Organic Food Quality & Health Newsletter May 2006

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About this Newsletter

This newsletter, edited by the Organic Food Quality and Health Association (FQH), is provided to keep researchers, the industry and other interested parties abreast of the latest news of organic food quality, research, health and diet. From this edition onwards, the newsletter will also announce coming events. Comments and contributions are welcome: fqh@uni-kassel.de

In order to encourage FQH-members to submit contributions, the board has decided to make a payment for articles. Half a page and recommended papers will be reimbursed with 50,- €; one and more pages with 100,- € per paper. Authors are kindly asked to send their international bank data to the FQH-coordinator. The following types of contributions are considered:

- Brief reports about new research results and reports about relevant events (max 2 pages)
- Reviews of relevant books / articles

Furthermore we would like to ask the readers of this newsletter to submit information on coming events, relevant news, websites, books and papers. To qualify for publication in the FQH Newsletter the English must be correct and preferably have been checked by a native speaker of the English language.

Contents

FQH News

1st Scientific FQH Conference in Frick, Switzerland, November 28 and 29, 2005 - Short summary of the discussion

***Angelika Ploeger*[1]**

November 28-29, 2005 the first Scientific FQH Conference took place in Frick, Switzerland, at the Research Institute of Organic Agriculture (FiBL).

Angelika Ploeger, who chaired the final discussion of the conference, described the framework in which the conference and the discussion about research priorities have to be seen within the EU research activities.

The booklet of the European Commission „Organic Food and Farming Research in Europe“ 2005 (EUR 21713)[2] states clearly that in the past couple of years several EC-funded collaborative research projects on organic farming have been funded within the Sixth Framework Programme for Resarch and Technological Development. Nevertheless, the European Commission and national representatives noted at a workshop held in November 2004 in Brussels[3] that research in the field of organic agriculture and food should be complemented by "improvement in coordination, communication, infrastructure and training .... to underpin policy initiatives in order to create a stable and competitive organic food and farming sector in Europe" (p. 5).

The European co-operation on organic food and farming started at a conference in Denmark in May 2001 where the Ministers from governments all around Europe signed the so called *Copenhagen Declaration* in which they agreed that organic farming is a highly relevant tool which has the potential to solve a range of problems related to food production, environment, animal welfare and rural development. They also agreed that organic food and farming should be developed further in Europe. As a direct result of a meeting hosted by the European Commission's Research DG in September 2002 in Brussels a submission was made for a Coordination Action under the European Research Area Network (ERA-NET) that led to the establishment of a European network to coordinate national programmes on organic food and farming research (CORE Organic)[4]. The EU directly funds research and technical development (RTD) through its Framework programmes. Research related to organic food and farming is mainly funded under Thematic Priority 5 (TP 5) "Food quality and safety" and some are funded under the programme Scientific Support to Policies (SSP). At the end of 2006 the Commission will launch the Seventh Framework Programme for RTD which will run for five to seven years.

The four recommendations to improve transnational research co-operation within the field of organic agriculture and food can be summarized as follows:

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2 A PDF version of the broshure "Organic Food and Farming Research in Europe" is available at the homepage of the European Commission at http://europa.eu.int/comm/research/agriculture/pdf/organic_farming_en.pdf

3 Information on the second seminar on organic food and farming research, organised by the European Commission is available at http://europa.eu.int/comm/research/agriculture/events/organic_farming2004.html

4 For information see www.core-organic.org

- Research is needed to advance the adoption and integration of new technologies in organic farming and food processing.
- Research is needed to assess the socio-economic impact of organic farming and its contribution to rural development (provision of public goods, multifunctional activities, biodiversity, on farm processing etc.).
- Research is needed to underpin the impact of organic agriculture and food on human and animal health. Special attention must be paid to the whole-chain safety of plant and animal production systems including post harvest treatments, conservation and transport.
- Research is needed to clarify aspects related to the coexistence of different agricultural production systems to provide scientific support for revision of the relevant regulations.

FQH as a European Association of Research Institutions in the field of organic agriculture, food and health, aims for an improvement in the field of research coordination, thus complying to the goals of the European Commission. An important key to that is the discussion of experimental designs and the corresponding research results.

Therefore FQH´s first Scientific Conference started with reflections about experimental designs of field trials and farm comparison trials and their results concerning food quality (e.g. sensory attributes of the produce, nutrient content). The second unit of the conference reflected the problems of experimental design in animal housing and feeding in relation to milk quality parameters such as fatty acids. This included results of so called complementary methods for food quality such as copper-chloride-crystallisation. The speakers of the session focused also on milk quality in relation to constitutions of cows and their health status and on human health and milk quality.

The third unit of the conference dealt with the question of how to define food quality, and this led to the discussion about corresponding methods. The topic of validation of methods was presented, and it was stated that a method can only be validated if the question / hypothesis has been clearly addressed and if the experimental design is appropriate. In the discussion all scientists agree that the chemical analyses of samples is commonly used to describe food quality including its effects on human and animal health although it is clear that e.g. the level of vitamin C or nitrate is only one small factor for health (especially human health as defined by the World Health Organization).

On the second day of the conference market research was one important topic (e.g. what do consumers expect when they buy organic food, how is the processing of organic food legally defined , how is it described by processors, and is it in accordance with the expectations – such as whole food - of consumers). The paper of a representative of the trade stated clearly that there is not "**The** organic consumer", but that there are different consumer groups looking for their (emotional) needs which should be met by organic food. The topic health seems not to be an important reason for buying organic food in Europe. The need of intensifying research to link parameters of food quality to animal/human health was not expressed by consumers but from the research side and partly by the market.

