BY JOHANNES KAHL, GEERT JAN VAN DER BURGT, DANIEL KUSCHE, SUSANNE BÜGEL, NICOLAAS BUSSCHER, EWELINA HALLMANN, URSULA KRETZSCHMAR, ANGELIKA PLOEGER, EWA REMBIALKOWSKA, and MACHTELD HUBER

Organic FOOD CLAIMS in Europe

Better regulatory guidelines, improved testing methods, and additional research into product quality criteria are needed to further develop the European organic food market.

The market for organic foods in Europe is growing at a steady pace (Hamm et al., 2004; Willer and Yussefi, 2006; Hughner et al., 2007; Figure 1). In Europe, Germany is the largest market for organics, followed by France, the United Kingdom, and Italy (Figure 2).

Increasingly, consumers are deciding in favor of organic produce because they believe it is naturally produced (e.g., minimally processed), safe, and healthy and that it contributes to a form of production that is sustainable for the environment and society (Torjusen et al., 2004; Siderer et al., 2005; Midmore et al., 2006). These consumer expectations can be divided into two elements: "process-quality," which considers the way a product is produced and processed and how it affects the environment, and "product quality," which consists of measurable properties of the food itself (Alföldi et al., 1998; Woodward and Meier-Ploeger, 1999; Schmid et al., 2006). While it is not disputed that the production process of organic foodstuffs meets process-oriented quality expectations (Kretzschmar et al., 2007), product-oriented quality claims of organic food are under discussion (Alföldi et al., 1998; Siderer et al., 2005; Dangour et al., 2009a, b; Lairon, 2009).

Organic food and its process- and product-related aspects are described in the guidelines of the International Federation of Organic Agricultural Movements (IFOAM, 2006) and in the European regulation on organic production and labeling of organic products (European Commission No. 834/2007). The European Commission (EC) regulations on organic production focus on practical agronomy but are very limited in relation to processing. Only limited food additives or processing agents are allowed but no recommendations for processing techniques are given. In the developing organic market, more and more products have become complex, multi-step processed products. They are the so-called convenience products like deep-frozen pizza or ready-to-eat items such as breakfast cereal and soup. In the organic movement, it is supposed that the impact of intensive processing, which is involved in the processing, which is involved in the production of the aforementioned foodstuffs, might threaten product quality (Woodward and Meier-Ploeger, 1999). The gap between consumer expectations and how regulations may fulfill them underlines the importance of this topic (Beck et al., 2006; Schmid et al., 2006; Niggli and Leifert, 2007).

If consumers are supposed to pay for a "plus" in organic product quality, it is a challenge to first define and second to prove this "plus." With this article, it is our aim to identify potential food claims, to verify whether they can be guaranteed by the EC organic regulation, and to discuss possible criteria for testing their evidence. A second aim is to

Healthful options for an organic breakfast.

Photos in this feature are courtesy of Directorate General for Agriculture and Rural Development of the European Commission

identify research needs in organic food quality.

Organic Food Quality Definitions

We focus first on the impact of organic production on organic food product quality; process-related quality will be examined when research on farm management is discussed. Further, our focus is on nutrient content and not on the content of undesired substances, e.g., residues or mycotoxins. A wide range of original papers, review articles, and research studies document that the system of farm management and food production (regulated in the EC No. 834/2007) results in a high level of biodiversity (McNeely and Scherr, 2001; Lakner, 2004), the preservation of natural resources (Köpke et al., 2005), and the application of high animal welfare standards (Rymer et al., 2006).

The IFOAM guidelines define the purpose of the organic production method, which is "to optimize the health and productivity of … people" (IFOAM, 2006). The aim is to "produce sufficient quantities of high-quality food, fiber, and other products" (IFOAM, 2006; Halberg et al., 2006; Niggli and Leifert, 2007). In section 6.3 of the guidelines, the general principles for regulating processing methods are defined in this way: "Organic food is processed by biological, mechanical and physical methods in a way that maintains the vital quality of each ingredient and the finished product" (IFOAM, 2006).

In the existing regulations, organic quality is defined as food production based on organic standards; organics are processed without the use of a genetically modified organism (GMO) and ionic radiation, with limited use of additives and processing aids, and without the use of chemical processing techniques (like modified starch, fat hydrolyses, etc.). These guidelines do not define the general term "quality" but they define the goal to produce high quality (EC No. 834/2007, Article 3,b). The term "vital" may describe a possible quality aspect, but neither definitions nor limitations are reported. In the EC regulation No. 834/2007, organic production is defined as "a production method in line with the preference of certain consumers for products produced using natural substances and processes" (EC No. 834/2007, (1)), but the term "natural" is not defined in this regulation. Furthermore, the expected impact of the agricultural production process on the food is not described.

Processing methods, which are allowed by the regulation, should "guarantee that the organic integrity and vital qualities of the product are maintained through all stages of the production chain" (EC No. 834/2007, (19)). Here, the terms "organic integrity" and "vital qualities" are not further defined or described. In the objectives and principles for organic production, the aim is defined as "producing products of high quality" (Article 3,b). »»

Furthermore, the food responds "to consumer demand for goods produced by the use of processes that do not harm ... human health" (Article 3,c). This seems to be connected to food safety aspects, and we wonder why it is mentioned especially for organic production. The specific principles that are applied to the processing of organic food exclude substances and processing methods "that might be misleading regarding the true nature of the product" (Article 6,c). In addition, it is specified that the processing should be done with care (Article 6,d). With the exclusion of two processing methods (GMO, ionizing radiation) and several food additives (Annex VIII of the regulation No. 889/2008), it seems that all other processing technologies available and applied in the market are not regulated, and, as the terms "true nature" as well as "care" are not defined, they are also allowed to be applied within EC No. 834/2007.

