ELM FARM RESEARCH CENTRE

ELM FARM RESEARCH CENTRE CONFERENCE

DOES ORGANIC FOOD HAVE AN 'EXTRA QUALITY'?
New Research, New Perspectives and New Insights

A record of the Conference held on TUESDAY, 23RD NOVEMBER 2004

This Conference was sponsored by Sheepdrove Trust in collaboration with

FQH (International Network for Food Quality and Health)
Sustain (the alliance for better food and farming)

ELM FARM RESEARCH CENTRE
The Organic Research Centre
'For organic principles and best practice'

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DOES ORGANIC FOOD HAVE AN "EXTRA QUALITY"?
New research, New perspectives and New insights Conference
23rd November 2004

Proceedings Contents

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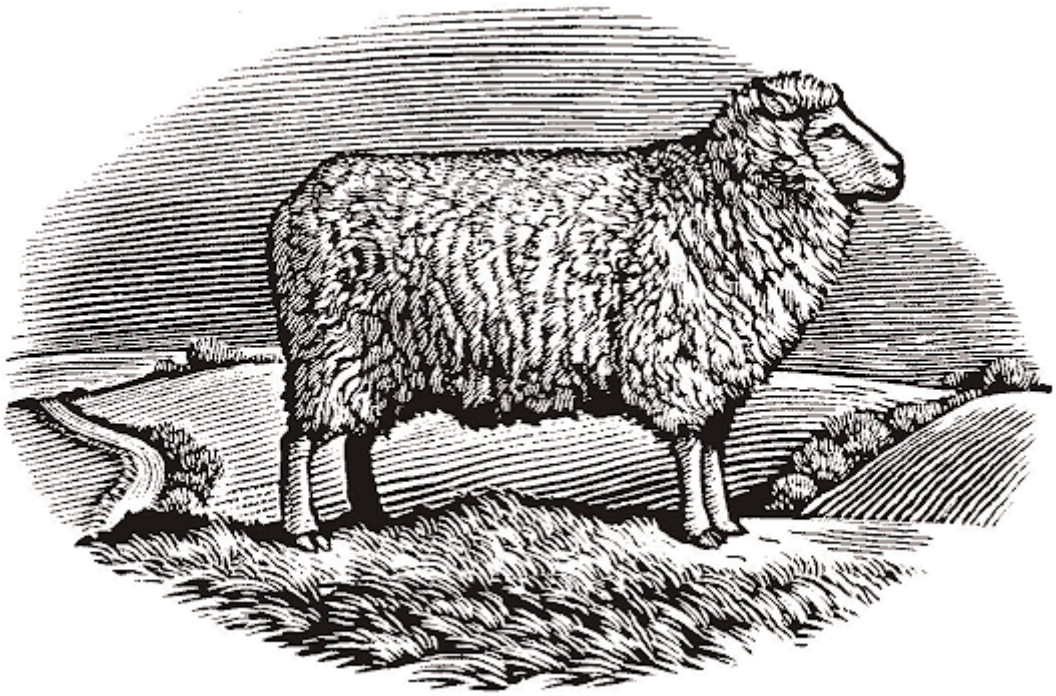
A special acknowledgement

We acknowledge and thank the Sheepdrove Trust for its financial support towards this Conference which allowed the use of the beautiful setting of the Kindersley Centre and its excellent facilities



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Acknowledgements

We would like to thank **all** those who participated in the Conference on 23rd November 2004 - those who gave presentations, those who chaired, those who responded and those who participated in asking questions and the discussions.

We also thank the team that organised the event so effectively.

The production of these proceedings has been supported by:

promar International

"Stressing the importance of differentiating between accepted dogma: "Organic food is better for you" and what is actually "true", i.e. the scientifically proven, Dr Brandt's interesting and balanced paper highlighted the need for a consistent approach and common understanding if claims about organic food are to be accepted.

The science that proves the "extra qualities" of organic food, or equally that demonstrates the detrimental effects of "conventionally-produced" foods, on our health is still developing, as shown by other speakers. But Dr Brandt concluded that organic farming, which has distinct benefits for the environment and food produced, has that "extra quality" that was the Conference's theme.

For consumers, the key benefit of organic produce may simply derive from the fact that positive choices are made in food purchasing that enhance a sense of individual value and well-being".

Alara Wholefoods

"Projects that give statistically robust nutritional differentiation between organic and non-organic food are very welcome by organic food manufacturers".

Duchy Home Farm

FOREWARD

The following pages are a record of a conference that took place on 23rd November 2004 at the Kindersley Centre, Lambourn, Berkshire UK.

These pages have been produced from material provided by the speakers and from a transcript of the presentations given on the day and the ensuing discussions. They are therefore a faithful but edited representation of the day's events.

None of the major speakers presented in their native language and whilst we have "tidied up" somewhat we have not attempted to produce polished papers. Similarly references have been included for information but we have not attempted to follow a uniform style or order.

All the presentations have or will shortly be appearing in the scientific literature. Our aim here is to; firstly respond to the wishes of conference delegates who wanted to access the material they saw and heard on the day; secondly to disseminate information which we believe is very important to a greater number of people than could fit into the conference hall; and thirdly to provide access to those who would not normally consult scientific journals.

The addresses of the speakers are included to enable readers to follow up any issues directly with them.

Lawrence Woodward O.B.E
Elm Farm Research Centre

SPEAKER BIOGRAPHIES

DR. KIRSTEN BRANDT

Senior Lecturer

School of Agriculture, Food and Rural Development
University of Newcastle

Originally trained in plant biochemistry. Her research focuses on links between agricultural methods, plant chemistry, food quality and health of humans and animals. Until the end of 2003 worked as senior scientist in the Danish Institute of Agricultural Sciences, initiating several multi-disciplinary research programmes in these areas

Roles and Responsibilities

In a new FP6 IP project on organic agriculture "Quality Low Input Food" , coordinates the part on nutrition and health, comprising 3 work packages and involving 6 institutions across Europe. Presently an important part of her work is to coordinate the establishment of a Research Centre on Food Quality at University of Newcastle, linking a range of research groups with specialised expertise in food related areas, such as human nutrition, consumer science, agronomy and economics. The objectives are to enhance the impact and exploitation of the research and training activities in industry and society and to facilitate the creation and success of multidisciplinary research projects

Research Interests

Links between agricultural methods, plant chemistry, food quality and health of humans and animals, in particular:
Effects of plant secondary metabolites (natural pesticides) on humans, in order to improve the beneficial impact of vegetables and other herbs on human health.
Plant adaptation to low-input conditions regarding product quality and susceptibility to pests and diseases, in order to improve the balance of environmental and economic sustainability in agriculture and horticulture

DR. JOHANNES KAHL

1990	B.S. Department of Chemistry, University of Dortmund
1993	Diploma in Chemistry, Institute for Environmental Protection (INFU)
1997	Ph.D. in Chemistry (BMBF-Project), Institute of Spectrochemistry and Applied Spectroscopy (ISAS)
1997-1999	Postdoctoral Research, Max-Planck-Institute Chemical Ecology, Jena, Germany
1999-2001	Management Marketing of organic food and services
2000	Lectures at the University of Sao Paulo, Brazil, Teaching Travel Award, German Academic Exchange Service
since 2001	Head of the food quality group at the University of Kassel (together with N. Busscher)

PROFESSOR DR. ANGELIKA MEIER-PLOEGER

PHD at the Justus-Liebig-University, Home economics , Nutrition and Food Sciences. For 3 years scientific employee at the Institute for Nutrition Sciences (Prof Dr. C. Leitzmann). From 1976-1981 taught on the Government Teaching Institution for dietitians at the clinics of the Justus-Liebig-University in Gießen. Activity in industry (1981-1984) at the Alfa Institute GmbH, Eltville-Erbach (a Swiss Company, head of the Departments Nutrition Sciences as well as Economics).

Appointment as professor at the University of Applied Sciences Niederrhein (1984-1986).

1986 appointment as professor to the University of Applied Sciences in Fulda, Dep. for Food and Nutrition. Emphasis on investigations in the field of nutrition ecology as well as food quality.

Since October 2001 Professor at the University of Kassel, Head of the Dep. for Organic Food Quality and Food Culture at the Faculty of Organic Agricultural Sciences, Witzenhausen, Germany.

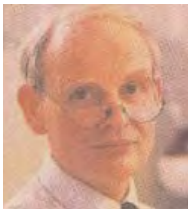
Member of the Scientific Advisory board (Consumer and Nutrition policy) for Ministry of Consumer Affairs, Food & Agriculture.
Member of the Scientific Advisory board (Genetic Resources, Biodiversity) for Ministry of Consumer Affairs, Food & Agriculture.

Chairperson of the International Research Association for Organic Food Quality and Health (FQH).

Board member of the German Association for Nutrition Behaviour (AGEV e.V.)

SPEAKER BIOGRAPHIES

Dr. JURGEN STRUBE



Dr Jürgen Strube is managing director and head of the biophysics department of the quality research company KWALIS Qualitätsforschung Fulda GmbH located in Dipperz, Germany. KWALIS specializes in food research, testing and analysis.

Jürgen Strube studied electronics and microwave science at the University of Bremen (Germany). It was his involvement in industry technical projects while at the university that led to his interest in biophysics and, more specifically, to the light emission of plants (induced luminescence).

After a number of research projects he founded KWALIS GmbH where his primary focus is on the differences between crops grown organically and those grown conventionally. Jürgen Strube was chosen as an external expert for the German Federal Research Institutes' working group on the differences in food from organic and conventional farming. The method he developed, known as fluorescence excitation spectroscopy of whole parts of plants, was validated according to ISO 17025 in a project for the German federal program for organic farming in cooperation with the University of Kassel. KWALIS investigates plant samples originating primarily from controlled farming systems of different institutions (such as the FiBL, Switzerland and Louis Bolk Institute, Netherlands). An overview of the method, typical results of samples and their significance is contained in a book that was published in German language in August 2004. This book, entitled "Lebensmittel vermitteln Leben", was written by Jürgen Strube together with Dr. Peter Stolz, who investigated the samples from a chemical point of view.

LAWRENCE WOODWARD OBE

1980	Formation and development of **Elm Farm Research Centre (EFRC).**
1980 - 1994	Co-ordinator Elm Farm Research Centre
now	Director Elm Farm Research Centre
2002	Awarded an **OBE** for Services to Organic Farming

POSITIONS HELD include:

1982	Chairman - **British Organic Standards Committee**. An organic movement initiative to produce the first agreed UK organic standards. Founder member of British Organic Farmers.
1982 -1984 -	Chairman of the **International Federation of Organic Agriculture Movements** -1986 Vice President
1985	Expert Consultant to **EU** Commission on the EU Organic Directive/Regulation
1984 - 5	Chairman of the **Soil Association** Standards Committee
1985 - 1991	Member of the Soil Association Council and Management Committee.
1987 - 1999	Member of the government-backed **UKROFS** Board (United Kingdom Register of Organic Food Standards)
1995	Chairman UKROFS R&D Committee.
1997 - 1999	Chairman UKROFS Certification Committee.
2000 -	Member Steering Group SUSTAIN Organics Target Bill campaign
1998 -	IFOAM EU Group member
2000	Founder member ECOPB European Consortium of Organic Plant Breeding
2003	Organic Action Plan Working Group member

Has advised and spoken about the methods of organic agriculture to a wide range of government bodies, NGOs, research bodies, academic institutions and farmer groups in the UK an internationally. Has played a pivotal role in the strategic and practical development of organic sector in the UK. Has written and contributed to numerous publications including scientific journals, technical publications, conference proceedings and press, as well as many contributions to radio and television broadcasts.

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ABSTRACTS

Towards Whole Food Quality

Lawrence Woodward
Elm Farm Research Centre

Organic agriculture is the only farming system that has as its underpinning philosophy the achievement of positive health. In the words of Lady Eve Balfour, " the health of soil, plant, animal and man is one and indivisible". This is implies that a narrow sensory perspective of food quality is inadequate. A broader view encompassing the entire food chain and its impact on the social and ecological environment is required - especially as the onset of genetic engineering raises questions about the very essence of food and health.

A definition of total or holistic food quality has been formulated for some years but has yet to be widely taken up. However, although it is valuable this perspective does not address the core question of whether health is a dynamic state where its components are "one and indivisible". Indeed very little progress has been made in assessing or developing McCarrison's observations concerning the diets of the "healthiest peoples" upon which Balfour's statement is based.

