewed by many consumers as the ultimate proof of organic origin, and any report of the occurrence of pesticides in organic foods will automatically question the integrity of the operator and carry an unpredictable risk of unleashing a scandal. However, with sufficiently advanced analytical methods almost any commodity can be shown to contain some level of pesticide residue or their breakdown products. What can still be claimed as organic? Most of the residue cases identified can be related to (unforeseen) weak points in the quality assurance system that can be prevented in the future. But, the demands placed on the operator should be weighed up against the principle of proportionality.

Annex III No 9 to Regulation (EEC) 2092/91 gives responsibility to the operators in case of suspicion, consideration and doubt. However, many operations have not yet implemented a strategy in case of a detected irregularity. Sources for non-compliance and contaminations especially should be detected in any case. Experiences from contamination cases should find entrance into the internal quality management system, which must be adopted to the need of the specific organic sector and for the scale and type of the operation. Sampling on a regular basis provides data on background contamination. Based on such results, operators might be able to elaborate internal orientation (threshold) values for future internal assessment. The production of organic foodstuffs requires such extensive action on the part of quality assurance in terms of contaminations that is necessary to budget an appropriately large proportion for this part of the business.

The lecture will highlight the topic and further elaborate what can be done in a case of an irregularity. In general, the next few steps should be considered: i) stop further operation and marketing until the irregularity has been resolved (self-inhibition); ii) take measures by an internally assigned person to clarify the consideration of suspicion, in the sense if products can be further market with the label “organic” or if the inspection bodies/food authorities need to be informed; iii) implement measures which improve the organic status in the future.

Contaminants and micro-organisms in organic versus conventional food

Ron Hoogenboom[1], Martin Northolt[2], Jan Bokhorst[2], Nico Broex[1], Dik Mevius[3], Jac Meijs[4], Joop van der Roest[1]

[1] *RIKILT-Insitute of Food Safety, P.O. Box 230, 6708 AE, Wageningen, The Netherlands*
[2] *Louis Bolk Institute, Hoofdstraat 24, 3972 LA Driebergen, The Netherlands*
[3] *CIDC, Postbus 2004, 8203 AA Lelystad, The Netherlands*
[4] *Biologica, Postbus 12048, 3501 AA Utrecht*

Contact: Ron.Hoogenboom@wur.nl

On behalf of the Agricultural Ministry and the Dutch Food Authority, RIKILT performed a survey in close cooperation with the Louis Bolk institute, CIDC and Biologica, aiming at differences in certain contaminants and micro-organisms between organically and conventionally produced food. Based on current practice and other studies running in parallel, a selection was made on specific food items and contaminants and micro-organisms.

Analysis of Dutch wheat samples, harvested in 2003 and 2004, showed no differences in mycotoxins, like deoxynivalenol and zearalenone. Although levels were markedly increased in samples collected at the end of September 2004, they were very similar for the two types of production. This confirms results from other recent studies in Norway and Germany.

Levels of the heavy metals cadmium, lead, arsenic and mercury in organic wheat, lettuce, carrots and potatoes were below the limits. Those of lettuce and wheat were compared with conventional products and showed no difference. Levels of lead, arsenic and mercury in kidneys and meat of organic pigs were also well below the limits. Cadmium levels were most close to the limits but also did not exceed them. No heavy metals could be detected in eggs of organic hens.

Nitrate levels in organic and conventional iceberg lettuce were similar, but in the case of field lettuce they were much lower in the organic products. Levels of nitrate in organic carrots were markedly higher than in their conventionally produced counterparts. Nitrate levels in organic potatoes were low, but were not analyzed in conventional products.

Pesticides were analyzed in the various samples of wheat, carrots, lettuce and potato described above but no levels above the limits were found. In organic products they could not be detected at all.

Despite the use of dung, none of the samples organic lettuce contained *Salmonella* or *E. coli.* Initial screening of dung from 10 well-experienced organic pig farms, revealed no *Salmonellas*. Inclusion of another 20 farms (including 4 older farms) showed 8 positives, 1 coming from an older farm, the others from farms that switched recently to organic. Other programs show that in the conventional farming, 30% of the farms is positive. *Campylobacter* was present at 55% of the organic farms, similar to conventional farms.

No *Salmonellas* were observed in dung from organic laying hens or broilers, whereas in conventional chickens *Salmonellas* are normally observed in 12% of the farms. *Campylobacter* was detected in 9 farms, the frequency being similar to conventional farms.