In EC No. 834/2007, organic food is defined by referring to the EC food regulation No. 178/2002. In this regulation, food is defined as "any substance or product, whether processed, partially processed, or unprocessed, intended to be or reasonably expected to be ingested by humans" including "drink, chewing gum, and any substances, including water, intentionally incorporated into the food during its manufacture, preparation, or treatment" (EC No. 178/2002, Article 2). Quality is defined as "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" (ISO 9000, 2005). To summarize the findings, there is no specific definition of organic food. As there is no specific quality definition or concept for organic food, the stated or implied definition must be extracted from the EC organic regulation, the IFOAM guidelines, marketing strategies of the involved companies, consumer studies, and research findings (Kerbage et al., 2006; van de Vijver, 2007).

Based on the existing guidelines and consumer expectations on organic products, we hypothesize that there is a need for a clear definition and strategy that can complement the process-oriented regulations in order to meet consumers' needs and expectations of organic food as high quality and vital (Cooper et al., 2007; Niggli and Leifert, 2007).

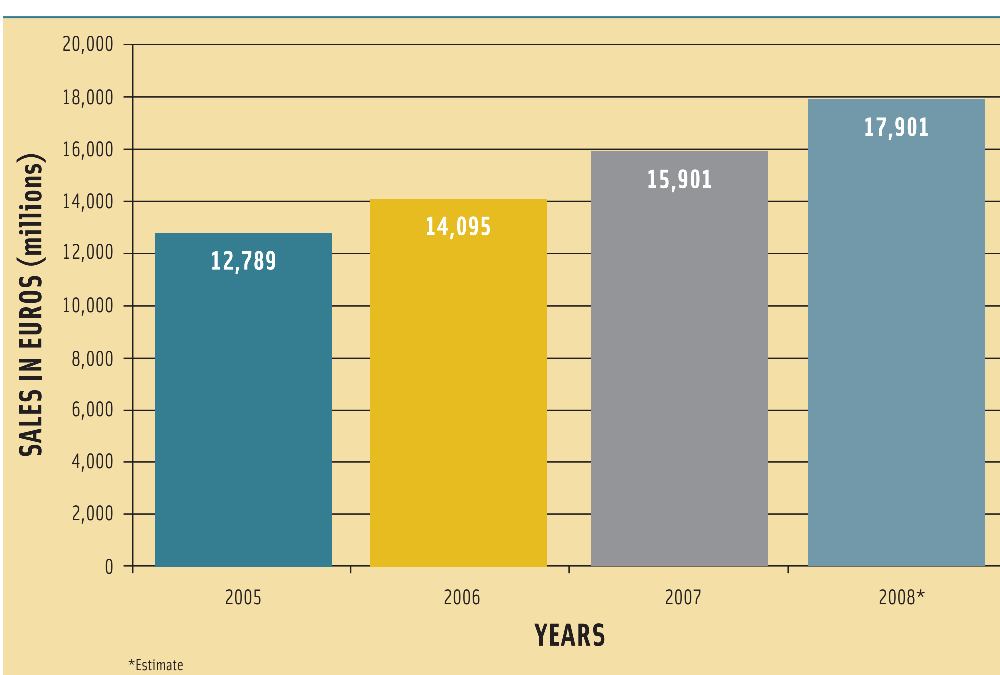
If consumers are supposed to pay for a 'plus' in organic product quality, it is a challenge to first define and second to prove this 'plus.'

Possible Organic Food Claims

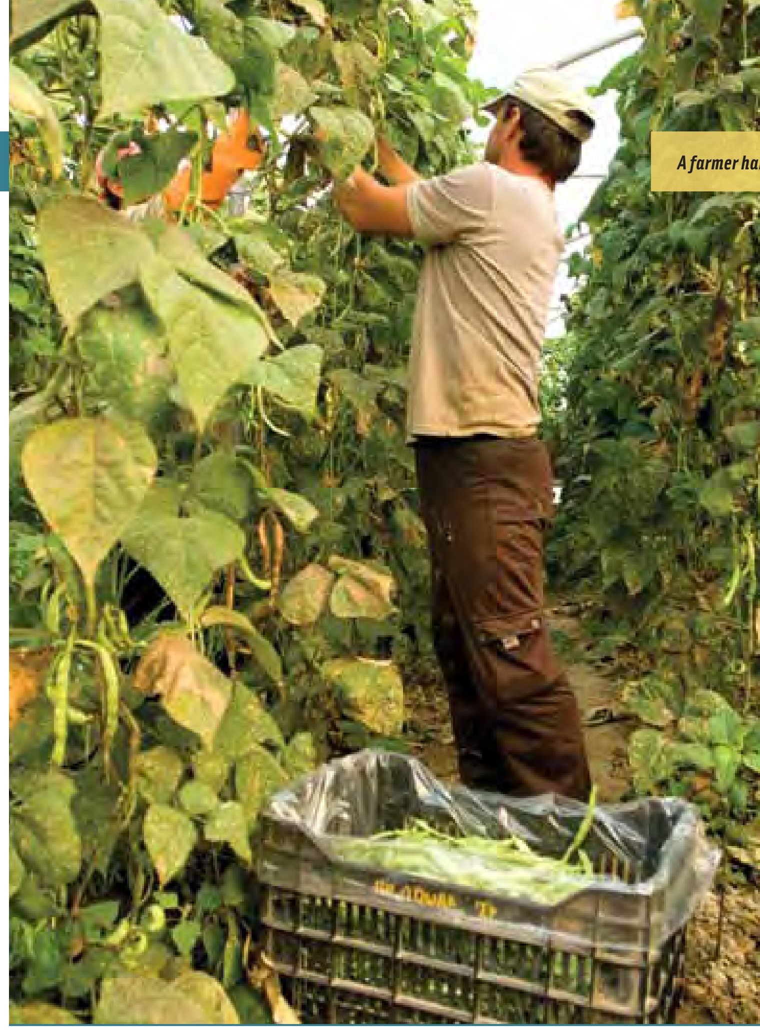
In general, nutrition and health claims made on food and, therefore, also including organic food, are regulated within EC No. 1924/2006. Evidence-based studies have to be carried out before health promotion can start. The studies can apply methods to measure food ingredients (nutrients, health-related compounds) and energy. The health claim regulation refers to EC No. 90/496. Here, food nutrients are listed that may be declared on the nutrition label along with their recommended daily allowances (RDA) as well as what a "significant amount" means (nutrition claims may be applied only when "significant amounts" are present in the advertised food). Up until now, few studies have reported on this evidence for organic food products.