However, some notable progress has been made using both mainstream and alternative methods in assessing some characteristics of food and their relationship to production methods. These will be discussed during this conference. At the same time it is reported that there has been a decline in beneficial components of food whether organically or conventionally produced. So even if we can determine that organic food can have an "extra quality" that is important to health, can we manage production and processing systems "on the ground" to consistently deliver it?

Understanding the relationships between production methods and food quality using mainstream scientific concepts.

Kirsten Brandt
University of Newcastle

Almost all research on food and health has been focused on avoiding harmful extremes, either deficiencies or toxic effects. Other effects have rarely been investigated. Due to this we know almost nothing about the consequences for health of differences in food composition, when it is clear that neither deficiencies nor toxic effects are involved.

Formally this means that a modest difference in composition or other measurable characteristic, no matter how significant and systematic, is not evidence for any difference in effect on health. Also an observation of an improvement in health correlated with such a modest change in dietary composition does not prove a causal relationship with the measured characteristic, if untested confounding factors are present (as they normally are). For example, the benefits of a high intake of fruits and vegetables does not prove that a high antioxidant intake benefits health, unless it can be shown that such a benefit is also consistently observed in studies where everything else is kept constant or equivalent while the antioxidant intake is increased.

So the existing generally accepted knowledge on this topic is clearly inadequate, indicating a need for development of new methods for evaluation of food quality. The question is then whether this should be done by a critical revision of the interpretation of existing and new data within the framework of the existing mainstream scientific concepts (as defined below) or if radically different concepts are needed.

In my understanding, the mainstream scientific concept is that new methods must build on the same overall understanding of the laws of nature and of generally accepted scientific principles as is reflected in the present scientific literature, and provide the best model of reality obtainable with the present level of knowledge - for food quality, reality is represented by sensory tests and/or assessments of health indicators. It is possible, and should be encouraged, to challenge existing dogmas and paradigms, whenever their predictions are shown not to fit with actual observations. However, such a challenge should be constructive, defining flaws in the existing theories that result in mismatch with documented observations, and explaining how the new ideas

correct these flaws. In this concept, a new theory can result in a radically new interpretation of existing data, but it must be able to account for all documented facts.

This means that a theory which requires rejection of generally accepted scientific data, or the introduction of aspects that cannot be measured using generally accepted scientific methods, does not correspond to the mainstream scientific concept.

For me this is not an issue of science being reductionist or holistic, the relevant categories are good and bad science. Good science constantly strives for consistency with all known data, by testing the predictions of its hypotheses and implementing revisions whenever inconsistencies are identified. Any theory that ignores data that fail to correspond to its predictions is bad science, irrespective of whether this is due to simple oversight, unreflecting acceptance of well-established but inadequately tested dogmas or (rarely) conscious manipulation.

The presentation will provide examples of applications of the mainstream scientific concept in food and health research, and descriptions of some of the relevant, novel options for the improvements in our understanding of food quality that can be formulated within this concept.

A major advantage of using the mainstream scientific concept is that it is relatively easier to communicate results constructively and obtain acceptance of them by the scientific community than for results obtained using otherwise equivalent alternative concepts. Still, the resilience of established scientific dogmas should not be underestimated; the history of science is that of a continued struggle of reason against authoritarianism.

Complementary methods of food quality determination - their value and validation

Angelika Meier-Ploeger
University of Kassel, Faculty of Organic Agricultural Sciences,
Dept of Organic Food Quality and Food Culture

Food is more than just a necessity to many people. It is a way to express their values and their lifestyle. Nowadays when the term "quality" is used with respect to food, a value judgement is made. The partners in the market - producers, processors, medical doctors or consumers - might have different judgements. To keep expanding the market, processors and retailers have to come up with new products or new results from scientific work that prove a better quality.

Food quality is composed of various partial aspects and represents the sum of all characteristics scored highly by partners in the market. Six criteria are used to identify important components of quality (authentic, functional, biological, nutritional, sensual, ethical; EFRC, 1996):

The quality of food for humans is estimated by comparison of their nutrient contents with the recommended dietary allowances (RDA) and the amount of nutrients in the food. The value judgement is nutrient driven and therefore the methods for food quality assessment, too. In contrast to that development in nutritional sciences, a significant number of people like to practice so called alternatives in nutrition e.g. vegetarian, macrobiotic or wholefood nutrition, in which not single nutrients but the whole dietary regime with its many interactions is considered.

Results of feeding experiments with animals support a wider view of nutritional food quality. Some investigations have shown that even if the proportion and amount of chemically determined feed components are equal, the fertility and survival rate of newborn animals is different (Staiger, 1988). The scientific work of Werner Kollath and Rudolf Steiner in Germany, Bircher-Benner in Switzerland and McCarrison in GB is based on the following premises: "The living whole is more than the sum of its parts". They conclude from this that: Life is bound to forms / structures and their maintenance; Life is bound to light; Life is linked to communication; Life is reproduction.

To verify the validity of these premises it was and will be necessary to develop and to test new methods for the determination of food quality. The aim of the paper is to present the results of a validation process for some holistic methods (with coded blind

samples). Holistic approaches in organic food quality analysis requires a strict coordination, well defined samples, a good sample storage and delivery, comparative samples, scientists willing to understand the principle and language of alternatives, scientists eager to discuss results and willing to argue about concepts and interpretation.

The challenges will be to compare and correlate data from chemical analysis to those of the holistic methods. There remains the question of whether these holistic methods do show more than the sum of different single nutrients from chemical analyses? And crucially whether these "pictures/structures/ forces/ energy" are important for animal and human health.

Fluorescence excitation spectroscopy method as applied on selected plants

Jürgen Strube
KWALIS Qualitätsforschung Fulda

The purpose of the method is to distinguish culture conditions on the samples. By fluorescence excitation spectroscopy data are gathered from integral parts of a plant sample. The sample is excited by light and the total light emitted by the sample is measured after the end of excitation. The process of excitation is repeated eight times in total for eight different excitation colours out of the visible part of spectrum and near UV. For the evaluation of different samples the spectral data of the samples are compared to each other. Measurements are performed with special equipment, developed for this purpose.

In order to show reliability of data and results, the method was validated according to ISO 17025. Validation means, to show that process is reliable and the method is suited to answer the question, which sample is grown under which conditions.

In a project funded by the German federal program for ecological farming the method was applied to carrots and wheat. Carrots were grown under controlled conditions at the University of Kassel (two fertilisation steps) and the Forschungsinstitut für Biologischen Landbau (FiBL) at Frick (Switzerland), with different sorts (hybrid and open pollinating). Wheat samples were out of the well-known DOK-trial of FiBL and included organic, biodynamic, pure mineral, mineral with manure and neutral variants. All samples were coded with numbers until the results were delivered to the coding institution, the Institut für ökologischen Landbau (Trendhorst) as part of the German federal Forschungsanstalt für Landwirtschaft.

Under the blind conditions it was possible, to separate the fertilised carrots from the non-fertilised ones and to identify in all four repetitions the same samples. Furthermore it was possible to identify which carrots were fertilised. The hybrid variants could be separated from the open pollinating variants.

For the blind wheat samples it also was possible, to separate the group which was fertilised by mineral fertiliser from the organic samples. Furthermore it was possible to identify which samples were grown under mineral fertiliser and which ones under organic conditions.

Other samples illustrate differences of the products that are in relation to the culture method. In general terms organic farming leads to more ripeness of fruits and more 'seed-like' seeds in the case of cereals.

Characterization of the biocrystallization method on using computerized image analysis

Johannes Kahl, Nicolaas Busscher, Angelika Meier-Ploeger
University of Kassel

The growing market of organic food products demands product oriented quality control (Tauscher et al. 2003, Statusbericht 2003, Senatsarbeitsgruppe). One major concern is the differentiation of organically from conventionally grown food. In addition to standard methods of analysis, several screening methods are applied. The biocrystallization screening technique is based on the crystallographic phenomenon that when adding organic substances to an aqueous solution of dehydrate CuCl2, reproducible

patterns are formed during crystallization (Morris & Morris 1939, J. Phys. Chem. 43, 623-629; Kleber & Steinike-Hartung 1959 Zeit.Kristall. 111, 213-234; Andersen et al. 2001, Biol. Agr.Hort. 19, 29-48). The effects of additives on the morphological features are not a mono causal phenomenon, but a complex interaction involving chemical structure, hydrophilic properties of the additives, and colloidal properties of the crystallization solution (Morris & Morris 1939; Selawry 1957, Die Kupferchloridkristallisation in Naturwissenschaft und Medizin. Fischer-Verlag, Stuttgart; Beckmann 1959, Diss. Univ. Bonn). A favoured field of successful application of the method are comparative studies of the effects of different farming systems on the crop and product quality, as a complement to chemical analysis of minerals, vitamins etc. (Granstedt & Kjellenberg, 1997 Proceedings Tufts University, 79-90; Maeder et al. 1993 Acta Hort. 339, 11-31; Soil Association 2001, Bristol; Andersen et al. 2001; Weibel et al. 2000, Acta Hort. 517, 417-421). Recently initial efforts have been made to standardize the method, including optimization of crystallization technique and development of computer software for image analysis of the patterns (Andersen et al. 1999, Computers and electronics in agriculture 22, 51-69; Meier-Ploeger et al. 2004, final project-report 02OE170, BÖL). The requirements for validation were tested for the biocrystallization method for the statistically proofed discrimination of products from different farming systems (defined field trials, e.g. DOC-trial at FIBL/CH, Maeder et al. 2002, Science, 296, 1694-1697) and also from different single production factors. A systematic assessment of the factors influencing the result was carried out as one of the criteria for the determination of the performance of the method. This includes a control system for the crystallization process and a computer based laboratory documentation system. Furthermore the method parameters repeatability and reproducibility are determined for the samples used. Intercomparisons were carried out together with laboratories in Germany, the Netherlands and Denmark.

Food Quality and Health - Concepts into Practice

Angelika Meier-Ploeger
University of Kassel

Organic food - in the consumers view - is an important component for good health and wellbeing. A change in the structure of organic buyers in Europe will force the market and science to prove that organic food is healthier for humans. Therefore politicians in several states of Europe asked for scientific reports about product orientated differences in organic produce. This paper will present the results of the scientific reviews in France and Germany. The aims and projects of the International Research Association for Organic Food Quality and Health will also be presented in the paper.

Although there is some evidence that nutrients differ between conventionally and organically produced vegetable - and animal produce the question has to be discussed as to which methods can be used to show "health" and "wellbeing" as defined by WHO in 1942. This definition accepted that human beings are creatures with physiological and psychological characteristics. System (human) orientated methods are needed to evaluate these different parameters alongside methods used for product assessment.

TOWARDS WHOLE FOOD QUALITY

Lawrence Woodward O.B.E. Director EFRC

Does Organic Food Have An Extra Quality? Is it healthier than conventional food? Can the quality of organic food be linked to both environmental health and human health? These are some of the questions that we hope to address. It is unlikely that they will be answered because they are huge questions that go - not merely to the core justification of organic agriculture - but to the heart of perceptions and concepts of health.

It is claimed that organic agriculture is the only farming system that has as its underpinning philosophy and goal the achievement of positive health in its broadest sense. But what is this claim based on? Has it any justification?

Of course, we know that there are differences in the levels of chemical residues, protein and vitamin levels favouring organic over conventional food but we also know that; a) they do not apply across the board to a wide range of foods; b) modern usage and monitoring of agro- chemicals is increasingly able to produce foods with low or non detectable residue levels; c) the levels that are detected have unknown consequences but we cannot conclusively say that they are always detrimental to health; d) because variety selection and manure use is not controlled in a good deal of organic production some organic food is as problematic as conventional; e) highly processed organic food is likely to be as nutritionally deficient as highly processed conventional foods; f) out of season production, lengthy distribution chains and over packaging of organic produce creates some of the same adverse consequences as those produced by conventional methods.

Furthermore the reported decline in mineral levels in vegetables and the reduction in the proportion of omega 3 levels in meat are modern and adverse trends that seem to be occurring in organic as well as conventional production, albeit in a less pronounced way.

However, none of this negates the claim: at least as things are at the moment. The practice of organic food production may not be as good as the aspiration of the original organic movement requires it to be; the character of the organic sector may sit uneasily with that aspiration; and even though some certified organic food is unworthy of the words - organic and food, nonetheless, organic agriculture still has a recognisable relationship with a philosophy and concept of health.

Even after the passage of more than sixty years it is hard to find a better description of that concept than the one given by Lady Eve Balfour; "the health of soil, plant, animal and man is one and indivisible." She was a disciple of Sir Robert McCarrison, one of the pioneers of human nutrition who, having systematically observed many peoples and many diets, realised that there was a quality in the diets of the healthiest peoples which was absent from the least healthy; "that the food in all these diets is, for the most part, fresh from its source, little altered by preparation, and complete; and that, in the case of foods based on agriculture, the natural cycle is complete. Animal and vegetable waste - soil - plant - food - animal - man; no chemical or substitution stage intervenes."