The general discussion which highlighted and finished the 1st Scientific FQH Conference struggled mainly with the topics how to generate a hypothesis, an adequate experimental design approach and a definition of organic quality, acknowledging organic agriculture as a "living system". In this context the statements of Lady Eve Balfour and Sir Albert Howard were discussed which state that health of human, plant and soil "is indivisible and one". In the course of the discussion the following questions emerged:

- Which experimental designs are appropriate to meet the “system approach” in organic agriculture (difficulties and advantages of e.g. field trials, comparison studies, neighbour farms)?
- Which experimental designs can be accepted for research in the field of animal and human health (ethics of research, animal welfare and limitations by needs of sampling)?
- Which parameters (along the food chain or the food itself) meet the (living) system in organic agriculture and food production system?
- What is assessed by complementary methods?
- Is there a correlation between the results of complementary methods (e.g. parameters identifying “structure”) and those from chemical and conventional analysis?
- Is it necessary and possible to formulate a code of practice for research in the field of organic agriculture and food?

The participants of the 1st Scientific FQH Conference agreed that the current legal standards and regulations for organic agriculture limit the wholeness of the organic system and that they are impedimental for defining organic quality where only a product oriented perspective can be appropriate. Organic quality must be viewed as a whole and living system while standards block that view and can not be a basis for comparing conventional and organic quality. An agreement of all attendees was that the exchange of results and questions especially the “system approach” unites FQH members and supporting scientists in their aim for precise and appropriate research. Nevertheless a second meeting of FQH researchers and supporting scientist will be necessary to follow up open topics of the discussion. The FQH board will prepare such a meeting for 2006. Providing a basis for this a discussion paper will be composed addressing only the most important topics which need further discussion.

Urs Niggli of FiBL - vice chairperson and host of the 1st Scientific FQH Conference - closed the conference by thanking all participants for their contributions and his staff for the very good preparation. He stressed that this conference has been the first one for years where a real discussion about organic agriculture has taken place.

The proceedings of the First FQH conference, containing all papers presented are available at the FQH Homepage[5].

Report about the meeting and the general assembly of FQH in February 2006

Already for the third time BioFach - The World Organic Trade Fair - in Nuremberg, Germany, hosted a FQH workshop at which latest results of research related to organic food were presented. The two hour workshop, held on February 16th, 2006 comprised topics like food processing, problems of food contaminations, secondary plant compounds, food quality studies etc. Abstracts of the presentations and several full presentations are available for download at the FQH homepeage http://www.organicfqhresearch.org/.

The minutes of the general assembly are available at the member area of the FQH Homepage.

5 The proceedings are available at http://www.organicfqhresearch.org/downloads/proceedings_1st_fqh_conference.pdf

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Research

Soil Foodweb in Europe: Breaking the Vicious Cycle

Jayantha Ratnayake [6]

The European branch of the international Soil Foodweb[7] was established in the second half of 2005 at Laverstoke Park in the UK. Soil biological fertility can now be assessed at the Laverstoke Park Soil Foodweb laboratory without sending soil samples to US for Soil Foodweb analysis.

The Laverstone Park Soil Foodweb laboratory is currently able to measure total and active bacteria and fungi and also nematodes, protozoa and mycorrhiza in the soil.

The role of these microorganisms in the soil is worth so much more than one can begin to account for. At very basic level, they are responsible for breaking down polymeric complex organic substrate into simple organic monomers that act as a source of food for them as well as plants. Humus, a very useful end product of microbial decomposition can improve physical, chemical and biological properties of the soil. Further, they unlock mineral elements embedded in plants and animal waste and rocky materials to the soil making the minerals available to the plant. But it does not end there. A soil rich in biodiversity eliminates the need of human intervention in pest and disease control. Some are sceptical about how far microorganisms can help us to resolve our agronomical problems. The simple answer is if we make our soil environment friendly to microorganisms we can cut down on the need for most of the interventions we use today.

The laboratory is equipped with the latest hardware but also with the latest software and in addition it has highly skilled personnel. The senior scientists at Laverstoke are more than equipped to evaluate your soil in microscopic detail and advise on remedial measures or provide powerful management information.

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7 http://www.soilfoodweb.com/

Nutritive quality of tomato fruits from organic and conventional cultivation

Rembiałkowska Ewa[8], Hallmann Ewelina[9], Szafirowska Anna[10]

Abstract

The aim of this study was to compare the nutritive quality of tomato fruit from organic and conventional cultivation. Five tomato cultivars were selected for investigation: three large-fruit cultivars (Atol, Awizo and Etna) and two cherry tomatoes (Piko and Koralik). The tomatoes were cultivated in certified organic fields and in a conventional field in Skierniewice (Mazovian region, Poland). Samples of ripe tomato fruit were chemically analyzed twice: at the beginning of fructification and at the end of cultivation. Results obtained showed that the type of cultivation had a positive influence on the quality of tomato fruits. Tomatoes from organic cultivation contained higher levels of total sugars, vitamin C, β - carotene and flavonoids in comparison to conventional fruit which contained more reducing sugar, lycopene and had higher titratable acidity. The dry matter content was the same in organic and conventional fruit.