A number of studies have looked at the content of primary and secondary metabolites in different production systems, e.g., organic and conventional systems. Some of the older studies have been reviewed in Woese et al. (1997), Worthington et al. (2001), Heaton

Figure 1. Size of the European market for organic food and drink. From Research Institute for Organic Agriculture (FiBL)



(2001), and Bourn and Prescott (2002). The main conclusion from these reviews is that organic produce has higher dry matter, lower levels of nitrate, and lower pesticide residues. Regarding vitamins, the reviewers conclude that there are trends toward higher vitamin C content in organic produce, while data on mineral content were inconclusive. Since then, approximately 200 papers concerning nutritive content of organic vs conventionally produced foods have been published, and it is evident that interest in this field has increased dramatically over the years. In plants, the focus over the past 10 years has been on the content of vitamin C, carotenoids, and phenolic compounds. Recent reviews, using different criteria for including or excluding studies, report different outcomes and give rise to scientific debate (Winter and Davis, 2006; Rembiałkowska, 2007; Benbrook et al., 2008; Dangour et al., 2009a, b; Lairon, 2009). More recently, the focus has been on counting healthy fatty acids in milk from animal products (Butler et al., 2008, 2009).



A farmer harvests organic green beans.

Potential and Limits

From EC No. 834/2007, we conclude there is no focus on clearly defined product quality aspects or criteria that can be used for testing claims as discussed in this paper. The regulation gives the basis for sustainable production and, with limitations in processing, also the basis for authentic foodstuffs. However, the regulation, as it is at the moment, cannot *guarantee* a consistent quality, nor premium and "vital" quality, meaning the "plus" of these products. Although it is difficult to come to a final guarantee of these qualities, the challenge is to refine the definitions of these terms as potential food claims in a way that allows for the best choice of production method along with scientific verification, using measurements.

Agricultural product properties are primarily constituted in the field. Given a cultivar of a certain crop, the properties of the product at the end of the cultivation are the resulting effect of the environment—in its broadest sense. For animal production, this is essentially the same, although more complex. Research has shown that many product properties are, in order of importance, an overall result of the following: 1) variety of the plant; 2) year/weather/season; and 3) soil and agronomy (Heaton, 2001; Bahar et al., 2008; Benbrook, 2008; Roose et al., 2009). Since variety, year, and soil are not part of the organic regulations, agronomy alone—being a process-oriented regulation—might not cause differences in the level of single food constituents. In many agronomic practices, conventional and organic systems do not differ that much. For example, the type of fertilizers used in conventional and organic farming is only partly different (manures are also used in conventional farming), and quantified parameters on nitrogen application are not able to distinguish (with certainty) between conventional and organic agriculture (here we use the term organic as defined by EC No. 834/2007). If differences in process quality are not guaranteed, the resulting product quality will very likely show an overlap between conventional and organic products. A market survey might eventually result in *statistically* proven differences between organic and conventionally produced foodstuffs but not in *guaranteed* differences. Although when a defined field trial will show significant differences between, e.g., plant products grown organically and conventionally, the difference would be within the range of variation when taking other locations, varieties, etc., into account.

Based on results from controlled trials using best agricultural practices (Mäder et al., 2002; Bloksma et al., 2007), we conclude that organic products can *potentially* be distinguished from conventional products. The question as to whether observed differences between organic and conventional products can or cannot be addressed as a "plus" for organic is not yet answered and depends on the selected claim. We conclude that the regulations—with the process-oriented approach—must be more precise so that those practices, processes, and technologies are more strictly excluded, ensuring that they do not lead to a potential guaranteed claim.