Others reached similar conclusions and the concept - that health was part of a continuum through soil, plant, animal and man; and that by recycling nutrients through this chain, productivity could be maintained over time and health could be enhanced at all stages - this concept became a foundation stone of the international organic movement.

TOWARDS WHOLE FOOD QUALITY

Lawrence Woodward O.B.E. Director EFRC

Or possibly a millstone! Because this concept is rooted in another and very problematic one; that of wholeness (the two words wholeness and health share the same origin after all): problematic, because in the words of Dr. Innes Pearce one of the founders of the Pioneer Health Centre and the renowned "Peckham Experiment", "biological wholes,…..unlike their parts, cannot be examined a-part; hence cannot be analysed; nor are they definable in terms of quantification."

Whether in agriculture, food and nutrition or healthcare this problem has dogged the practioners of what might, somewhat unsatisfactorily, be called "holistic science". There will be arguments against such terminology and it will be pointed out that the relevant distinction is whether the science is good or bad. Which is a fair point, especially as one of the determining factors of whether science is good or bad is the whether the methodologies are appropriate or fit for the purpose they are employed.

And for the most part the methodologies available to those researchers and indeed lay people who are interested in the dynamics of whole biological systems and their relationship to the whole quality of food have been lacking. They have allowed us only a partial look and yielded largely indicative information.

This is of course extremely valuable. We know there is a clear trend that in appropriate crops organic produce contains more desirable components and less undesirable than conventional produce. We also know that in livestock trials, animals fed on organically grown feed generally show greater fertility and longevity than those fed on conventionally produced feed. I am sure that researchers will continue to add to this body of information and that in time some commentators will accept that there are real differences between organic and conventional food that have implications for health.

I hope that we will become smarter in using this information in order to improve organic systems - both on farm and in food processing. Frankly, we have to, if organic production is going to legitimately continue. And it may be that this is as much as can be manage.

But I hope not; because such indicative information does not, for me at least, tells us enough about the nature of health and how to enhance it; nor about the relationship between the health of the living organisms (including humans) that share the same living biological systems; to put it another way, about the essence of living.

McCarrison spoke about an extra quality in the diet of the healthiest people; Scott Williamson and Pearce wrote about health being a biological process not a state; others have referred to vitality being transferred being living organisms. To learn about these things, if they exist, we must surely develop new insights and methodologies.

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UNDERSTANDING THE RELATIONSHIP BETWEEN PRODUCTION METHODS AND FOOD QUALITY USING MAINSTREAM SCIENTIFIC CONCEPTS

DR KIRSTEN BRANDT, UNIVERSITY OF NEWCASTLE

Edited from transcript of the presentation by Lawrence Woodward.

There are different ways of looking at how science can investigate aspects of food quality. I don't really like to see this question as an issue of using reductionist or holistic methods, but there clearly are differences in the type of methods people use and I am quite happy to represent what I have here defined as a mainstream scientific concept. Of course, within this concept there are some shortcomings, nonetheless in my view you don't actually need to step outside of this concept but you may need to challenge some of the dogmas which have found there way into the field. I am going to give examples of how I see that it is possible to define some ways of understanding what is happening in terms of agriculture, food quality, health and still stay within the mainstream scientific concepts.

I will address the following issues:

- Definition of "mainstream scientific concepts".
- Shortcomings of traditional mainstream science in the food and health area.
- Documentation of differences between foods indicating consequences for health.
- Examples of "under-utilised" topics relevant to food and health research.
- Specific suggestions for future work.

A definition of "mainstream scientific concepts".

- Based on a common understanding of the laws of nature, including evolution.
- Requires consistency with observations on all levels.
- Observations _ hypothesis _ predictions _ testing _ revision _ predictions _ etc.
- Predictions must match reality.
- When new observations appear, all relevant hypotheses should be re-evaluated.

Mainstream scientific concepts, as I see it, is science which is based on a common understanding of the laws of nature including evolution and one of the requirements in scientific concept is that you need to have consistency with the different observations on all levels - including the level of the whole and the level of detail. If you think of astronomy: it doesn't work to have one type of physics for what happens inside a star, and another type for the universe - they have to be consistent. This means that there is in fact a holistic concept, but sometimes people forget about it when they get too caught up with the detail of one particular issue.

The main principle of mainstream science is that you start out with some observations, you then make a hypothesis and from this hypothesis you make some predictions and from these predictions you make some new observations e.g. an experiment, which allows you to test the hypothesis. If this testing shows that you seem to be on the right track then you just go on in that way. If your testing shows that you did not get the same outcome as you have predicted then there is something wrong with the hypothesis and you have to revise the hypothesis. You can make new predictions and so on and so on and so on ….
Very importantly, those predictions must actually match reality. It doesn't work if you make a laboratory experiment, which shows for example this thing if you eat it will kill you, and then you have reality showing that people are happily eating this stuff and they are not dying - well then there must be something wrong with your hypothesis and your predictions.

Of course science develops and new methods and new observations emerge. Then it is part of the concept to go back and re-evaluate whatever you have done before. For example in astronomy; five years ago everybody thought the universe had ceased its expansion and then some observations showed that it is still expanding, consequently the whole field of cosmology has completely changed.

Mainstream scientific concepts do not accept:

- Theories involving "intelligent design" or other ideas based on faith rather than data.
- Theories that require acceptance of mechanisms, which cannot be integrated with the presently accepted laws of nature.
- Theories based on data that cannot be replicated by others.

In contrast, challenge of established scientific dogmas is actively encouraged!!

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Nonetheless, dogma finds its way into and "dogs" mainstream science in the following ways:

- Traditional mainstream science contains numerous elements that have not undergone rigorous testing by its own rules.
- Most of these dogmas or "common understandings" are hypotheses that have become generally accepted since they appear logical and are difficult to test.
- Some are commercially or politically useful.
- Such generally accepted theories are often confused with scientific knowledge.

There are hypotheses that appear logical and seem to fit nicely with recognised concepts but might be difficult to test or are politically or commercially expedient. After a time they become accepted and it is forgotten that they haven't been tested. This is especially so with the literature citation game where papers are cited over and over again until the point where an untested hypothesis becomes an accepted fact through repetition. Food science is not especially bad, but it does have some rather bad examples of this.

Shortcomings of traditional mainstream science in the food and health area.

The following are examples of untested "dogmas" relating to food and health:

- A diet with adequate levels of all known nutrients and minimal levels of all known toxins is optimal for health.
- Carcinogens increase the cancer risk proportionally to concentration at any level ("no threshold").
- Food components can (or should) neither prevent nor cure diseases ("food is not medicine").
- All natural or synthetic toxins with similar physiological effects are similarly dangerous to human health.

All of these are often cited but there is little or no data showing that they are actually true. For the most part the work has not been done, merely assumed. Of course, we do not have scientific proof that, for example, a particular food has medicinal properties so you cannot go out and make a medicinal claim but the fact that the science does not exist to base such a claim on doesn't mean that there is never any medicinal properties in food - just that the work has not been done.

- Almost all research on food and health has been focused on **avoiding harmful extremes**, either **deficiencies** or **toxic effects.**
- Other effects have rarely been investigated.
- Due to this we know **almost nothing** about the **consequences** for health of differences in **food composition**, in contexts where it is clear that neither deficiencies nor toxic effects are involved.

Which is why we can make measurements of components such as minerals, vitamins and toxins but it doesn't tell us much about health. That doesn't mean that it cannot be investigated, it just means that it hasn't been investigated - not yet.

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Differences between foods indicating consequences for health.

We know and it is accepted that analysis shows up differences between foods produced in different production systems. What is unclear is how important these differences are for health. The differences listed below (see box), it is now widely agreed, tend to be found when analysing some - but not all - organically and conventionally produced foods.

Traditional conventional view of how different production systems are important for human health

	Organic		Conventional
		Plant foods have more:	
-	Dry weight %, minerals		- Nitrate
-	Vitamin C		- Protein
-	% essential amino acids		- -carotene
-	Natural pesticides		- Synthetic pesticides*
		Animal foods have more:	
-	Unsaturated fatty acids, CLA		- Resistant bacteria
		Processed foods have more:	
			- Food additives*

The two main areas of difference are synthetic pesticides and food additives found in conventional food but as with nitrate levels there is a good deal of controversy and an uncertain level of agreement about there impact on health.

All of the things listed are relatively easy to measure but are not what is necessarily important for health. For example vitamin C; it is fine if a food has more vitamin C but in this part of the world 95% of the population already get all the vitamin C they need, so they are not going to benefit anything from getting 20% more from, say, an organic carrot. On the other hand, 20% more is not so much it is harmful so it is concluded that extra vitamin C in organic carrots makes no difference to health.

My view is that if we want to understand something about the connection between the way we produce our food and our health, we need to look at other aspects where there are larger and more consistent differences between organic and conventional products; and which can be studied within mainstream scientific concepts. Listed below are some aspects of the production systems which are much more consistent and much more differentiating than the earlier examples; and where I think can be found some differences which have real importance for health and quality whilst still staying squarely within mainstream scientific concepts.

Un-traditional view (still within mainstream scientific concepts) of who different production systems may be important for health

	Organic		Conventional
		Plants have more:	
-	Intrinsic resistance to diseases and pests		- Easily available nutrients - Susceptibility to post-harvest infections
-	Resilience to stress		
		Animals have more:	
-	Exercise		- Stress
-	'Green' fodder		- Susceptibility to infections
		Processed foods have more:	
			- Low quality raw materials

I would now like to illustrate this with some examples.

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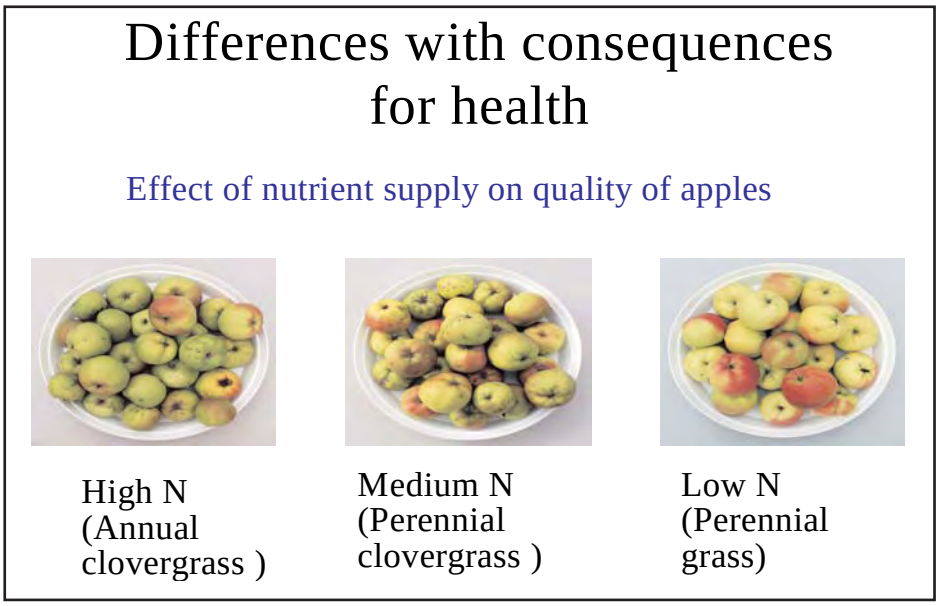
Example 1 - Apples

Figure 1 is from an apple experiment. These apples are all certified organic but are grown under different conditions where they have surplus of nitrogen or a little deficiency of nitrogen.

Figure 1.



You should be able to see that the apples look different. On one side they are bigger and more mature and the other they are smaller, clearly more attacked by disease. This is an issue of simply the nitrogen content. These were not sprayed with anything and they did not receive any synthetic fertiliser
Analysis for phenolic compounds (Figure 2) showed small differences but not big enough to explain to explain the observable quality difference.

Figure 2.