Dung of organic pigs and broilers was investigated for the presence of bacteria resistant to antibiotics. Both in pigs and broilers the frequencies were in general lower than in conventional animals.

Future challenges to organic food processing

Ursula Kretzschmar and Otto Schmid
Research Institute of Organic Farming (FiBL), Ackerstrasse, CH-5070 Frick, Switzerland

Contact: ursula.kretzschmar@fibl.org

Study design

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

Results

In this presentation we will especially reflect to results, which would have a direct influence on the product quality and give input to a further development in the organic food processing.

Defining organic food processing

The main focus of the first part of the survey was to narrow and clarify definitions, which are often used to characterize organic food processing. The definitions with the best acceptations of the terms **careful processing, fresh product and authenticity** are as follows:
Careful processing: **"the maximum to keep the important compounds and the maximum to avoid undesired compounds or nutritional losses".**
Fresh product: **Product with a short shelf life needs to be stored at a specific temperature or under controlled temperature conditions".**
Authenticity: **"Production and processing steps and the origin are visible/recognizable to the consumer"**

Definitions have an influence of a global understanding of the mostly used terms in organic food processing and with that an indirect influence on food quality. Based on the feedback from the experts we can conclude that instead of a final definition of the up mentioned terms a more elaborated definition of the production methods as well a good labelling would be more helpful for the producers as well for the consumers (when the intent of the terms can be addressed indirectly).

Important aspects in organic food processing

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

Freshness/Sensory quality

Regarding the importance of the subjects sensory quality and freshness for the success on the market, it is clearly reflected, that the consumer of organic food is expecting more than only “organic”. It is important to advance the quality understanding by the different market player. The innovation prize at the Biofach is one of a possible instrument.

Minimum use additives

The experts clearly supported the reduction of the use of additives in organic processed food. A further development in this area is really needed. It could be a three step scenario:

- standardizing evaluation processes for the authorization of additives
- reduction of the already allowed additives on a minimum
- replacement of additives on agriculture origin with certified organic additives (e.g. organic soy lecithin)

Authenticity

The high relevance of the aspect authenticity in the survey reflects the sensitisation of the consumer on the different scandals in food processing (actual “refreshing”, repackaging of meat in Germany) and with that the sensitisation of the experts. There are two steps to take account to this expectation:

- sensitisation in the product development of organic food: a cream sauce should be made with cream and not be a mixture of low fat milk powder, palm fat, water, emulsifier and a little cream.
- a more detailed declaration: EU-legislation should give recommendations regarding what is allowed to be labelled and what cannot be labelled.

The impact of agronomic measures on the quality of organic potatoes (*Solanum tuberosum* L.) for processing into French fries and chips

T. Haase[1], N. U. Haase[2] & J. Heß[1]

[1] *Department of Organic Farming and Cropping, University of Kassel, Nordbahnhofstrasse 1a, D-37213 Witzenhausen*
[2] *Institute for Cereal, Potato and Starch Technology, Federal Research Centre for Nutrition and Food, Schützenberg 12, D-32756 Detmold*

Contact: thaase@wiz.uni-kassel.de

The potato crop plays an important agronomic and economic role for the majority of organic farms in Western Europe. Organic cultivation of potato raw stock for industrial processing into French fries (UK: chips) or chips (UK: crisps) may be a new source of income for organic farmers, yet research until recently focused exclusively on the table potato. In three field experiments the impact of pre-crop, seed tuber-preparation, N and K-fertilization and cultivar on graded yield, dry matter, starch and reducing sugar concentration, crude-mash discolouration, after-cooking darkening and quality of the finished product (French fries and chips, respectively) were examined, at harvest and after a storage period of 4 months at 8°C.

Results on the response of tuber yields confirm that presprouting is an essential instrument to secure marketable tuber yield, since a lower number of tubers much more likely will reach the required size grades under conditions of limited N supply. Leguminous precrops such as pea (*Pisum sativum* L.) and short-term alfalfa-grass clover leys were found to be favourable in terms of higher tuber yields for French fries. The increased N supply caused a decrease of both, dry matter and starch concentration, however without impairing quality of the finished product. Glucose and fructose content of tubers was hardly affected by agronomic measures except cultivar choice. In both multifactorial experiments, reducing sugar concentration was at a very moderate level, yet increased appreciably during storage in one year. A negative correlation between tuber concentration of reducing sugars and chip colour could be established. Besides, results showed that under conditions of organic farming the quality standards for raw stock can be accomplished when adequate cultivars are chosen. Further research is required to develop strategies to minimize the negative impact of storage and the individual cropping season.