Possible Research Actions

From these findings, there are three critical steps that need to be clarified in order to establish guaranteed organic food claims. First, the process regulations describe several production goals as moving toward a "plus" in organic food without a clear definition of the claims. Second, the defined goals, which aim to form a basis for these potential claims of organic food, are not fully embedded in the existing food concepts (e.g., terms like "integer," "vital," etc.). Third, the potential methods needed in order to make claims are not available or tested in such a way that allows for the determination of the levels and/or limits. Therefore, we suggest the following actions to overcome the problems in organic food quality determination:

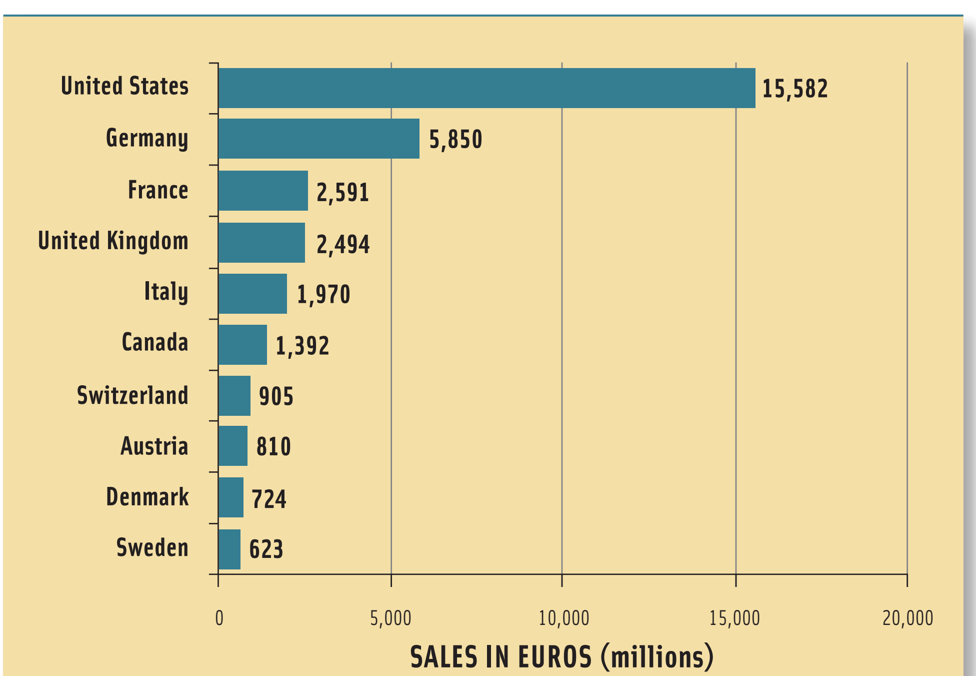
- Studies comparing different production methods according to the potential claim;
- Definition of the terms within EC No. 834/2007 which can be used as potential food claims and application and/or development of concepts for their scientific description;
- Tests, development, and validation of methods for the determination of the food aspects/criteria important for the defined food claims; and
- Revision of EC No. 834/2007 in order to exclude production methods that do not allow extras (the "plus") in the organically produced food.

Quality Concepts and Determination

Food quality is generally related to the presence of desired and/or healthy constituents and the absence of harmful components and microbial and fungal impurities (EC No. 1924/2006). However, there is a growing insight that the *presence* of single substances may not be the only criterion. For some substances, research has shown that it makes a difference if a substance is present in a food product or taken in as a food supplement (Omenn et al., 1996; Lippman et al., 2008). Moreover, the health effect of single food constituents, like secondary plant compounds, is controversially discussed (Heinonen and Albanes, 1994; Omenn et al., 1996; Brambilla, et al., 2008). Although a positive health effect against cancer was proposed for lycopene in tomatoes (Rao and Agarwal, 2000), recent studies show that this compound seems not to be responsible for the effect; instead, tomatoes as a whole (or other compounds) are responsible (Gitenay et al., 2007a, b). This was also shown for beta-carotene in carrots (Heinonen and Albanes, 1994; Omenn et al., 1996) and selenium in vegetables (Lippman et al., 2008). In other words, the *context* and the food product as a whole is relevant, not just the presence and consumption of a single substance. Therefore, representatives from the organic sector support the view which suggests that there is a different structure and order and/or organization in organic products (Verhoog et al., 2007; Kusche et al., 2009). So far, a consistent analytical method to differentiate the products from different cultivation systems is nonexistent (Siderer et al., 2005). However, methods developed to determine the level of order and/or organization of products are occasionally able to differentiate between defined food samples from organic and conventional origin (Turinek et al., 2009). These new methods are not yet fully validated and their principles are still under investigation (Busscher et al., 2009).

From this, we conclude that a quality assessment restricted to single substances is not sufficient.

Figure 2. Leading markets in organic food sales. From Research Institute for Organic Agriculture (FiBL)



Methods are needed that determine product quality at higher levels of integration (e.g., sensory analysis, biocrystallization, or others). Concepts of food quality are needed that are related to these higher levels. These concepts should be connected to the principles of organic farming within a systems approach and should allow for verification (Baars and Baars, 2007).

According to Siderer et al. (2005), scientifically testable concepts are necessary to frame new assessment methods. Streiner and Norman (2001) presented a validation route for new concepts and new parameters, which can be used for framing the concepts of food quality. The organic movement does not yet have consensus about a suitable concept for product quality evaluation although many concepts have been introduced (Kahl et al., 2009). Most of the concepts propose an extension of the existing quality concepts, which means from single substance measurement and evaluation toward evaluating the product as a whole. One of these concepts was developed (Bloksma et al., 2007) to integrate quality aspects as potential food claims, conceptual theories, and methods to test the hypothesis.