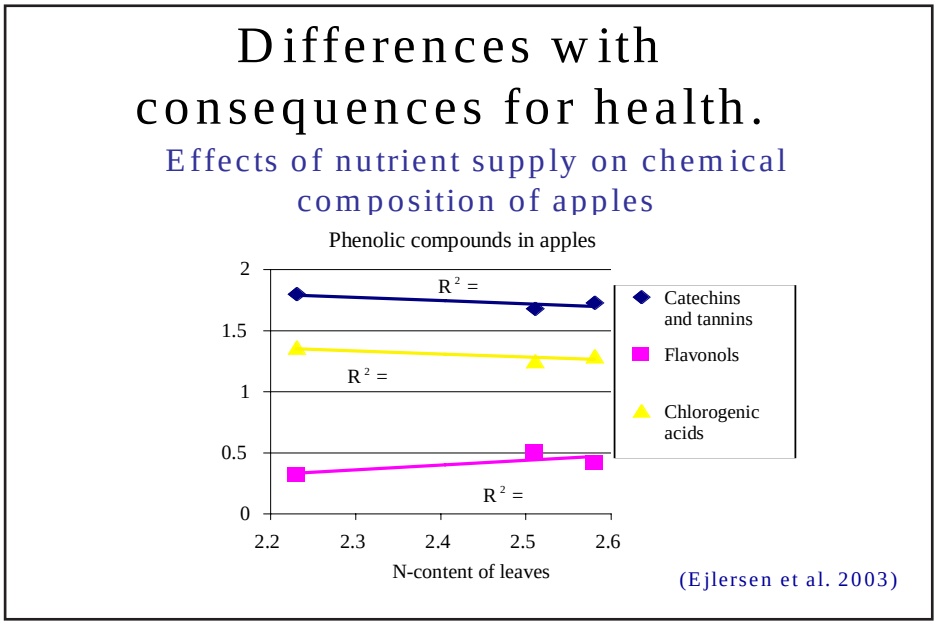


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Figure 3 reveals some differences in terms of diseases and attacks by pests. These are quite large differences, which I interpret as indicating that there is some other secondary metabolite than the phenolic compounds which are having an influence, although there may of course be other explanations.

Figure 3.

Differences with consequences for health.

Effect of nutrient supply to apples on resistance to diseases and pests

Treatment % of fruit with:	Annual clover grass (high N)	Perennial clover grass (medium N)	Perennial grass (low N)
Apple scab	17.9	8.9	2.3
Sooty blotch	11.8	8.7	8.0
Apple saw fly	8.4	5.8	4.6

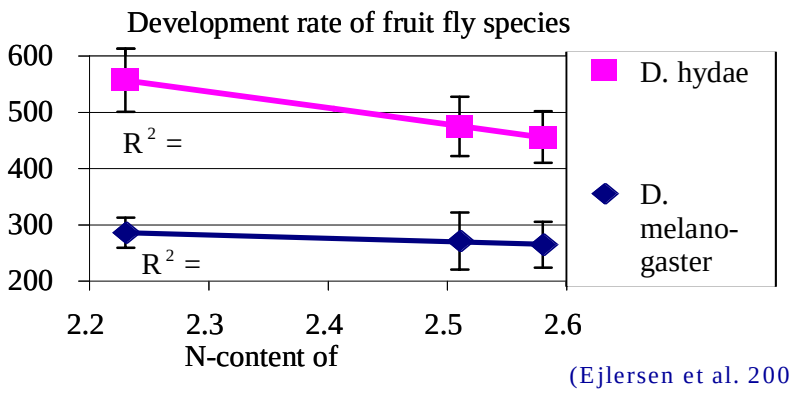
(Berthelsen & Pedersen 2002)

But what does all this mean for health? It is difficult to make experiments with humans but relatively easy to experiment with animals or insects which have a very short life cycle. Figure 4 shows what happens when those apples from different nitrogen regimes were fed to fruit flies.

Figure 4.

Differences with consequences for health.

Effects of nutrient supply to apples on health of fruit flies



(Ejlersen et al. 2003)

It is clear that the life cycle of the fruit flies is affected significantly, not just by 5-10% as with the phenolic compounds. Of course these apples were actually all organic so whilst the example shows that the way plants are grown does impact on health, it also shows that merely being certified organic is not enough. In this case, having too much nitrogen in the system - even if it is from an approved source - can still deteriorate quality and results in a product that looks very much like the conventional.

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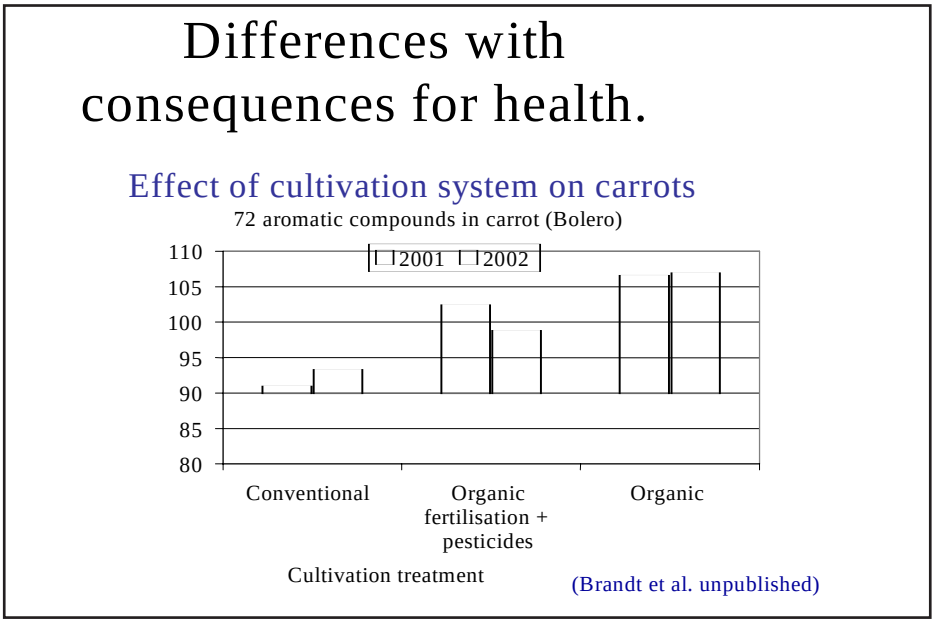
Example 2 - Carrots

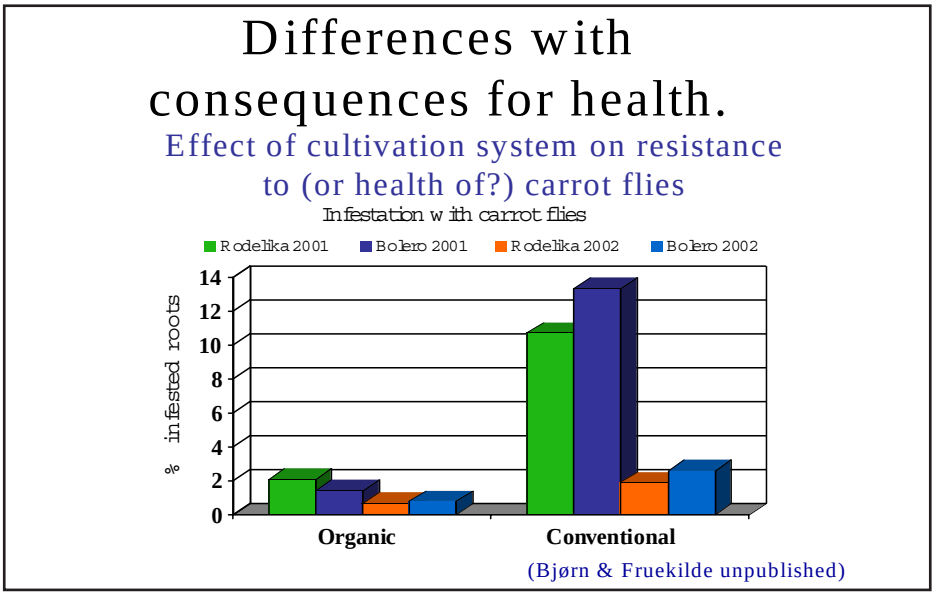
In a two-year experiment measuring aromatic compounds in carrots we found clear and definitive differences favouring organic production (see Figure 5).

Figure 5.



These compounds are important for taste but they are also known to defend the carrots against diseases and pests. This is demonstrated below in Figure 6 in another experiment.

Figure 6.



There is significantly less infestation of organic carrots even though some of the conventional ones were actually sprayed with pesticides. It is not possible at this moment to say what this means for health but it is important to know about this significant difference. There is something there, which I believe we can investigate using mainstream laboratory methods to find which compounds are responsible for the difference.

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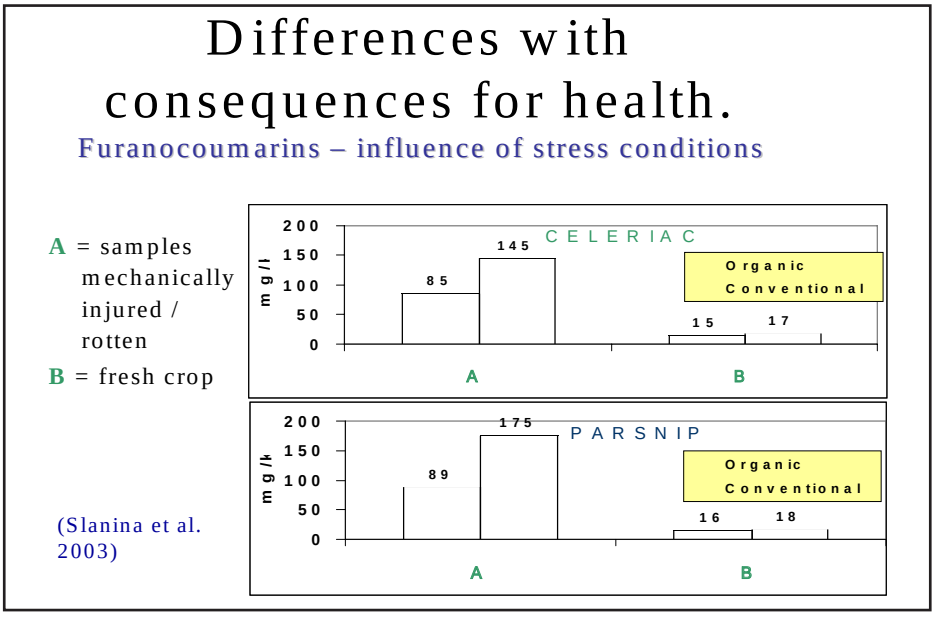
Example 3 - stress conditions in celeriac and parsnip

Organic plants seem to be more resilient to stress and in this context show differences of natural toxin levels to conventional plants. This can be seen in figure 7 where a very strong type of toxin called furanocumarin is produced in differing levels in organic and conventional celeriac and parsnip.

Here the normal crop showed no difference in furanocumarins between the organic and conventional. However in damaged plants the conventional ones rose to much larger toxin levels than the organic ones, actually to levels which are clearly above what is normally is accepted as safe in food. I interpret this as showing greater resilience to stress.

Figure 7.



All of these are examples where mainstream scientific methods have revealed consistent and highly significant differences between organic and conventionally produced food. We do need to add to this body of information but we also need to investigate what relevance these differences have to health.

Examples of "under-utilised" topics relevant to food and health research.

Two areas that may help in this task which have been under-utilised are:

- Regulation of **plant defence** mechanisms by **growth conditions** to optimise fitness,
- Combined with **dose-response** relationships of plant defence compounds on.

Both areas relate to natural toxins; the first is about understanding how plants defend themselves, how is that regulated by growth conditions; secondly whether the compounds produced by the plant's defence mechanisms affect human health.

Figure 8 is taken from a recent review on plant defence mechanisms. It is not specifically about organic or even agriculture in general but about what happens in nature.