Introduction

Organic methods of horticultural production are well known as being friendly to the environment and increase the quality of obtained crops. Organic farming is more and more popular in Europe and other parts of the world; it is doubtless one of the fastest growing sectors of agricultural production. For example, in the United Kingdom the organic market has increased rapidly over recent years with growth rates of 30 to 50% per annum (Department for Environment Food and Rural Affairs 2003).

Research has shown that organic agricultural plants contain fewer nitrates, nitrites and residues of pesticides, and more vitamin C, total and reducing sugars and flavonoids (Rembiałkowska, 2000, Rembiałkowska *et al,* 2003). Knowledge about the nutritive value of organic vegetables is, however, still insufficient. There is scarce information about the content of phytochemicals, such as carotenoids (lycopene, α- and β-carotene), vitamins other than vitamin C and phenol compounds (such as flavonoids), which are of great health importance.

Flavonoids are chemical compounds universally occurring in vegetables and fruits. Generally plants can accumulate flavonoids mostly in fruits, considerably less in leaves and only a few in roots (Kohlmünzer, 1998). Vegetable flavonoids, especially those belonging to the flavones group: quercitine, kempferol and mercitine can diminish the risk of cancer (Zornoza and Esteban, 1984, Aherne and O`Brien, 2002).

Lycopene is regarded as a very interesting carotenoid and considerably stronger antioxidant than the β–carotene. It was found that lycopene reduces degeneration changes and stops the

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development of glaucoma. Lycopene has an influence on fat transformation in decreasing the cholesterol level. Due to its ability to stop antioxidative changes in lipoproteins contained in blood, lycopene retards the development of arteriosclerosis. It also hampers the development of some cancer forms. Tomatoes are one of the main sources of lycopene. Some studies have shown that organically cultivated tomatoes contained lower level of carotenoids but at the same time, higher level of flavonoids than conventional ones (Rembiałkowska *et al,* 2003).

The tomato (*Lycopersicon esculentum* Mill) is one of the most prevailing vegetables in world production. In Poland, tomato production is about 230 thousand tons, while consumption is still low compared to other European countries. These data concern only tomatoes from conventional production; organic tomatoes are cultivated at a small scale and only under plastic sheath (Statistic Annual 2002).

Cherry tomatoes (*Lycopersicon esculentum* var. *cerasiforme*) are well known for their good taste and flavour among different tomato cultivars. Although cherry tomato yield is almost half compared to standard large-fruit tomato, it is worth cultivating this new vegetable, especially in organic systems, because of the high fruit value (Hobson and Kilby, 1985, Elkner, 1992, Dobromilska and Fawcett, 1999). It has been found that cherry tomato fruits have the highest nutritive value. Compared to standard tomatoes, they contain more dry matter, total sugars, organic acids, vitamin C, free amino acids and antioxidants like beta – carotene and flavonoids. Cherry tomato fruits have also obtained the highest grades during the sensory evaluation of typical tomato taste and smell compared to the standard tomato fruits (Hallmann, 2003).

Material and Methods

Five tomato cultivars - three large-fruit (Atol, Awizo and Etna) and two cherry cultivars (Piko and Koralik) - were selected for the investigation. The tomatoes were cultivated in certified organic and conventional fields in Skierniewice (Mazovian region). The organic field was spatially separated from the conventional field which was advantageous for the experiment, because there was a buffer zone between the fields. In the organic system all recommended rules for fertilization, plant protection and rotation were applied. In the crop rotation legume plants and white mustard were used as green manure for fertilization. In conventional cultivation mineral fertilizers and chemical plant protection were applied. Samples of ripe tomato fruit were chemically analyzed twice: at the beginning of fructification period and at the end of cultivation. Dry matter content was determined by the scale method (PN-91/R-87019), total and reducing sugars content by the Luff–Shoorl's method described in PN-90 A-75101/07, total acidity content as titratable acidity (PN-90 A-75101/04), vitamin C content by Tillman's method (PN-90 A -75101/11), carotenoids (lycopene and β carotene) by the liquid column chromatography method (Saniawski and Czapski, 1983), modified by Hallmann (pers. comm.). Flavonoid content was determined by the Christ–Müller's method, described by Strzelecka, *et al.* (1978). The results of those qualitative characteristics of the fruits were statistically calculated using the Statgraphics 4.1 program, specifically Tukey's test at α = 0.05.

1.1.1 Results

The results of the chemical analysis are presented in tables 1 to 4. Results obtained show that the accumulation of dry matter in tomato fruits both at the beginning and at the end of cultivation did not show any statistically significant difference (tables 1 and 2). At the beginning of the fructification time organic tomatoes contained on average 7.17 % and conventional 7.19 %, while at the end of cultivation adequately 7.00 % and 6.95 % of dry matter in fruits. Irrespective of the cultivation method used, cherry tomato fruits contained the highest level of dry matter in comparison to the rest of examined tomato cultivars (table 1 and 2).