This "Inner Quality" concept is based on the plant physiological processes during "growth," the vegetative phase of plant development, and "differentiation," the generative phase, and their integration (Bloksma et al., 2007), and the concept has been studied in multifactorial trials (Bloksma et al., 2001, 2004; Northolt et al., 2004. It connects to the "growth-differentiation-balance-hypothesis" (GDBH) of plant physiologists. According to the GDBH, growth is necessary for primary metabolism and differentiation for secondary metabolism. This concept is being used primarily by farmers to improve their product quality by taking adequate agronomic measures. Secondly, it is being applied to

Organic lettuce and vegetables.

find parameters in the harvested product to assess product quality (claims), but until now, has been restricted to plant products (Bloksma et al., 2007). It is suggested that it should now be developed further so that it can be used for processed organic food.

Research Requirements

To explore the area of product quality further, research should be intensified. This research must meet the actions to overcome the existing problems, as mentioned above. According to the statement that organic food production is "an overall system of farm management and food production" (EC No. 834/2007 (1)), research approaches should include the whole production chain, from field to fork. To avoid unnecessary research, at first the most critical and relevant steps in the food chain must be identified, where the potential food claims are generated or diminished. The potential claims must be defined and embedded in quality models/concepts, and methods must be adapted or developed for measuring specific criteria. Initially, studies should explore the *potential* differences between conventional and organic farming in relation to cultivation measurements and not only the actual average product quality in the market.

Research should generate two types of output: criteria/parameters (to be included in the quality assessment as potential food claims) and quality concepts (for embedding terms like "vitality" or "integrity").

Exploring Farm Management

For testing the impact of farm management, field trials are necessary to generate datasets to validate selected variables. Two different approaches should be applied: factorial field experiments and farm system research. To understand the mechanisms that cause the differences in product quality, factorial trials (at field level) are essential. As crop variety is a very important variable with a potential major influence on product quality parameters, the choice of cultivars should be studied. In scientific literature, using the same cultivar in comparing field trials is described as the "golden" standard (Harker, 2004), but it is also argued that organic agriculture needs specific cultivars with suitable root systems to obtain optimal results (Lammerts van Bueren et al., 2002; Przystalski et al., 2008). Equivalent to the search for the most critical point in the chain (from field to fork), key factors at farm or field level should be identified (de Wit and de Vries, 2008; Husted and Holst-Laursen, 2009). This process of identification is needed to understand and interpret differences between systems for selected plant metabolites based on knowledge of the fundamental biochemical pathways. Preferably, the parameters to be tested must be selected from the list of potential food claims, but the quality aspects as described also need to be integrated once they are clearly defined.

Processing Methodologies Needed

The focus of future research activities on organic food quality should also be on the processing of the food. Carefully processed food is an expectation of the consumer as well as a principle set out in EC No. 834/2007. Here, technologies have a very high impact on different quality aspects (Kretzschmar and Schmid, 2006; Lanzon et al., 2009). Furthermore, processing is not well defined in EC No. 834/2007 (Kretzschmar et al., 2007). Sustainable farming systems occur in practice, but there are no regulations regarding sustainable processing or packaging.

Possible research tasks include reviews on the existing technologies regarding their potential for guaranteeing an organic claim. New technologies, e.g., nanotechnology, should be evaluated in this way. Research methods should include quality analyses of critical control points at an industry level, followed by pilot plant studies on the critical steps involved. Furthermore, selected technologies should evaluate how they fulfill "careful processing" as mentioned in EC No. 834/2007 or "minimal processing" as suggested by the market (Kretzschmar et al., 2007). Life cycle assessments should be a standard criterion for the evaluation of processing techniques. A standardized method for the evaluation of careful processing methods should be established.

Implications Moving Forward

Several studies indicate a potential difference between products from organic and conventional farming (Rembiałkowska, 2007; Benbrook et al., 2008; Lairon, 2009). Neither organic standards (e.g., IFOAM) nor regulations (e.g., EC No. 834/2007) can guarantee a "plus" in nutritional and health benefits if farming practices and processing technologies are not strict enough (Dangour et al., 2009a, b). Additional potential claims on organic food, as mentioned in the standards and regulations (e.g., true nature, careful processing, organic integrity, etc.) need to be defined in relation to food quality concepts and methods for determination. Future research should focus on these tasks. Furthermore, identification and evaluation of weak and critical points in the whole food chain are necessary, whereby storage, transport, and food processing are the most important steps for optimization. Finally, effect studies on product consumption of different qualities in animals and humans is inevitable if we are to undertake an ultimate test of consumer expectations. **FT**

***Johannes Kahl**, Dr., a Member of IFT, is Senior Researcher, Dept. of Organic Food Quality and Food Culture, Univ. of Kassel, Nordbahnhofsstr. 1a, D-37213 Witzenhausen, Germany (kahl@uni-kassel.de). **Geert Jan van der Burgt** is Researcher, Louis Bolk Inst., Hoofdstraat 24, NL-3972 LA Driebergen, The Netherlands (g.vanderburgt@louisbolk.nl). **Daniel Kusche** is Researcher, Dept. for Biodynamic Agriculture, Univ. of Kassel (daniel.kusche@uni-kassel.de). **Susanne Bügel**, Ph.D., is Assoc. Professor, Dept. of Human Nutrition and Centre for Advanced Food Studies, Faculty of Life Science, Univ. of Copenhagen, Denmark, Rolighedsvej 30, DK-1958 Frederiksberg (shb@life.ku.dk). **Nicolaas Busscher**, Dr., is Senior Researcher, Dept. of Organic Food Quality and Food Culture, Univ. of Kassel (busscher@uni-kassel.de). **Ewelina Hallmann**, Dr., is with Warsaw Univ. of Life Sciences, Nowousrynowska 159 c, 02-787 Warsaw, Poland (ewelina_hallmann@sggw.pl). **Ursula Kretzschmar** is Head of the Dept. Food Quality, Safety and Processing, Research Institute of Organic Agriculture (FiBL), Ackerstrasse, 5070 Frick, Switzerland, (ursula.kretzschmar@fibl.org). **Angelika Ploeger**, Dr. agr,. Dr. h.c. mult., is Head of the Dept. of Organic Food Quality and Food Culture, Univ. of Kassel (a.ploeger@uni-kassel.de). **Ewa Rembialkowska**, is Professor, Warsaw Univ. of Life Sciences (ewa_rembialkowska@sggw.pl). **Machteld Huber**, MD, is Senior Researcher, Louis Bolk Inst. (m.huber@louisbolk.nl).*