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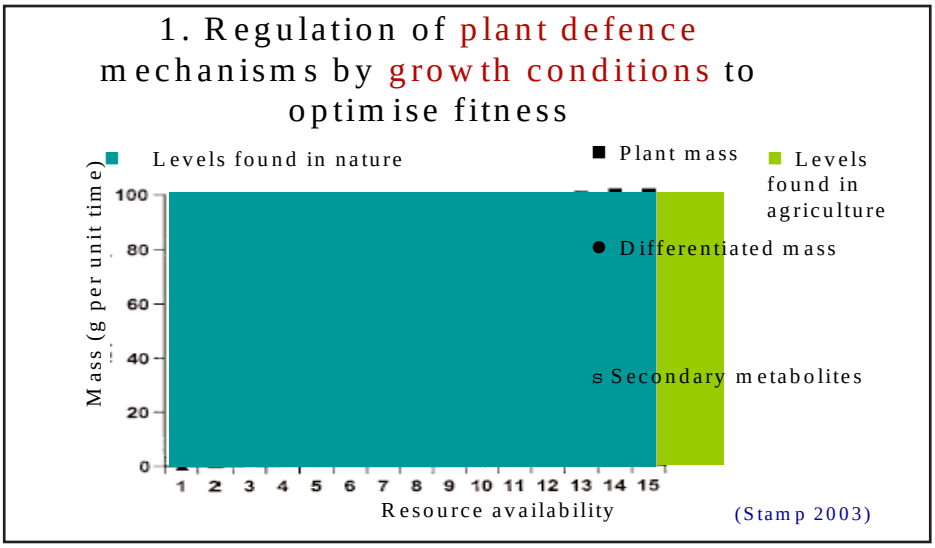
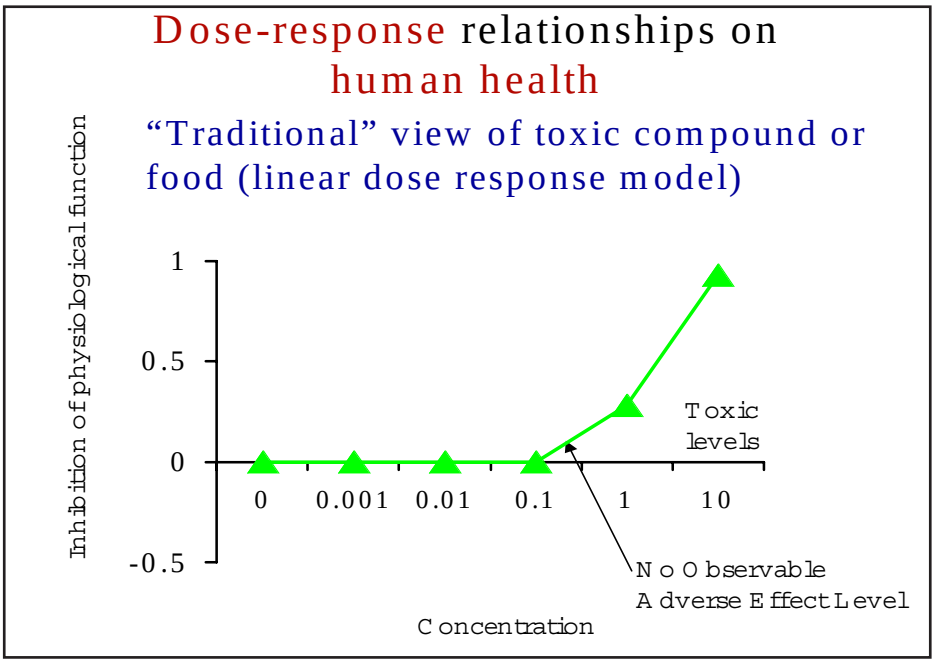
Figure 8.



It shows the relationship between nutrient resources - mainly nitrogen - and secondary metabolites, which represent the plant's defence mechanisms. Increased availability of nutrients leads to a higher productivity of plant mass but at the same time to a lower content of secondary metabolites. As nutrient levels reach those found in agriculture the dropping away of secondary metabolites is most marked.

But how do these compounds actually affect human health? The traditional view of toxins is the linear dose response model where a compound is regarded as toxic at high levels but has little or no effect at low levels (see Figure 9). This is the model on which almost all safety evaluations for pesticides, is based.

Figure 9.



For nutrients - vitamins, minerals, essential amino acids etc - a different model is used (see Figure 10).

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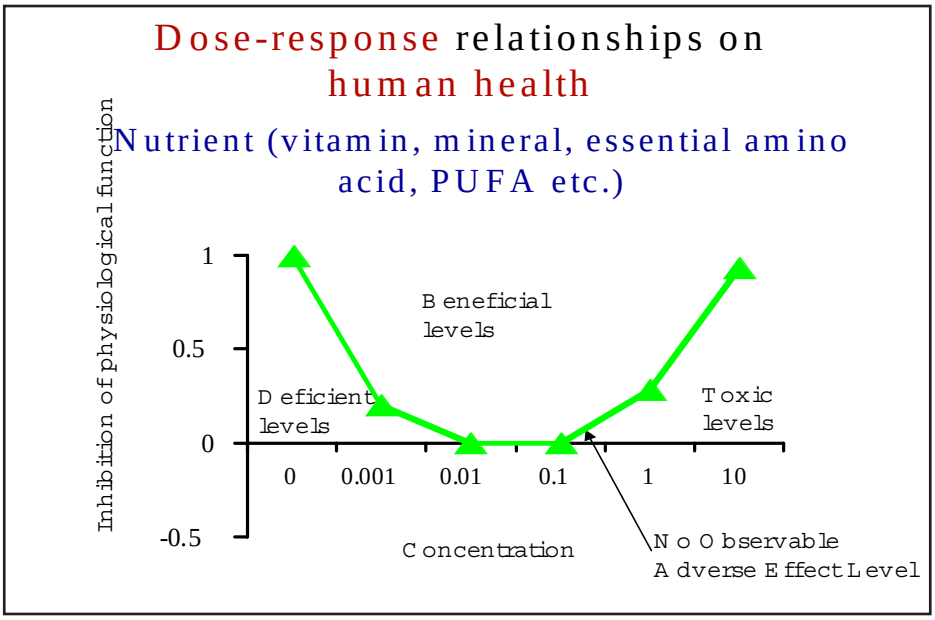
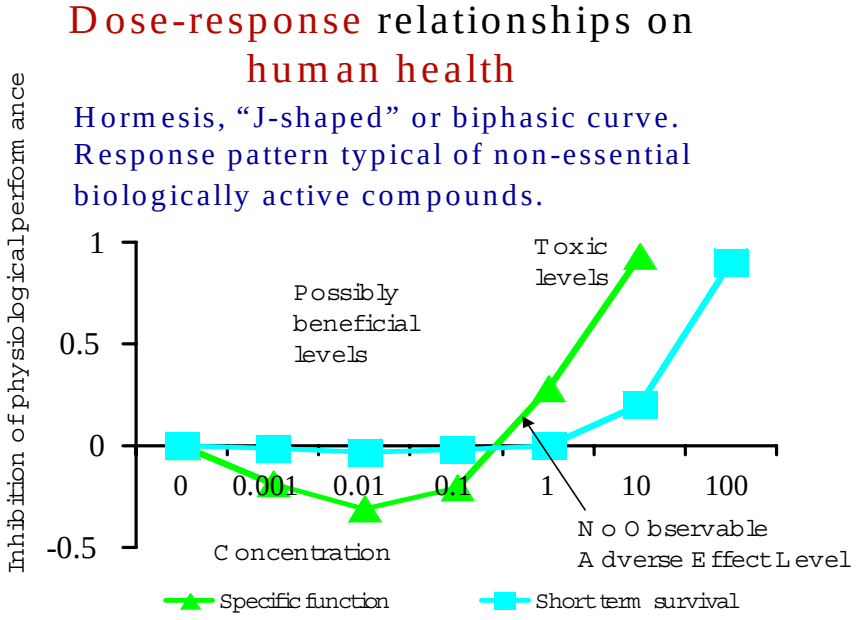
Figure 10.



Here low levels are seen as deficient and certainly not positive for health. But there is also a maximal level above which adverse effects are found. In fact, you have too much of a good thing.

However, relatively recent research has shown that biologically active compounds - such as secondary metabolites or natural toxins - that are adverse at high concentrations can still be good for you at certain low concentrations. This is called hormesis (see Figure 11). A very good and well-known example is alcohol where it has been shown that if you have one or two units of alcohol per day it is better for your health and in particular cardiovascular disease, than no alcohol at all.

Figure 11.



Very little work has been done on most things which are, might be, important for health so we do not know what is the best level we can get. However, there is a growing belief amongst toxicologists that this is the way that all compounds work.

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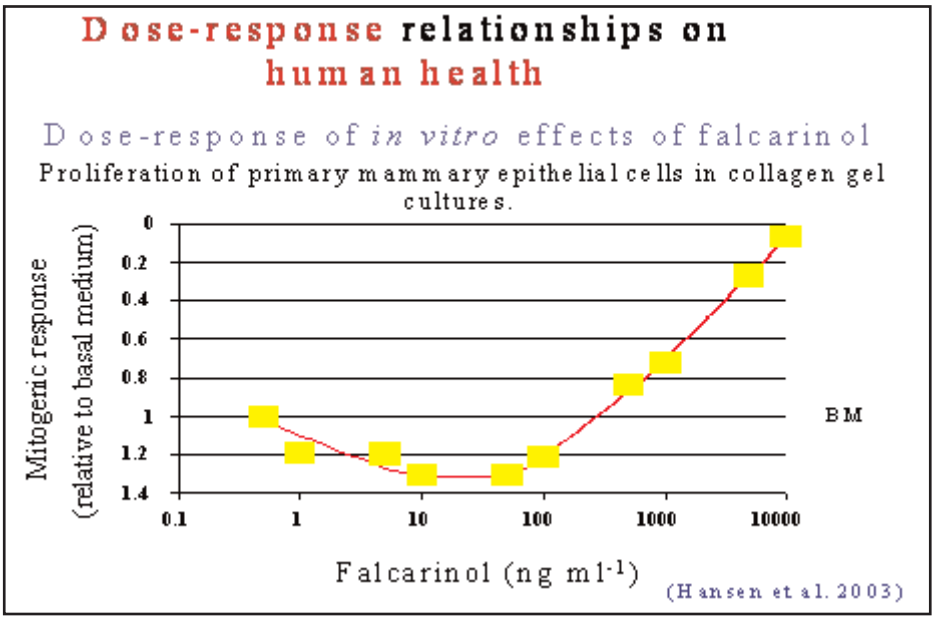
An example is falcarinol, which has been traditionally seen as a toxic compound in carrots. Figure 12 shows falcarinol some cell culture where you can measure both positive and negative effects.

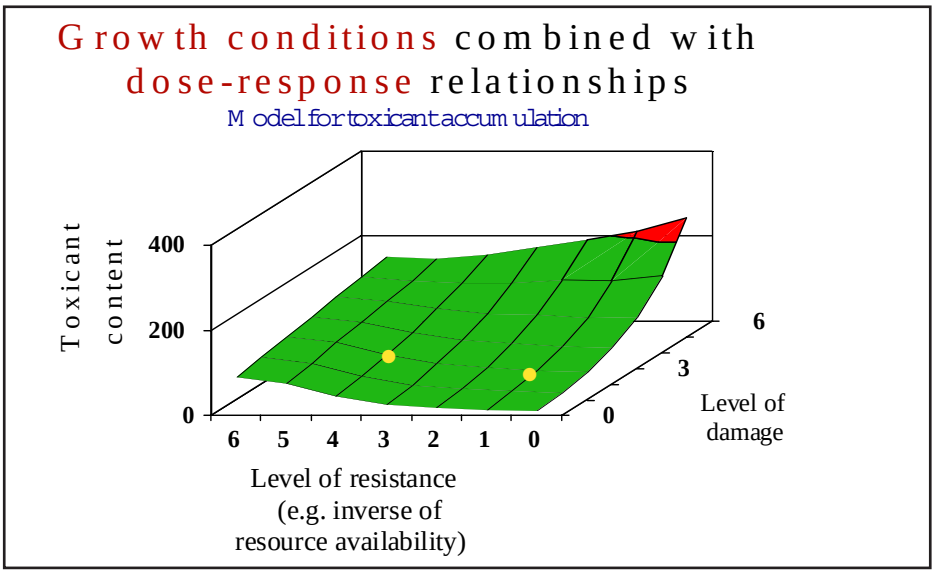
Figure 12.



This shows that there is a benefit at the highest and lowest concentration. In fairness, I should point out that the same experiment with betacarotene did not give these results.

Figure 13 is a model to show toxicant accumulation. Toxic compounds at dangerous high levels are shown in red on the curve while the green areas are where we don't know the dangerous levels and what might be levels that are beneficial. Using data for intrinsic resistance and plant stress, it shows that if you have plants that have a low intrinsic resistance and are subjected to a lot of stress, they would reach high, even dangerous, levels of toxic compounds. Whereas plants with high intrinsic resistance, even subjected to stress would have low levels of toxins that would not be dangerous and might be beneficial.

Figure 13.



Much work needs to be done on this but it might be the case that differences between organic and conventionally produced plants could be highlighted through this approach.

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Suggestions for future work.

It seems to me that to understand food and health it is necessary to find out what actually is important and then look at how the farming systems can deliver. It is therefore important to:

- Use the full spectrum of available knowledge!
- Make a conscious effort to develop methods for neutral assessment of observations; avoiding the filters of traditional assumptions, political correctness and existing legally defined procedures.
- Identify the food components with highest actual impact on health.
- Identify the aspects of farming systems that influence these components.
- Promote the individual's own responsibility for safety (and other aspects of food quality)!