Table. 1 Content of dry matter, total and reducing sugars in fruits of five tomato cultivars at the beginning of fructification period.

cultivation method	cultivars	dry matter (g*100^{-1}g f.w.)	sugars: total (g*100^{-1}g f.w.)	sugars: reducing (g*100^{-1}g f.w.)
organic	Atol	5,80	4,32	4,17
	Awizo	8,01	6,48	4,59
	Etna	6,45	4,92	4,07
	Piko	8,40	7,44	4,07
	Koralik	8,36	7,92	4,87
	mean	**7,17**	**5,79**	**4,22**
conventional	Atol	5,91	4,44	4,29
	Awizo	7,69	5,28	4,84
	Etna	6,93	4,92	4,79
	Piko	8,15	6,84	4,67
	Koralik	8,24	6,36	4,79
	mean	**7,19**	**5,25**	**4,68**
	$NIR_{/0,05/}$ for cultivation method	n.s.	0,40	n.s.
	$NIR_{/0,05/}$ for cultivar	0,18	0,92	n.s.
	$NIR_{/0,05/}$ for interaction	n.s.	0,27	0,07

Table. 2 Dry matter content, total and reducing sugars in fruits of five tomato cultivars at the end of fructification period.

cultivation method	cultivars	dry matter	sugars total	sugars reducing
		(g*100^{-1}g f.w.)	(g*100^{-1}g f.w.)	(g*100^{-1}g f.w.)
organic	**Atol**	6,05	5,40	3,90
	Awizo	7,36	5,40	2,64
	Etna	5,07	4,68	2,16
	Piko	9,52	6,48	3,84
	Koralik	9,99	6,84	4,08
	mean	**7,00**	**5,49**	**3,14**
conventional	Atol	6,61	4,44	4,32
	Awizo	7,17	4,20	3,24
	Etna	4,96	3,48	3,36
	Piko	9,86	4,56	4,44
	Koralik	9,08	5,88	5,64
	mean	**6,95**	**4,50**	**4,14**
	$NIR_{/0,05/}$ for cultivation method	n.s.	0,40	0,40
	$NIR_{/0,05/}$ for cultivar	0,28	0,93	0,93
	$NIR_{/0,05/}$ for interaction	n.s.	0,30	0,32

Organic tomato fruit contained more total sugars in both periods of analysis. It was approximately 5.79 % and 5.49 % for organic tomatoes, while in conventional tomatoes it was 5.25 % and 4.50 %. Cherry tomatoes, especially those from organic cultivation, contained more total sugars in comparison to other cultivars examined (tables 3 and 4). Conventional tomatoes contained higher levels of reducing sugars: at the beginning and at the end of fructification. The tomatoes cultivars examined had different level of reducing sugars, especially at the end of the fructification time.

Table. 3 Content of total acidity and vitamin C in fruits of five tomato cultivars at the beginning of fructification period.

cultivation method	cultivars	total acidity	vitamin C
		(g*100^{-1}g f.w.)	(mg*100^{-1}g f.w.)
organic	Atol	0,48	15,30
	Awizo	0,38	19,20
	Etna	0,35	14,46
	Piko	0,54	18,36
	Koralik	0,60	20,57
	mean	**0,44**	**16,83**
conventional	Atol	0,47	9,64
	Awizo	0,45	16,83
	Etna	0,47	11,17
	Piko	0,57	15,37
	Koralik	0,65	17,82
	mean	**0,51**	**13,86**
	$NIR_{/0,05/}$ for cultivation method	0,04	1,10
	$NIR_{/0,05/}$ for cultivar	0,10	2,54
	$NIR_{/0,05/}$ for interaction	0,01	0,31

The results obtained showed that conventional tomatoes contained more organic acids in comparison to those cultivated by organic methods, in both periods of analysis, being approximately about 0.51 % and 0.45 % at the beginning and at the end of the fructification period. At the same time, it should be noted that cherry tomatoes were richer in organic acids in comparison to other examined cultivars, independently from the used cultivation system (Table 3 and 4).

Organic tomatoes contained higher level of vitamin C in both periods of analysis; the average content of vitamin C was approximately 16.83 mg*100^{-1}g f.w. at the beginning and 16.85 mg*100^{-1}g f.w. at the end of cultivation period. Conventional tomatoes contained adequately 13.86 mg*100^{-1}g f.w. and 11.08 mg*100^{-1}g f.w.

It was also found that cherry tomatoes contained more vitamin C in fruits in comparison to all tomato cultivars examined. Vitamin C was approximately 19.04 mg*100^{-1}g f.w. in organic tomatoes and 14.96 mg*100^{-1}g f.w. in conventional ones. For the large-fruit tomatoes, it was only 16.32 mg*100^{-1}g f.w. in organic and 11.69 mg*100^{-1}g f.w. in conventional cultivation.

Table 4 Content of total acidity and vitamin C in fruits of five tomato cultivars at the end of fructification period.

cultivation method	cultivars	total acidity	vitamin C
		($g*100^{-1}g$ f.w.)	($mg*100^{-1}g$ f.w.)
organic	Atol	0,31	19,35
	Awizo	0,28	15,60
	Etna	0,28	14,00
	Piko	0,44	18,43
	Koralik	0,59	18,81
	mean	**0,33**	**16,85**
conventional	Atol	0,39	12,62
	Awizo	0,35	9,37
	Etna	0,43	9,56
	Piko	0,45	13,88
	Koralik	0,62	12,77
	mean	**0,45**	**11,08**
	$NIR_{/0,05/}$ for cultivation method	0,06	0,49
	$NIR_{/0,05/}$ for cultivar	1,47	1,14
	$NIR_{/0,05/}$ for interaction	0,00	1,16

The results showed that the lycopene content in organic tomatoes was lower in comparison to conventional ones. The average content of this pigment at the beginning of the fructifcation period was only 5.16 $mg*100^{-1}g$ f.w., while for conventional tomatoes 7.89 $mg*100^{-1}g$ f.w. (Figure 1). At the same time, it should be noted that at the end of the fructification period all cultivars produced more lycopene in fruits than at the beginning. Cherry tomatoes from organic cultivation contained approximately 2.8 times more lycopene at the beginning and 2.0 times more at the end of cultivation, in comparison to traditional cultivars (figure 1). The cherry tomato cultivar Koralik contained the highest level of lycopene regardless of the cultivation method.