The authors of this article are members of the International Research Association for Organic Food Quality and Health (FQH), an organization that aims to investigate and develop a scientific basis for organic food quality as well as novel methods to examine food quality and to study the influence of organic food on human health.

REFERENCES

Alföldi, T., Bickel, R., Weibel, F. 1998. A comparative quality analysis between organically and conventionally grown products: A critical review of research from 1993 to 1998. Research Inst. for Organic Agriculture (FiBL), Frick, Switzerland.

Baars, E. and Baars, T. 2007. Towards a philosophical underpinning of the holistic concept of integrity of organisms within organic agriculture. NJAS Wageningen J. of Life Sci. 54(4): 463-477.

Bahar, B., Schmidt, O., Moloney, A.P., Scrimgour, C.M., Begley, I.S., and Monahan, F.J. 2008. Seasonal variation in the C, N and S stable isotope composition of retail organic and conventional Irish beef. Food Chem. (106): 1299-1305.

Beck, A., Kretzschmar, U., and Schmid, O. 2006. Concept papers outlining parameters for further development of organic food processing—crucial topics for the revision of the EU regulation 2092/91. Research Inst. for Organic Agriculture (FiBL), Frick, Switzerland.

Benbrook, C., Zhao, X., Yanez, J., Davies, N., and Andrews, P. 2008. New evidence confirms the nutritional superiority of plant-based organic foods. State of Science Review. The Organic Center. http://www.organic-center.org/science.nutri.php?action=view&report_id=126. Accessed Oct. 1, 2009.

Bloksma, J., Northolt, M., and Huber, M. 2001. Parameters for apple quality and an outline for a new quality concept, part 1 and 2. Louis Bolk Inst., Dept. of Healthcare & Nutrition, Driebergen, The Netherlands.

Bloksma, J., Northolt, M., Huber, M., Jansonius, P.J., and Zanen, M. 2004. Parameters for apple quality and the development of the Inner Quality Concept 2001-2003. Louis Bolk Inst., Dept. of Healthcare & Nutrition, Driebergen, The Netherlands.

Bloksma, J., Northolt, M., Huber, M., van der Burgt, G.J., van de Vijver, L.P.L. 2007. A new food quality concept based on life processes. In "Handbook of Organic Food Safety and Quality," eds. J. Cooper, U. Niggli, and C. Leifert, pp. 53-73, Woodhead Publishing, Cambridge, UK.

Bourn, D. and Prescott, J. 2002. A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. Crit. Rev. Food Sci. Nutr. 42(1): 1-34.

Brambilla, D., Mancuso, C., Scuderi, M.R., Bosco, P., Cantarella, G., Lempereur, L., Di Benedetto, G., Pezzino, S., and Bernardini, R. 2008. The role of antioxidant supplement in immune system, neoplastic, and neurodegenerative disorders: a point of view for an assessment of the risk/benefit profile. Nutr. J. 7: 29-40.

Busscher, N., Kahl, J.., Andersen, J.O., Huber, M., Mergardt, G., Doesburg, P., Paulsen, M., and Ploeger, A. 2009. Standardization of the biocrystallization method for carrot samples. Biol. Agric. Hortic. 27(1): 1-23.

Butler, G., Nielson, J.H., Slots, T., Seal, C., Eyre, M.D., Sanderson, R., and Leifert, C. 2008. Fatty acid and fat-soluble antioxidant concentrations in milk from high- and low-input conventional and organic systems: seasonal variation. J. Sci. Food Agric. 88: 1431-1441.

Butler, G., Collomb, M., Rehberger, B., Sanderson, R., Eyre, M., and Leifert, C. 2009. Conjugated linoleic acid isomer concentrations in milk from high and low-input management dairy systems. J. Sci. Food Agric. 89(4): 697-705.

Cooper, J., Leifert, C., and Niggli, U., eds. 2007. "Handbook of Organic Food Safety and Quality." Woodhead Publishing Limited," Cambridge, UK.

Dangour, A., Aikenhead, A., Hayter, A., Allen, E., Lock, K., and Uauy, R. 2009a. Comparison of putative health effects of organically and conventionally produced foodstuffs: a systematic review. Report for the Food Standards Agency PAU221. http://www.food.gov.uk/multimedia/pdfs/organicreviewreport.pdf. Accessed Oct. 1, 2009.

Dangour, A., Dodhia, S., Hayter, A., Aikenhead, A., Allen, E., Lock, K., and Uauy, R. 2009b. Comparison of composition (nutrients and other substances) of organically and conventionally produced foodstuffs: a systematic review of the available literature. Report for the Food Standards Agency PAU221. http://www.food.gov.uk/multimedia/pdfs/organicreviewappendices.pdf. Accessed Oct. 1, 2009.