Mainstream scientific concepts and methods are an essential part of this task and should not be dismissed or disregarded.

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Complementary methods of food quality determination - their value and validation

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Edited from transcript by Lawrence Woodward

Introduction

Food is more than a basic necessity to many people. It is a way to express their values and their lifestyle. Nowadays when the term "quality" is used with respect to food, a value judgement is being made. Participants in the food marketplace - producers, processors, commentators (ranging from food writers to medical doctors) and consumers can have different judgements about the value of e.g. a functional food drink or yoghurt.

Commercially the image world of "quality" is a magical place - full of thoughts and wishes that brings smiles to the face and money to a "mature" market. To keep expanding the market, processors and retailers have to come up with new products or new results from scientific work that seeks to provide evidence of a better quality. This leads to the question "Are there differences between the quality of organic and conventional food?" - and if so - "which parameters can show this?" And last but not least "Are organic foods better for health?"

Over 20 years ago EU legislation, EC 2092/91, defined organic food through a description of the production process not by an assessment of the final product. So the question is can we find and validate methods that are able to distinguish differences between blind samples from different farming systems (i.e. organic and conventional) and whether differences in the production process are seen in the quality of the final product itself?

A definition of food quality

The term "food quality" is difficult to define because it is subject to differing perceptions and value judgements including those of consumers as well as the status and development of science. One approach recognises that food quality is composed of various partial aspects but in order to regard a product as "good" quality the sum of all characteristics should be considered with all components scoring highly in the assessment. This approach proposes that six criteria are used to identify important components of quality:

Authentic	Food that is authentic (e.g. not genetically modified), traditional or natural and has not been synthesised or adulterated in production, processing or storage
Functional	How appropriate food is to its specific purpose, i.e. food that produces, stores or cooks well
Biological	How food interacts with the body' s functioning, both positive and negative
Nutritional	how food contributes to a balanced diet, both positive and negative interactions
Sensual	Food that appeals to the senses
Ethical	This concept has four related but distinct meanings: environmental, social, ethical and political

This has been illustrated and labelled "The Magic Hexagon".

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Concepts and methods of food quality determination

Limitation of nutrient content assessment

The most common method of estimating the quality of food for humans is comparison of nutrient content with the recommended dietary allowances (RDA). Humans are seen as an accumulation of cells and their metabolic systems. The value judgement is solely nutrient driven.

Estimates of food value in terms of biological and nutritional quality has changed over the years and will change in the future as new results in nutrition research (e.g. dietary fibre or secondary plant components) are found. At present, chemical analyses are widely employed to determine the nutritionally desirable and undesirable content of food.

Of course this approach does not take account of environmental, ethical or social factors that are increasingly seen as important in perceptions of food. As a response methodologies such as eco-balance sheets and life cycle assessments are used alongside nutrient analysis to give a more comprehensive determination.

Furthermore some nutrition studies have demonstrated the limitations of a purely RDA approach.Results of feeding experiments with animals have shown that even if the proportion and amount of chemically determined feed components are equal, the fertility and survival rate of newborn animals is different. The table below shows that hare, fed with conventional feed compared to feed produced according to biodynamic standards had significantly fewer embryos in the 2nd and 3rd generation (6.3 and 6.3 per hare compared to 10.8 and 9.7) even though the analysed nutrient content was the same.

Fertility of hare influenced by feed from different farming systems

	1. Generation	average	deviation	n
Amount of embryos per hare	Group I	10,0	2,8	15
	Group II (organic feed)	9,0	2,8	10
Amount of born hare per litter	Group I	5,6	2,3	26
	Group II (organic feed)	6,2	2,4	19
	2. Generation	**average**	**deviation**	**n**
Amount of embryos per hare	Group I	6,3	4,4	8
	Group II (organic feed)	10,8	1,9	6
Amount of born hare per litter	Group I	4,9	2,2	26
	Group II (organic feed)	6,4	3,1	30
	3. Generation	**average**	**deviation**	**n**
Amount of embryos per hare	Group I	6,3	3,4	17
	Group II (organic feed)	9,7	2,8	29

A consideration of alternative methods

In part because of results like these and also because of different philosophical perspectives a significant number of people have sought for alternatives to the nutrient and even gene - driven developments in nutritional sciences. For example, vegetarian, macrobiotic or wholefood nutritionists go beyond consideration of single nutrients to address the whole dietary regime with its many interactions.

Complementary methods of food quality determination - their value and validation

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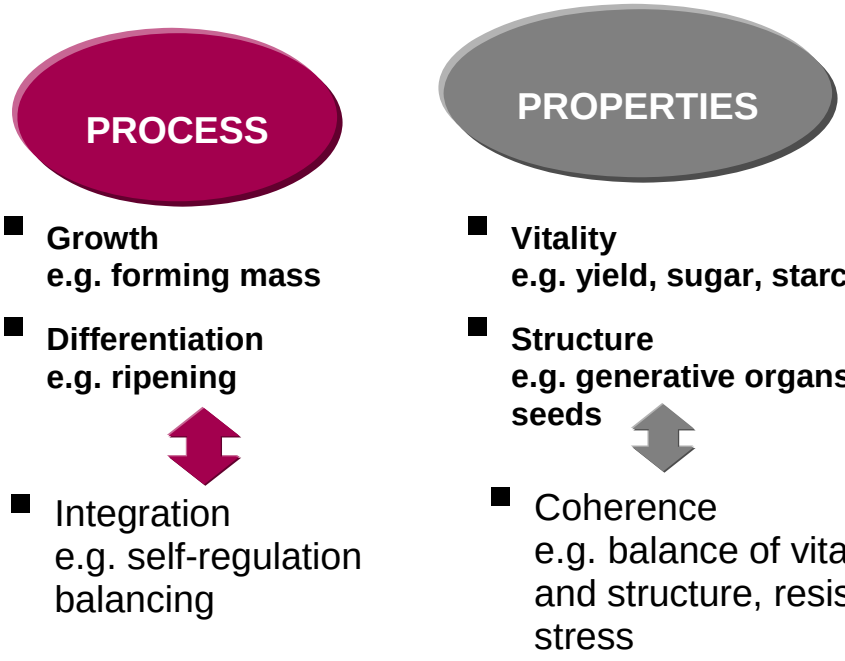
Other approaches e.g. macrobiotic include the concept of "balance" or "harmony" to describe the potential of food to human health. The bio-dynamic approach describes food quality as a balance between "growth" and "differentiation". Both have to be in harmony (integration). Therefore the methods to determine quality should focus on parameters showing these different steps in the growth process (yield, sugar), the structure (seeds) and coherence (resistance to stress).



Underpinning this approach is the "Concept of Vital Quality" which provides an example of an important differentiation within the range of alternative methods; those that are complementary and those than can be called holistic.

Concept of Vital Quality
Louis Bolk Institut, 2001

vitality is the result of
Growth

Structure is the result of
Differentiation

Coherence is the result of
integration

Complementary methods are those that seek to reflect aspects of food quality other than nutrients. Holistic methods are complementary methods that seek to provide evidence for the contention that "the living whole is more than the sum of its parts".

Holistic methods

Additionally a holistic method will not destroy the food itself during examination and therefore can provide some ideas about the matrix (e.g. binding form) and/or show results in response to a living organism. Included in this category are fluorescence excitation / low-level luminescence / biophotons; copper chloride crystallisation; microbiology tests (e.g. stress test); and sensory evaluation of food with men and animals (feeding trials, fertility tests).

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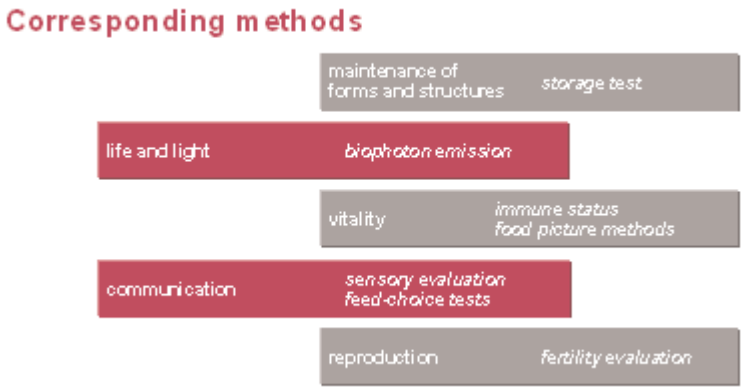
The question "What is life?" (As posed for example by Schrödinger) is the central focus point of holistic methods from a nature philosophical view. And from this immediately derives the question " Which kind of quality must food have to support life process?" The scientific work of Werner Kollath and Rudolf Steiner in Germany, Bircher- Benner in Switzerland and McCarrison in the Britain is based on the hypothesis that: "The living whole is more than the sum of its parts"

It can be concluded from their work that

- Life is bound to forms/structures and their maintenance
- Life is bound to light
- Life is linked to communication
- Life is reproduction

A number of methods for determining food quality have been developed to try to correspond or relate to these concepts. These can be seen below:



Of these, two copper chloride crystallisation and biophoton emissions/ fluorescence excitation have recently been validated according to international standards.

Copper Chloride Crystallisation

This method has been developed by Pfeiffer (1930), Selawry (1975) and Enqvist (1970) and is based on the philosophy of Rudolf Steiner (1861 - 1925). It tries to visualise force/ structure/ order in food and the potential of different foods to support life in this aspect. The "vitality" of foods is illustrated and determined by pictures developed from samples. Over the years work by different organisations and scientists have been remarkably successful in differentiating between farming systems and production techniques.

Fluorescence Excitation

Referring to investigations from the beginning of our century the physicist Popp (1991) pointed out that every living cell emits light (low level luminescence). Food is not only carrier of calories and nutrients but transmits information (energy) that builds up the structure of living systems and stabilizes them against external chaotic influences. This method seems to be capable to differentiating blind samples of plant produce from different fertilisation regimes and eggs from different housing and feeding regimes.

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Validation of Methods to ISO 17025 standards

Over the last 4 years a number of scientists from Germany, Denmark and Holland have worked together- with funding from the German Ministry of Consumer Affairs, Food and Agriculture and The Sheepdrove Trust- to validate these holistic methods.

The project involved the following methods:

* copper chloride crystallisation
* fluorescence excitation
* electrochemical method
* HPLC polyphenols
* physiological amino acid status

Blind samples were taken from

* different farming systems (same variety)
* different organic fertilizer
* different varieties

The main features of the project were

- strict coordination (methodology, statistics, logistic)
- well defined samples (primarily from the DOC trial in Switzerland)
- good sample storage and delivery
- scientists willing to work interdisciplinary
- scientists eager to discuss methods and argue about concepts

Conclusion

All interdisciplinary research projects - and especially intercomparison studies - are a challenge. They require strict coordination, a good sample storage and postage system. Additionally this one required scientists willing to understand "novel" principles and terminology and prepared to discuss, not only, results, but also, new concepts and interpretation in a constructive way.

Access to good and well-defined samples was critical and this project was able to use samples from the longest running and best documented, replicated organic systems comparison trial in the world. The DOK trial has been operated by FIBL in Switzerland for over 24 years and recently received particular notice in the journal "Science" (May 2002)

The achievement of gaining ISO 17025 validation for the copper chloride crystallisation and the fluorescence excitation methods is highly significant. It has shown that holistic methods can achieve the highest levels of standardisation and repeatability and that therefore the results obtained by them are real and valid. They can no longer be dismissed as "junk science".

More work needs to be done to correlate data from chemical analysis with holistic methods and many more studies will need to be undertaken before it is known how much more information they give us beyond nutrient status. It is likely to be some time before we know if these "pictures/structures/ forces/ energy" are important for animal and human health. But they do already show us that there is indeed an extra dimension or quality to organic food.