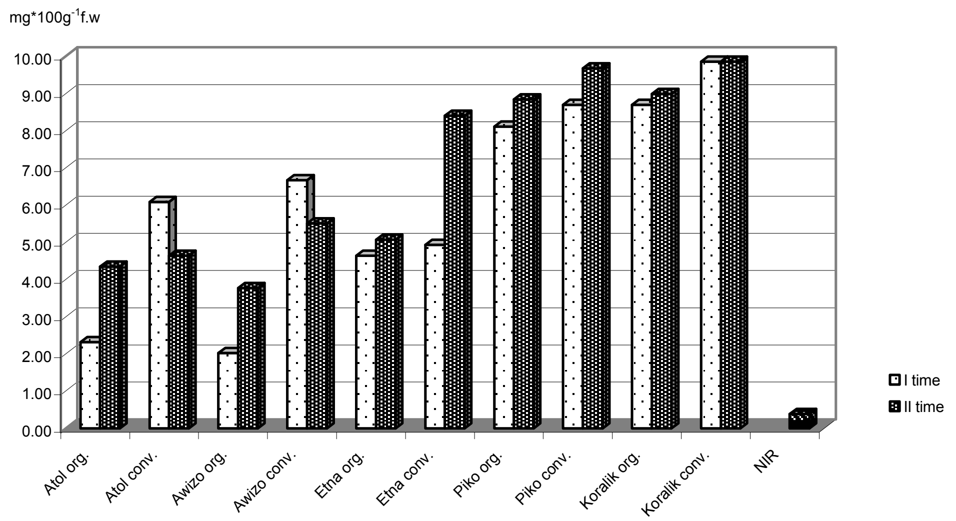

Figure 1. Content of lycopene in fruits of five tomato cultivars in dependence on the cultivation method

Tomatoes from organic cultivation contained more β-carotene compared to conventional cultivation, both at the beginning and at the end of fructification period. These differences were statistically significant only at the end of the fructification time (figure 2.). Organic cherry tomatoes produced more β-carotene in fruits (figure 2.), both at the beginning and end of the cultivation period. The cultivar Etna contained the lowest level of β-carotene in fruits in both cultivation systems (Figure 2.)

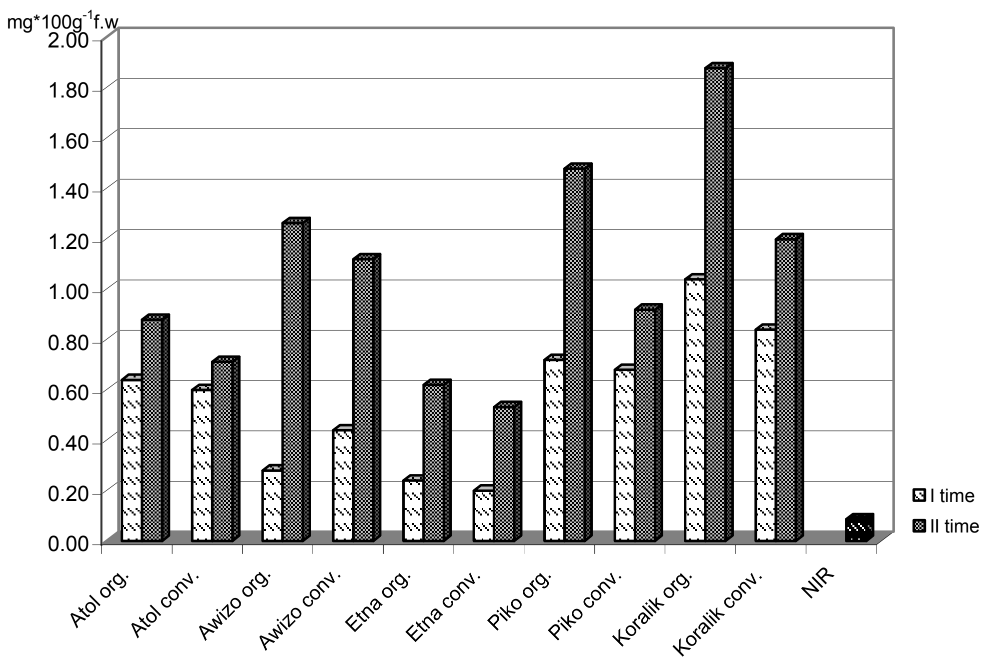

Figure 2. Content of betacarotene in fruits of five tomato cultivars in dependence on the cultivation method

Organic tomatoes contained much more flavonoids than conventional ones (figure 3). Cherry tomatoes from organic cultivation contained most flavonoids in comparison to other examined tomato cultivars. It has been proved that organic cherry tomatoes produced on average 7 times more and conventional cherry tomatoes 12 times more flavonoids in comparison to large-fruited tomatoes. The cultivar Awizo contained least flavonoids in fruits – 1.54 mg % in organic cultivation and 1.18 mg % in conventional cultivation.