De Wit, J. and de Vries, A. 2008. Feed composition and strategies to improve polyunsaturated fatty acid levels in organic cow milk. In "Cultivating the Future Based on Science," Vol.1 and 2. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR), eds. D. Neuhoff, N. Halberg, T. Alföldi, W. Lockeretz, A. Thommen, I.A. Rasmussen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H.H. Jensen, P. Migliorini, H. Willer, pp. 760-763.

EC. Council Regulation (European Community) No. 178/2002 of the European parliament and of the council of Jan. 28, 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.

EC. Council Regulation (European Community) No. 1924/2006 of the European Parliament and of the Council of Dec. 20, 2006 on nutrition and health claims made on foods.

EC. Council Regulation (European Community) No. 834/2007 of June 2007 on organic production and labeling of organic products and repealing Regulation (EEC) No. 2092/91.

EC. Commission regulation (European Community) No. 889/2008 of Sept. 5, 2008 laying down detailed rules for the implementation of Council Regulation (EC) No. 834/2007 on organic production and labeling of organic products with regard to organic production, labeling and control.

EEC. Council directive of Sept. 24, 1990 on nutrition labeling for foodstuffs (90/496/European Economic Community).

Gitenay, D., Lyan, B., Rambeau, M., Mazur, A., and Rock, E. 2007a. Comparison of lycopene and tomato effects on biomarkers of oxidative stress in vitamin E deficient rats. Eur. J. Nutr. 46(8): 468-75.

Gitenay, D., Lyan, B., Talvas, J., Mazur, A., George, S., Caris-Veyrat, C., and Rock, E. 2007b. Serum from rats fed red or yellow tomatoes induces Connexn43 expression independently from lycopene in a prostate cancer cell line. BBRC 364: 578-582.

Halberg, N., Alrøe, H.F., and Kristensen, E.S. 2006. Synthesis: prospects for organic agriculture in a global context. In "Global Development of Organic Agriculture: Challenges and Prospects," eds. N. Halberg, H. Alrøe, K. Fjelsted, M. Trydeman, and E.S. Kristensen, pp. 343-367. CABI Publishing.

References continued on p. 46 »»

REFERENCES (continued)

Hamm, U., Gronefeld, F., and Halpin, D. 2004. "The European Market for Organic Food: Revised and Updated Analysis," Organic Marketing Initiatives and Rural Development (OMIaRD) Series, Vol. 5. University of Wales, Aberystwyth, UK.

Harker, F.R. 2004. Organic food claims cannot be substantiated through testing of samples intercepted in the marketplace: a horticulturalist's opinion. Food Qual. Pref. 1: 91-95.

Heaton, S. 2001. Organic farming, food quality and human health. Soil Assn., Bristol, UK.

Heinonen, O.P. and Albanes, D. 1994. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. N. Engl. J. Med. 330: 1029-1035.

Hughner, R.S., McDonagh, P., Prothero, A., Shultz, C.J., and Stanton, J. 2007. Who are organic food consumers? A compilation and review of why people purchase organic food. J. Consumer Behav. 6: 94-110.

Husted, S. and Holst Laursen, K. 2009. Why is the chemical composition of organic and conventional products different? In "Towards Improved Quality in Organic Food Production." Proceedings of the Fifth European Integrated Project Quality Low Input Food (QLIF) Training and Exchange Workshop, eds. M. Hospers and G.J. van Der Burgt. Louis Bolk Inst., Driebergen, The Netherlands.

IFOAM. 2006. Basic standards and accreditation criteria, version 2005. The International Federation of Organic Agricultural Movements, Bonn, Germany. ISBN: 978-3-934055-58-2.

ISO 9000. 2005. Quality management systems – fundamentals and vocabulary. International Organization for Standardization, Geneva, Switzerland. www.iso.org.

Kahl, J., Busscher, N., and Ploeger, A. 2009. Questions to the validation of holistic methods testing organic food quality. Biol. Agric. Hortic. (in press).

Kerbage, L., Wyss, G., Granado, J., Weibel, F., Alföldi, T., and Niggli, U. 2006. Is organic a better solution? SZE (3+4): 7-11.

Köpke, U., Niggli, U., Neuhoff, D., Cornish, P., Lockeretz, W., and Willer, H., eds. 2005. "Researching Sustainable Systems." Proceedings of the First Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR).

Kretzschmar, U. and Schmid, 0. 2006. Approaches used in organic and low input food processing – impact on food quality and safety, results of a Delphi survey from an expert consultation in 13 European countries. Research Inst. for Organic Agriculture (FiBL), Frick, Switzerland.

Kretzschmar, U., Ploeger, A., and Schmid, O. 2007. Development of a framework for the design of minimum processing strategies which guarantee food quality and safety - principles, concepts and recommendations for the future. In "Improving Sustainability in Organic and Low Input Food Production Systems." Proceedings of the Third International Congress of the European Integrated Project Quality Low Input Food (QLIF), eds. U. Niggli, C. Leifert, T. Alföldi, L. Lück, and H. Willer. Accessed Oct. 1, 2009.

Kusche, D., Busscher, N., Kahl, J., and Ploeger, A. 2009. The concept of "structure" in the evaluation of food quality. Biol. Agric. Hortic. (in press)

Lairon, D. 2009. Nutritional quality and safety of organic food. A review. Agron. Sustain. Dev. (in press).

Lakner, S. 2004. Organic farming and sustainability - an assessment with ecological and economical indicators. Master thesis, Univ. of Göttingen, Germany.