The 2005 Louis Bolk Milk Study
A pilot study in search of parameters for quality and health

M.A.S. Huber, R. Adriaansen-Tennekes, J. de Wit, E. W. Baars, T. Baars[1]
Louis Bolk Instituut, the Netherlands, [1]*University Kassel/Witzenhausen,Germany*

Contact: m.huber@louisbolk.nl

Background

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

Study design

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

Parameters analysed

On a nutrient level fatty acids, that are considered to have a positive health effect, were measured: Conjugated Linoli Acid (CLA's) and omega-3-fatty acids in relation to the total fat content. As experimental holistic food quality parameters biophotone measurements (delayed luminescence) and biocrystallisations were investigated. Both parameters are hypothesised to show the level integration and inner coherence of a food product. Sensory analysis was performed by an expert taste panel. As indication for the cow's resistance the immune reaction of the cow's milk was determined.

Results

Healthy fatty acids

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

Biophotons

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

Biocrystallisations

Visual evaluation of the milk biocrystallisation pictures showed a better integration and coordination in organic milk. All organic milk pictures also showed more perradiation and longer 'side needles' (all $p < 0.001$).

Taste

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

The immune cell activity

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

Conclusions

In this pilot study almost all experimental parameters showed a difference in quality between organic and conventional milk. Remarkably good correlations were found between the different experimental parameters. Based on a pair wise comparison, differences between organic and conventional milk samples are significant, in favour of organic. Differences between the mean values of each group are less clear. These differences are interpreted as organic milk being of better quality and probably 'healthier' than the conventional milk. Adriaansen (2005) and Baars (2005) et al. extensively discussed the results. A problem was that the second milk sampling was done by another set of people. This may be an explanation that some methods showed a big variation between the two samplings. The study shows that relatively small numbers, if well chosen, can already show significant results.

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The State of Organic Science Research in the United States

R. Mark Davis, CEO
The Organic Center, 46 East Killingly Road, Foster RI 02825 USA

Contact: rmdavis@organic-center.org, www.organic-center.org

The Organic Center generates credible, peer reviewed information and communicates the verifiable benefits of organic farming and products to society, resulting in the conversion of agriculture to organic methods, improved health for the earth and its inhabitants, and greater awareness and demand for organic products. The Center was established in 2002 and is nonprofit organization.

The Organic Center works with the media to highlight the peer-reviewed, scientifically proven public health benefits of organic food and production methods and to stimulate new research into the "organic benefit" by urging new public funding in this area and funding crucial research. It also provides people directly with scientific information about the organic benefit so they can educate their network of friends and family as well.

This hard-core science will very soon enable the industry to make health claims on the labels of organic foods, and to help medical professionals understand how organic food can help prevent disease and promote good health. This effort will bring a new wave of consumers to the organic marketplace and create a new demand that will dramatically improve the environmental performance of the agricultural sector while making a contribution to our public health.

The first step in the Center's process is to gather and analyze peer-reviewed scientific literature relevant to understanding and quantifying some aspect of the organic benefit. These State of Science Reviews analyze existing data and serves as a benchmark for the identification of studies that still need to be conducted. The Organic Center's research is prioritized and directed by a twenty-six member Scientific Advisory Committee composed of leading researchers from academia, government, and the private sector.

This presentation will review the current research being conducted by the Center. The two main focuses of the current research are: Pesticide Exposure and Nutrientional Value.

In the Pesticide Exposure area scientific evidence will be presented that shows how humans can minimize pesticide dietary exposure through consumption of organic food, and the effect of pesticides on sexual development, reproductive outcomes, neurological development and the diseases of aging (e.g., Alzhiemers, Parkinsons, dimentia).

In the Nutrientional Value area evidence will be presented of the results of research that compare lycopene and other phytochemicals in tomatoes grown under conventional vs. organic management systems, new approaches to measure the impact of farming systems and technology on food quality, and a comparison of strawberry fruit quality from organic and conventional farms that focuses on the impacts of organic farming systems on antioxidant levels, nutritional quality, food safety, and sensory parameters.