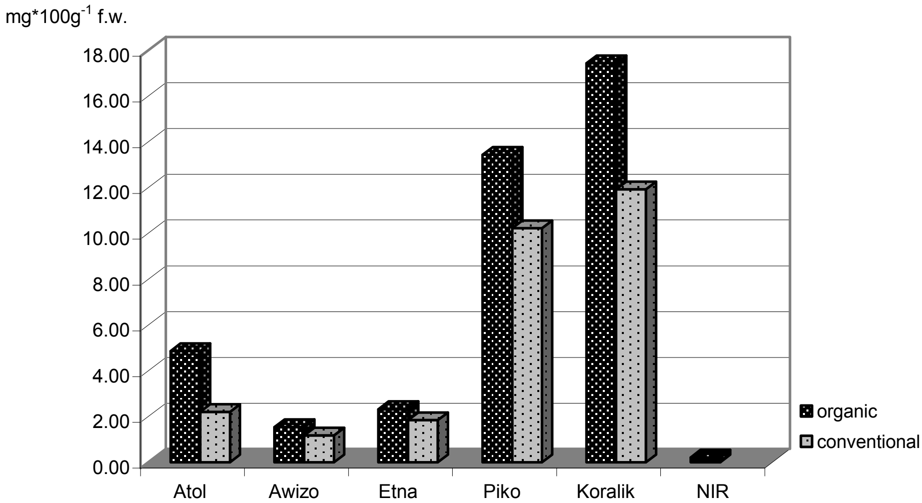

Figure 3. Content of flavonoids in fruits of five tomato cultivars in dependence on the cultivation method

Discussion

Very few studies have been conducted, so far, on tomato fruit quality from organic cultivation. In Sweden, the impact of cultivation methods on tomato quality has been investigated for three years; organically produced tomatoes showed a higher content of vitamin C, lycopene and chlorine (Lundegårdh, 2000).

Similarly Pither and Hall (1990) found a higher content of vitamin C, vitamin A and potassium in organic tomatoes. The results obtained in this paper are similar in terms of the vitamin C contents which was more abundant in organic tomatoes. However, in our study the lycopene content was lower: thus differing from Lundegårdh's study (2000). In our study clearly a higher content of flavonoids and β-carotene was found in organic tomatoes. These results can be only compared to similar own results obtained earlier (Rembialkowska *et al.,* 2003). Unfortunately there are virtually no other similar studies conducted and published.

The content of phyto-compounds in plant foods is a topic of great interest in food science nowadays. A growing amount of evidence indicates that secondary plant metabolites play a critical role in human health and may be nutritionally important (Asami *et al.*, 2003). Plant-based phenolic metabolites are particularly interesting because of their potential antioxidant activity and medical properties including anti-carcinogenic activity. There is a growing concern that the levels of some phenolic compounds may be lower than optimal for human health in foods grown using conventional farming practices (Brandt and Mølgaard, 2001). This concern arises because conventional farming practises utilize levels of pesticides and fertilizers that can result in a disruption of the natural production of phenolic metabolites in the plant (Macheix *et al.,* 1990).

There are two main theories explaining the factors influencing the level of compounds in plants (Brandt and Mølgaard, 2001). The Carbon/Nitrogen (C/N) Balance Theory says that when nitrogen is easily available, plants will at first make compounds with a high N-content, e.g. proteins for growth and N-containing secondary metabolites such as alkaloids.

When N-availability is limiting for growth, metabolism changes more towards carbon (C) containing compounds like starch, cellulose and non-N-containing secondary metabolites such as phenolic compounds and terpenoids.

The second newer theory is GDBH theory (Growth / Differentiation Balance Hypothesis) (Brandt and Mølgaard, 2001). It states that the plant always will assess the resources available to it and optimise its investment in processes directed toward growth or differentiation.

The notion „differentiation" comprises increased formation of defence compounds as well as accelerated maturation and seed development.

The C/N balance theory is a special and typical case of the growth/differentiation balance theory, since low nitrogen availability is the most common growth-limiting condition in natural ecosystems (Brandt and Mølgaard, 2001).

The results obtained in this study are very interesting because they confirm in most respects the GDBH theory. Organic tomatoes (both large-fruited and cherry cultivars) contained more vitamin C, more flavonoids, more organic acids, less reducing sugars and more total sugars than conventional tomatoes. Results concerning carotenoids were contradictory: more beta-carotene but less lycopene was found in organic tomatoes compared to conventional ones; the same results have been found in a previous study of Rembialkowska *et al.,* (2003).

The results show generally a higher contents of bioactive compounds in tomatoes from organic cultivation. Considering the positive impact of the phyto-compounds on human health (Bradlow *et al.*,1999, Bramley 2000) similar studies should be continued.

Conclusions

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

Conventional tomato fruit contained more reducing sugars, lycopene and had higher titratable acidity than organically produced tomato fruit.

The dry matter content was the same in organic and conventional fruit within the same cultivar.

Cherry tomato cultivars (Piko, Koralik) contained clearly more dry matter and more of all nutritive compounds examined (vitamin C, total sugars, total acidity, betacarotene, lycopene, flavonoids) compared to large-fruited tomatoes (Awizo, Atol, Etna).

The results obtained support, in most respects, the GDBH theory because the organic production system with lower N- availability in soil appeared to have the impact on higher content of several bioactive compounds in tomato fruit.