Lammerts van Bueren, E.T., Struik, P.C., and Jacobsen, E. 2002. Ecological concepts in organic farming and their consequences for an organic crop ideotype. NJAS 50: 1-26.

Lanzon, N., Kahl, J., and Ploeger, A. 2009. Nanotechnology in the context of organic food processing. http://orgprints.org/view/projects/int_conf._2009_wita.html. Accessed Oct. 1, 2009.

Lippman, S.M., Klein, E.A., and Goodman, P.J. 2008. Effect of selenium and vitamin E on risk of prostate cancer and other cancers. JAMA. http://jama.ama-assn.org/cgi/content/abstract/2008.864v1. Accessed Oct. 1, 2009.

Mäder, P., Fließbach, A., Dubois, D., Fried, P., and Niggli, U. 2002. Soil fertility and biodiversity in organic farming. Science 296: 1694-1697.

McNeely, J.A. and Scherr, S.J. 2001. Common ground, common future. How eco-agriculture can help feed the world and save wild biodiversity. http://www.undp.org/biodiversity/biodiversitycd/ecoagriculturepdf.pdf. Accessed Oct. 1, 2009.

Midmore, P., Wier, M., and Zanoli, R. 2006. Consumer attitudes towards the quality and safety of organic and low input foods. http://orgprints.org/8181/01. Accessed Oct. 1, 2009.

Niggli, U. and Leifert, C. 2007. Improving the quality and safety of organic and low input foods and maximizing the benefits to consumers and producers, presented at Third QLIF Congress, Hohenheim, Germany, March 20-23. http://orgprints.org/view/projects/int_conf_qlif2007.html. Accessed Oct. 1, 2009.

Northolt, M., van der Burgt, G.J., Buisman, T., and van den Bogaerde, A. 2004. Parameters for carrot quality and the development of the Inner Quality Concept. Louis Bolk Inst., Dept. of Healthcare & Nutrition, Driebergen, The Netherlands.

Omenn, G.S., Goodman, G.E., Thornquist, M.D., Balmes, J., Cullen, M.R., Glass, A., Keoghi, J.P., Meyskens, F.L., Valanis, B., Williams, J.H., Barnhart, S., and Hammar, S. 1996. Effects of a combination of beta carotene and vitamin A on lung cancer and cardiovascular disease. N. Engl. J. Med. 334: 1150-5.

Przystalski, M., Osman, A., and Thiemt, E. 2008. Comparing the performance of cereal varieties in organic and non-organic cropping systems in different European countries. Euphytica 163: 417-433.

Rao, A.V. and Agarwal, S. 2000. Role of antioxidant lycopene in cancer and heart disease. J. Am. Coll. Nutr. 19(5): 563-569.

Rembiałkowska, E. 2007. Quality of plant products from organic agriculture. J. Sci. Food Agric. 87: 2757-2762.

Roose, M., Kahl, J., and Ploeger, A. 2009. Influence of the farming system on the Xanthophyll content of soft and hard wheat. J. Agric. Food Chem. (57)

Rymer, C., Vaarst, M., and Padel, S. 2006. Future perspective for animal health on organic farms: main findings, conclusions and recommendations from the Sustaining Animal Health and Food Quality in Organic Farming (SAFO) network, presented at Fifth SAFO Workshop, Odense, Denmark, June 1.

Schmid, O., Beck, A., and Kretzschmar, U. 2006. Underlying principles in organic and "low-input" food processing – literature survey. Research Inst. for Organic Agriculture (FiBL), Frick, Switzerland.

Siderer, Y., Maquet, A., and Anklam, E. 2005. Need for research to support consumer confidence in the growing organic food market. Trends Food Sci. Technol. (16): 332-343.

Streiner, L.D. and Norman, G.R. 2001. "Health Measurement Scales: A Practical Guide to Their Development and Use," 4th ed. Oxford University Press, Oxford, UK

Torjusen, H., Sangstad, L., O´Doherty-Jensen, K., and Kjaernes, U. 2004. European consumers' conceptions of organic food: a review of available research. Project report 4-2004. National Inst. for Consumer Research, Oslo, Norway.

Turinek, M., Grobelnik-Mlakar, S., Bavec, M., and Bavec, F. 2009. Biodynamic agriculture research progress and priorities. Renewable Agric. Food Syst. 24(2): 146–154.

Van de Vijver, L.P.L., ed. 2007. "Measuring Food Quality: Concepts, Methods and Challenges." Proceedings of the Third QLIF training and exchange workshop. Louis Bolk Inst., Driebergen, The Netherlands.

Verhoog, H., Lammerts van Bueren, E.T., Matze, M., and Baars, T. 2007. The value of "naturalness" in organic agriculture. NJAS 54(4): 333-345

Willer, H. and Yussefi, M. 2006. The world of organic agriculture. Statistics and emerging trends. The International Federation of Organic Agricultural Movements, Bonn, Germany.

Winter, C.K. and Davis, S.F. 2006. Organic foods. J. Food Sci. 71(9): 117-124.

Woese, K., Lange, D., Boess, C., and Bogl, K.W. 1997. A comparison of organically and conventionally grown foods – results of a review of the relevant literature. J. Sci. Food Agric. 74: 281-293.

Woodward, L. and Meier-Ploeger, A. 1999. Does "organic" mean "quality"? Ecology and Farming 20: 16-17.

Worthington, V. 2001. Nutritional quality of organic versus conventional fruits, vegetables, and grains. J. Altern. Complement. Med. 7: 161-173. :182-8.").