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"Extra Quality" of Organic Food ? - Results by Fluorescence excitation spectroscopy methodas applied on selected plants

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Abstract: *Purpose of the work was to distinguish food samples with respect to their culture conditions. By the applied method of fluorescence excitation spectroscopy data are gathered from integral parts of a plant sample. In a project funded by the German federal program for ecological farming the method was applied to carrots and wheat. In order to show reliability of data and results, the method was validated according to ISO 17025. For blinded wheat samples it was possible, to separate and identify correctly the organic group from the conventional samples for the two years investigated. Under the blinded conditions it was also possible, to separate and identify the fertilised carrots from the non fertilised ones. The hybrid variants of carrots could be separated from the open pollinating variants. Measured differences can be interpreted in terms of quality.*

Keywords: food quality, organic farming, validation

Overview

During last years the question of influences of the farming method onto the product found increasing interest (Tauscher *et al*. 2003). A special focus is directed to methods which are applicable to a variety of products. Basic idea of the method presented in this paper is to relate farming methods to optical spectral data measured at the whole farming product. Different from the well-known NIR-method the method described here uses the visible part of the optical spectrum and there is a time delay between excitation of sample and measurement of emission (measurement of delayed luminescence). The method was already applied successfully for a number of different samples (Strube 1997; Strube und Stolz 1999; Strube und Stolz 2000; Bloksma, Northolt und Huber 2001a; Bloksma, Northolt und Huber 2001b; Strube und Stolz 2001; Strube und Stolz 2002; Strube und Stolz 2004). The method is presented in short and some elements of validation are mentioned. The application of the method to different kinds of samples is shown and the interpretation of results is given.

The following questions are addressed and answered: 1. Is the method precise and repeatable? 2. Does method separate between a)organic and conventional wheat? b)carrots from different fertilizing levels? c)hybrid and open pollinating carrots? 3. Is it possible to identify organic and conventional samples? 4. What is the meaning of differences? 5. Does organic farming have an "extra quality"? The latter question was taken up due it was the theme of the conference, for which this paper was prepared.

Method

Basic principle of the method is that differences of optical spectra of samples are related to culture conditions. For this the whole sample is put in an instrument. The sample is excited by light and the total light emitted by the sample is measured after the end of excitation. A view into open instrument and a scheme of the instrument are shown in figures 1 and 2.

Fig. 1: View into instrument. Carrot during excitation

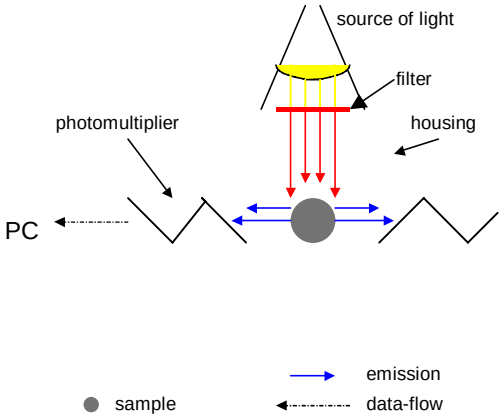

Fig. 2: Scheme of instrument.

The light emitted by the sample (delayed luminescence) decreases by time. A typical course of intensity over time is shown in fig. 3. Some terms used in the following text are also declared in this diagram.

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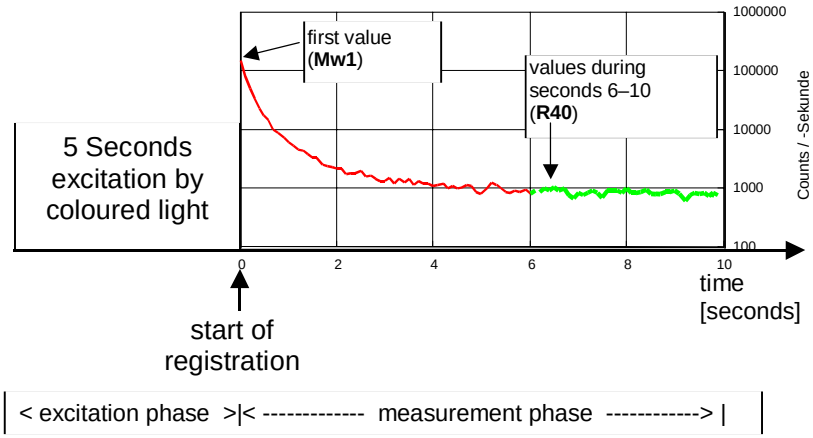

Fig. 3: Typical time dependence of the emission of a sample after an excitation.

The process of excitation and measurement of a sample is repeated eight times in total for eight different excitation colours out of the visible part of spectrum and near UV. The decreasing emission of the sample is different after each of the 8 excitations. For carrots and wheat are set in a common graph (fig. 4) the emissions during seconds 6 - 10 after excitation (named R40, see fig. 3) for each excitation colour. The values at the various colours are related to the values after white excitation as reference (=100%). The excitation spectra are fairly different for these kinds of samples.

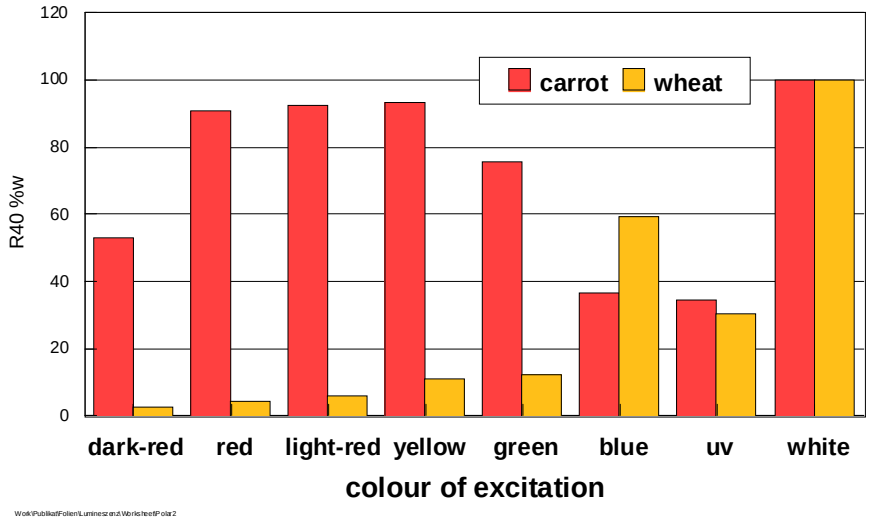

Fig. 4: Excitation spectra of carrots and wheat. Values referred to white=100%.

Validation

Validation means, to show that the method is reliable and suited to answer the question, which sample is grown under which conditions. Validation was performed in three steps. i) validation of the instrument ii) validation of the method applied to wheat and carrots iii) investigation whether method is able to show differences between farming systems.

One part of the validation of the instrument is the repetitive measurement of a inert test sample. A measure for precision and repeatability is the coefficient of variation (cv). The cv for repeated measurements (same day) is about 0.25 %, for long term repeatability (different days) about 3%.

The achievable precision at real samples is influenced by unavoidable changes of the sample. This generally increases the coefficient of variation (cv). For wheat a cv of about 5 % is achieved, for carrots the cv is about 8 %. All of these values depending somewhat on the special value out of spectrum which is investigated.

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Material

Material for the validation of method was from controlled scientific trials. All samples were coded.

The wheat was out of the DOK-trial of the Research Institute of Organic Agriculture FiBL, Frick (Switzerland) which is well documented (Mäder *et al*. 2002). Wheat samples consisted of the variants organic, bio-dynamic, pure mineral, mineral with manure and neutral.

Two variants of carrots of different fertilization were grown under controlled conditions at the University of Kassel (Michael Fleck). Two different hybrid sorts of carrots (Bolero F1, Nipomo F1) and 2 open pollinating sorts (Samson OP, Tiptop OP) came from Research Institute of Organic Agriculture FiBL, Frick (Switzerland).

Results

Data of the relation of R40yellow/R40blue out of the spectra of wheat from Samples of the harvests of the years 2002 and 2003 are shown in fig. 5.

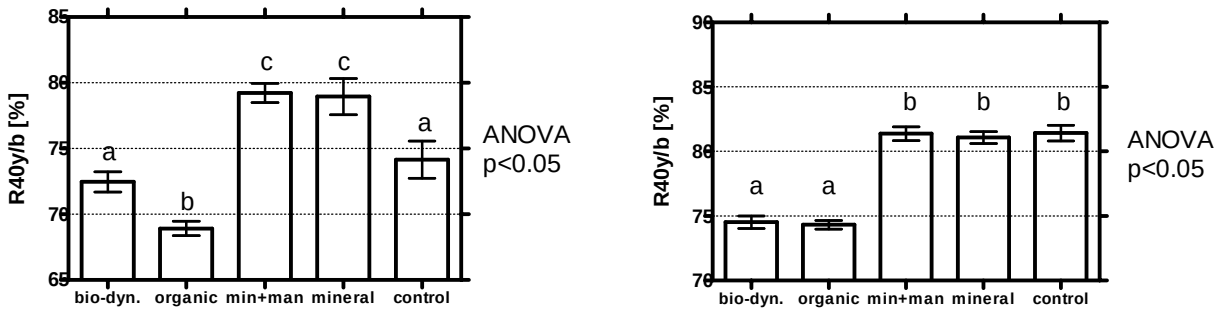

Fig. 5: Results of measurement on wheat of DOK-trial (FiBL) of harvests 2002 (left graph) and 2003 (right graph). Organic variants are depicted in green, conventional in yellow and neutral in grey.

The R40white-data of carrots of different fertilization harvested 2002 and 2003 are shown in fig. 6.

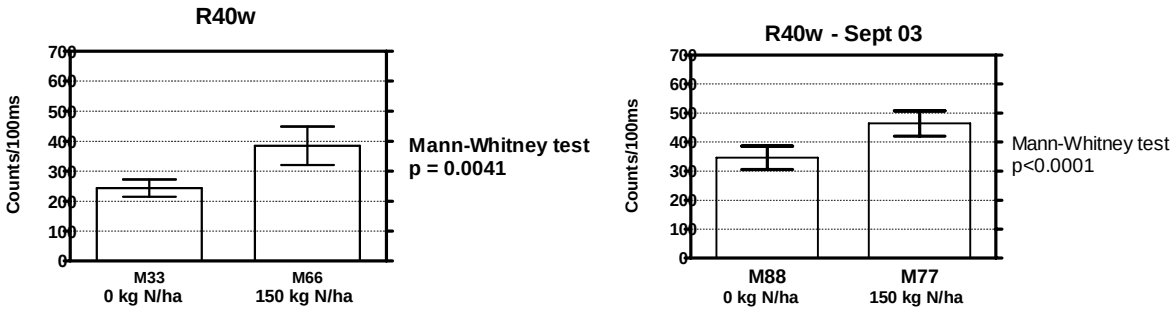

Fig. 6: Results of measurement on carrots of harvests 2002 (left graph) and 2003 (right graph). Unfertilized variants are depicted in blue, fertilized variants marked red.

There were significant differences between the variants at both harvests.
Differences between hybrid and open pollinating carrots were also detected with this method. Results of carrots harvested 2002 and 2003 are shown in fig. 7.

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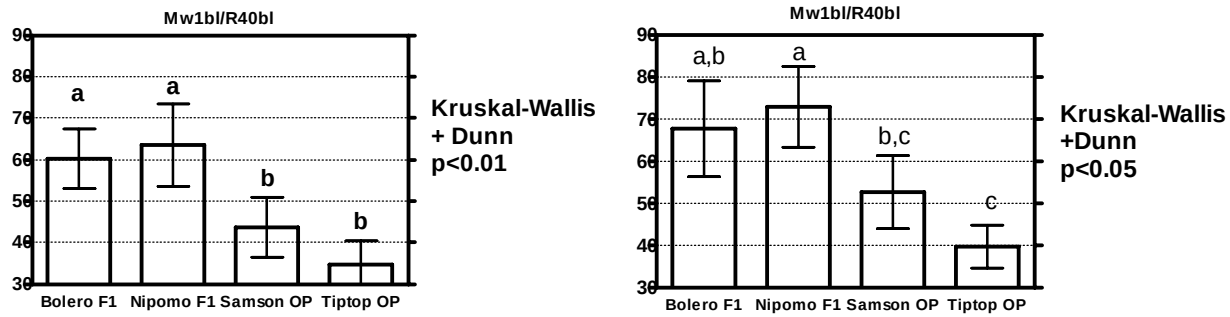

Fig. 7: Results of measurement on carrots of harvests 2002 (left graph) and 2003 (right graph). Hybrid variants are depicted in yellow, open pollinating variants marked green.

The results show significant differences between the hybrid and the open pollinating variants.
Related to the questions above it could be stated: The method is sufficient precise and repeatable. The method is able to discriminate between organic and conventional wheat, between different fertilizing levels of carrots and between hybrid and open pollinating carrots. And furthermore under the controlled conditions it was possible for these cultures to identify the related farming system of the samples.

Discussion

The still open questions are: What is the meaning of the differences measured? And whether organic farming has an extra quality?

On the way to answer these questions an extended look on excitation spectra of different kinds of samples reveals a systematic order.