Organic cherry tomato fruit can be recommended as health-supporting plant products useful in cancer prevention.

The results obtained are very important for consumers who are looking for safer and healthier foods, and also for for culinary arts and food service, which can use more organic products in order to attract more customers. The organic food sector is growing very quickly in Europe, so the evidences testifying to better health properties of organic products can support the further development of this sector.

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Summary

One of the indicators of product quality of carrot is the minimal presence of nitrate. Soil fertility and fertilization strategy have an important influence, as was shown in a quick scan among Dutch carrot growers in 2003 and 2004. The model NDICEA can be a helpful and cheap instrument for understanding and eventually changing the nitrogen dynamics of different farming strategies.

Introduction

The Louis Bolk Instituut is involved in research in the field of quality of organically grown products. Part of this research was focussing on nitrate in carrot (Hoogenboom et al, 2006). For carrots as part of baby food, 200 ppm nitrate is the legal EU maximum. For other consumption purposes there is no limit, but in general nitrate is considered a negative factor in food.

From the literature and experience it is clear that varieties show differences in nitrate content. Other known factors influencing the nitrate content are time of sowing, the weather in the days before harvest and leaf diseases. Furthermore, the amount of available nitrogen during crop growth might have a major impact, influencing both yield and nitrate content of the product. For a better understanding of the nitrogen dynamics of several fields, an intensive measurement program could be set up, which is costly. The use of a model reduces the costs sharply, resulting in a 'quick scan' of the nitrogen dynamics.

Material and methods

From organic farms cultivating carrots, the produce was gathered in 2003 (20 farms) and 2004 (15 farms) and analysed on nitrate. In a farm questionnaire, farmers were asked to provide the main agronomic data on the soil, crop rotation and the fertilization. These data were used as input for the NDICEA model (van der Burgt et al, 2006; www.ndicea.nl). The following model outputs were used for this study:

- Nitrogen availability during crop growth, related to crop demand
- Contribution of manure, crop residues, green manures and soil organic matter to the mineralization of nitrogen, average over the crop rotation

The nitrogen availability, in this case the difference between crop demand and available nitrogen, was compared with the nitrate content of the harvested crop. To understand the nitrogen availability, the relative contribution of different 'sources' was taken into account.

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Results

- The nitrate content varied between 34 to 449 ppm in 2003 and between 11 to 864 ppm in 2004.
- As expected, there is not a simple linear relation between the surplus of nitrogen in the soil at harvest (modelled, not measured) and nitrate content of the carrots, but in general high soil-nitrogen levels are corresponding with high nitrate contents in carrots, and vice versa.
- The NDICEA output offers insight in the nitrogen dynamics, which is useful in considering changes in the soil fertility and manuring strategies focussing on a lower nitrate level in carrots.
- As an example, graphs are shown (fig. 1 and 2) of two organic farms, both with a relatively high nitrate content in the carrots. The carrots of farm A contained 449 ppm nitrate, those from farm B 290 ppm.

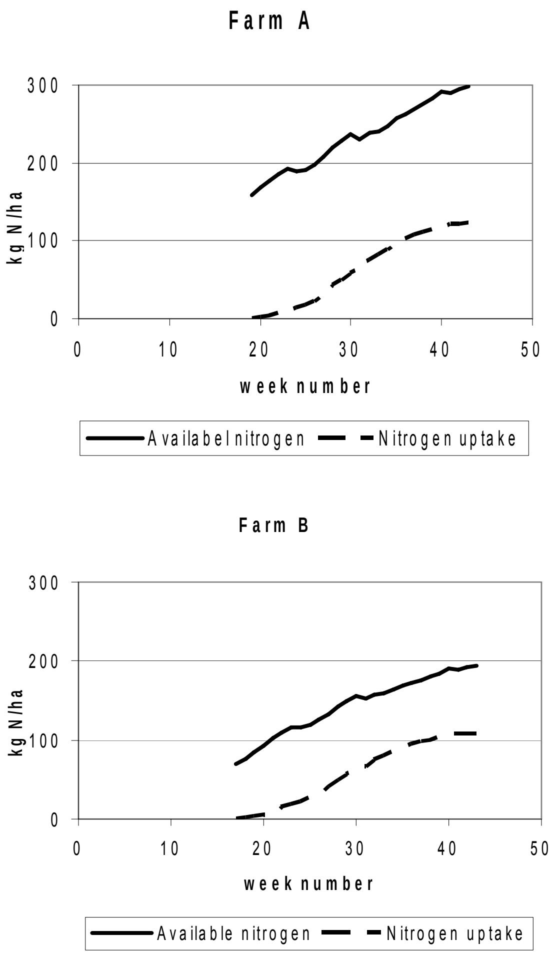

Fig. 1. Modelled nitrogen uptake (dotted line) and available nitrogen (solid line) during crop growth of farms A and B

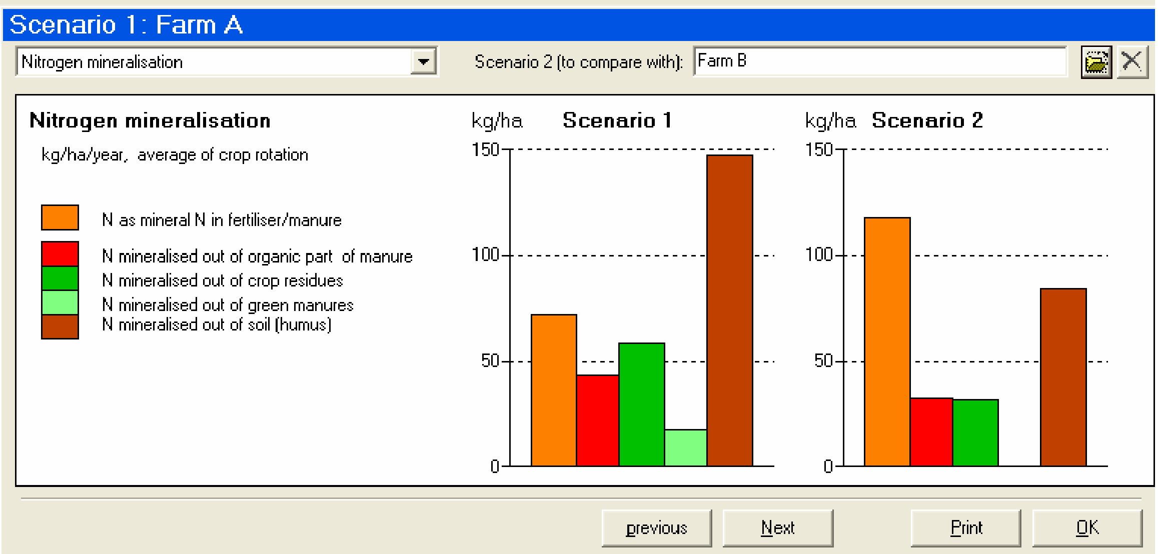

Figure 2. Sources of nitrogen mineralization. Scenario 1 = Farm A; scenario 2 = Farm B.

Discussion

As can be seen from figure 1, the carrot crop from farm A is growing with an almost constant available nitrogen level of 180 kg N/ha (difference between dotted and solid line) whereas at farm B this is about 80 kg. At harvest a substantial difference in nitrate content of the crops was measured: 449 and 290 ppm respectively. As stated before, this high nitrate level can not be fully explained by the difference in available nitrogen only. In this case, the crop from farm A had a serious infection with Alternaria, which is known to increase the nitrate content of the carrot. Further research is needed to go into quantification of the contribution of different factors influencing the nitrate content.

In figure 2 the different 'sources' of nitrogen are presented as average over the crop rotation. In farm A, a relative important part of mineralization is originating from soil organic matter and a minor part originates directly (inorganic N in fertilizers and manure) and indirectly (mineralization from organic N compounds) from manure. Since the soil organic matter and thus mineralization of N cannot simply be changed, farm A will have more difficulties in changing the strategy than farm B. In case of farm B, changes in manure strategy will influence the nitrogen availability in short term.

Conclusions

- Measurements of nitrate content of organically grown carrots in 2003 and 2004 in the Netherlands show a big variation, ranging from 11 to 864 ppm. Part of the produce contains nitrate at a level higher than 200 ppm, which is the maximum allowed in EU for baby food.
- Part of the variation in nitrate content can be explained by soil fertility and manure strategies.
- The NDICEA model offers an easy and cheap entrance to insight in the nitrogen dynamics, thus facilitating decision making related to manure application and soil fertility.

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www.ndicea.nl for more information and download. The model offers choice between Dutch and English model language.

Events

- May 29, 2006, 9 am to 6 pm
  2nd FQH-meeting in 2006 in Odense, Denmark
  The workshop aims at intensifying the scientific discourse on future research methods and on the concepts underlying organic food quality. The workshop is primarily open to the participants of the 1st Scientific FQH Conference, but also other scientists interested in the work of FQH are welcome to join in. This meeting is a satellite meeting of the Joint Organic Congress, held in Odense, Denmark, at the end of May 2006.
  Further details: www.organicfqhresearch.org AND http://www.organic-congress.org/satellite.html#Anchor-47857
- May 30 – 31, 2006
  Joint Organic Congress, Odense, Denmark
  In May 2006 - for the first time ever - researchers from virtually all EU funded research projects in organic food and farming will join the same congress to present their results for organic producers and processors, as well as for those interested in an overall sustainable development in Europe.
  Info at http://www.organic-congress.org/
- November 7-9, 2006
  EFFoST Conference 2006 " Sustainability of the Agri-Food Chain" in The Hague, Netherlands
  This conference is organized by the European Federation of Food Science and Technology (EFFoST) and aims to review the latest developments for the sustainability of the agri-food chain.
  Info at www.effost-conference.elsevier.com

Publication

New brochure about organic food quality and safety

The Research Institute of Organic Agriculture FiBL has recently published a brochure on the food quality of organic products in cooperation with Organic FQH. The brochure summarizes the main results of organic food quality research and has many attractive pictures and graphs. Currently it is available in German only, but an English and French edition will be published in the coming months.

The brochure „Qualität und Sicherheit von Bioprodukten - Lebensmittel im Vergleich" can be downloaded and ordered at https://www.fibl.org/shop/show.php?sprache=DE&art=1405.

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Imprint

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Manuscripts and contributions should be submitted in electronic format to the International Research Association for Organic Food Quality and Health FQH (address see above). Half a page and recommended papers will be reimbursed by 50,- €; one and more pages by 100,- € per paper. Authors are kindly asked to send their international bank data to the FQH-coordinator. The following types of contributions are considered:

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