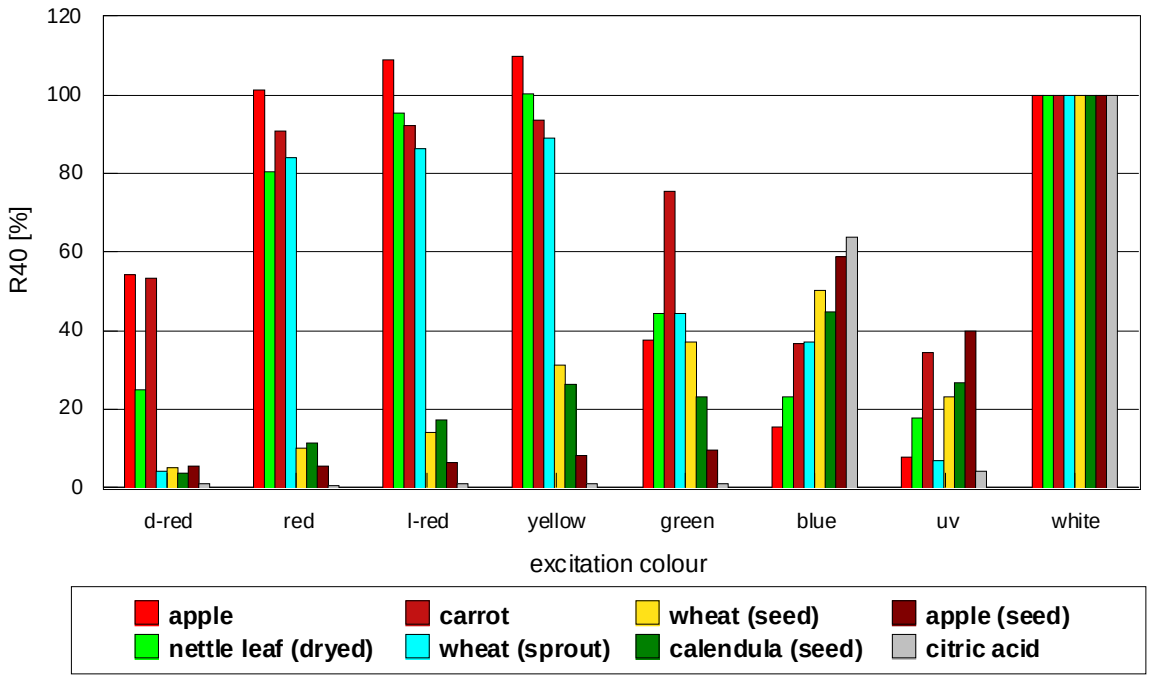

Fig. 8: Excitation spectra of different kinds of samples. Leafs and fruits show high values at red and yellow and lower values at blue. For seeds it is vice versa, seeds show low values at red and yellow but higher values at blue. A chemical (citric acid) is shown for comparison.

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In fig. 8 all emission-values are related to the emission measured after excitation by white light (white = 100 %). By this normalization differences of absolute emission caused by sample type and sample size are cancelled out. Two types of samples can be identified: On one side leafs and fruits which show high values at red and yellow and low values at blue, on the other side seeds which show low values at red and yellow and higher values at blue. Up to now we have not found exceptions from this rule.

This opposite behaviour with respect to light of leaves/fruits and seeds correlates with their different state of life. Active growing is related to leaves/fruits, rest or dormancy is related to seeds. If seeds are germinating their spectrum changes in direction to the type of leafs.

At apples the opposite behaviour was observable exemplarily when the apples were harvested in different states of ripeness (Bloksma, Northolt und Huber 2001a; Strube und Stolz 2002). Spectral values of the fruit-part of apples (outer side) at red/yellow increased with ripeness, the red/yellow values of the kernels of the same apples decreased with ripeness (fig. 9). Out of this data it can be concluded, that lower values at red/yellow are for seeds quite the normal development, indicating deeper dormancy of the seeds.

At apples of same date of harvest but different exposition to light and the variants of treatment by bio-dynamic preparations and no treatment, the exposition levels of light could be differentiated as well as the bio-dynamic treatment. The bio-dynamic treatment showed up in a way in the spectrum, as these apples would have got more light (Strube und Stolz 2002).

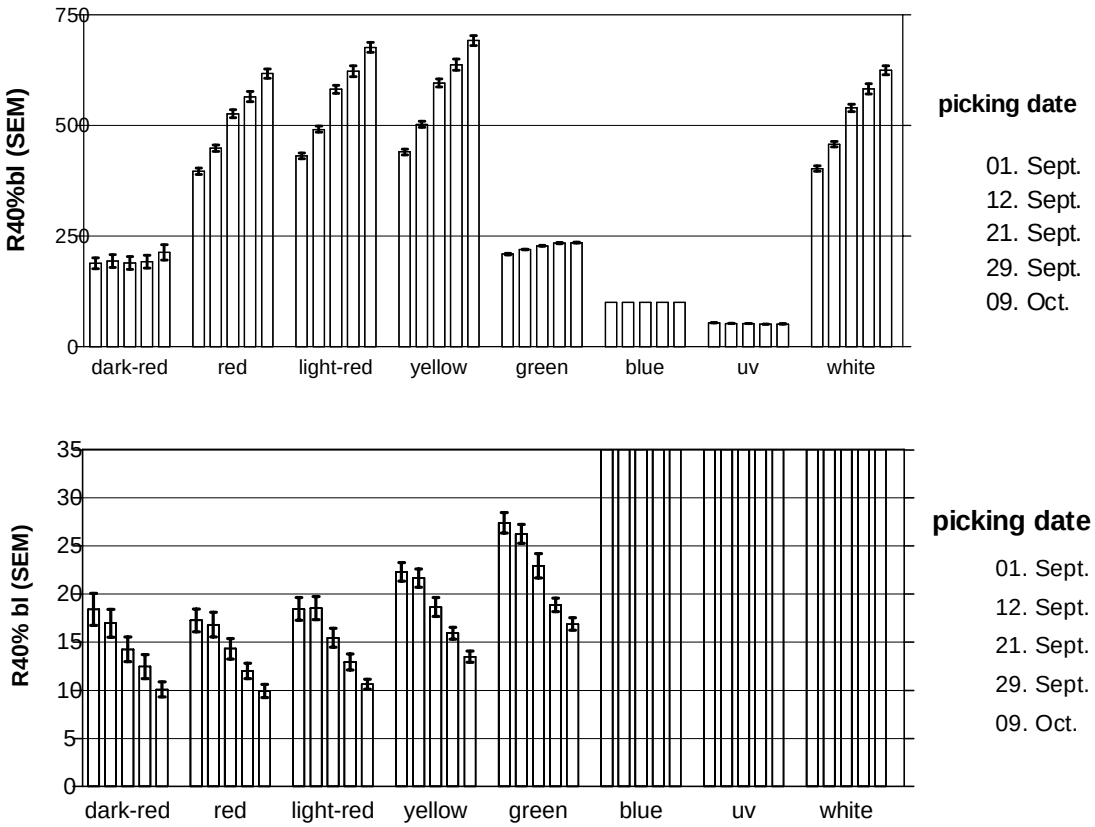

Fig. 9: Change of apple-spectra by ripeness. Spectrum of fruitflesh of apples is shown in upper graph, spectrum of kernels of same apples in lower graph. It can be concluded that ripeness means differentiation in spectrum (as well as morphological).

Seeds of wheat show differences in spectrum when they are fertilized differently. Higher fertilization results in a spectrum that indicates reduced dormancy of this seeds (increased values at red/yellow, reduced at blue). In a simple figure the change in spectrum can be expressed by the ratio of R40yellow/R40blue. This was applied in fig. 5 for the wheat samples from DOK-trial

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of FiBL. Graphs indicate, that organic farming produced wheat with deeper dormancy of seeds. That can be interpreted as a more species-typical development.

At white beans in a multi-factorial trial it could be shown (blinded conditions), that the beans could be differentiated still after two agricultural periods (two years) when they came from bio-dynamic or conventional farming. Also it was possible to differentiate between beans grown in soil and beans grown in hydroponic culture (Strube und Stolz 2000).

Out of these various experiments we conclude, that data can be interpreted in context of shifts in spectrum related to part of plant and change of conditions. That leads to the interpretation, that there is a clear tendency that organic farming leads to seeds which are more seed-like and fruits which are riper.

The question of an "extra quality" of organic farming could be answered in a summarized way by "organic products are more species-typical".

But it should be kept in mind, that these conclusions probably show a tendency. Under practical circumstances a lot of variation due to sort, geographical area, whether conditions and farmers practice may occur.

Acknowledgement
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CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

I will try to explain something about the biocrystallization method and I will start by saying that we started 2 years ago from scratch so we had nothing which has built up in the labs in Kassel. We build up a platform with other institutes ready for measuring intermediate precision and reproducibility.

Overview

1. **Why characterization of the Biocrystallization method?**
2. **Description of the Biocrystallization method**
3. **Results from measurements on coded wheat and carrot samples**
4. **Characterization results**
5. **Conclusions**

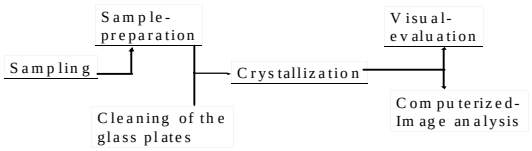
1. Why characterization of the Biocrystallization method?

- **Organic produce is a systemic approach**
- **Analytical methods detect single substances**
- **Biocrystallization method is systemic and makes properties visible**
- **The method has to be validated**

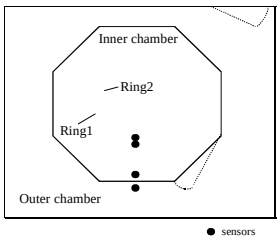
We call our method biocrystallization although it is also known as a copper chloride crystallisaton or just crystallization. I will talk about the characterisation of the biocrystallization method and look at how can we use such a method in analytical science and therefore I start with a question - why we characterise the biocrystallization method? and then I will describe the method.

Description of the Biocrystallization method

Procedure



Crystallization chamber



Why shall a method be characterised or why a method is introduced? Why should we use biocrystallization as the method because we have enough methods already available?

I think we refer to what Lawrence Woodward said earlier, that organic produce is a systemic approach and now we are looking for the analysis of the food and we apply analytical methods so we try to separate single compounds from the matrix. Why do we not introduce methods which are also systemic? The biocrystallization is a systemic approach but the method has to be validated and so validation in terms of the ISO 70 025 means to see if a method is fit for the purpose so can we re-apply the method for a question. We need a question before we start the validation process. But I don't want to talk about the validation but the requirements for validation and this is that we have to document the method or the procedures to come to a standardised operation procedure. Then we have to standardise the whole thing so that we can transfer the method to other places and next we have to make a statistical evaluation of the results.

What is the method about? Here you see a crystallogram.

It is simply that we mix a copper chloride solution together with a plant extract or juice and then we put this on a glass plate and let the water evaporate. Then we get a certain residue of copper chloride crystals and there is an overall ramification showing a structure and a texture, starting from the centre and then going to the outside. The interesting thing is that we cannot easily connect the macroscopic structure over 9 cm on the plate with the microscopic properties of the copper chloride.

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

That is a very important phenomenon. So we are dealing with crystal patterns and want to know if we can use those crystal patterns to get information about the sample.

When we start we say OK let's take the laboratory method as a normal analytical method for routine analysis and we have several steps to fulfil. We have the sampling, then of course the sample preparation because we need to have a juice or an extract. Then we have some preconditioned steps like cleaning the glass plates and then instead of a HPLC or gaschromotography and mass spectrometry or something like that, we have this crystallization step.

Then we have two different methods to evaluate the patterns. First the visual evaluation technique which was applied over decades and we try to standardise this in that we transfer the knowledge from sensory analysis to the visual evaluation of the patterns, so we just apply morphological criteria and we can come to the statistics of it. Here I want to focus on the second approach, the computerised image analysis because this evaluation method gives us the opportunity to deal with a large amount of patterns.

The crystallization unit is in a chamber and we have two different rings and on these rings there are the glass plates during evaporation and crystallization. It is very important that we control the whole system because the most variation is coming from the crystallization step.

This is the crystallization unit so we build just another chamber around to avoid air turbulence during the evaporation of the water and you see the glass plates on the two different rings 43 per each run and there are sensors to measure and control relevant humidity and temperature in different places inside and out of the chamber.

Crystallization chamber

The next slide shows the patterns - on the left side are carrots and on the right wheat.

Carrot

100mg substance
100mg CuCl2

100mg substance
75mg CuCl2

Wheat

90mg substance
135mg CuCl2

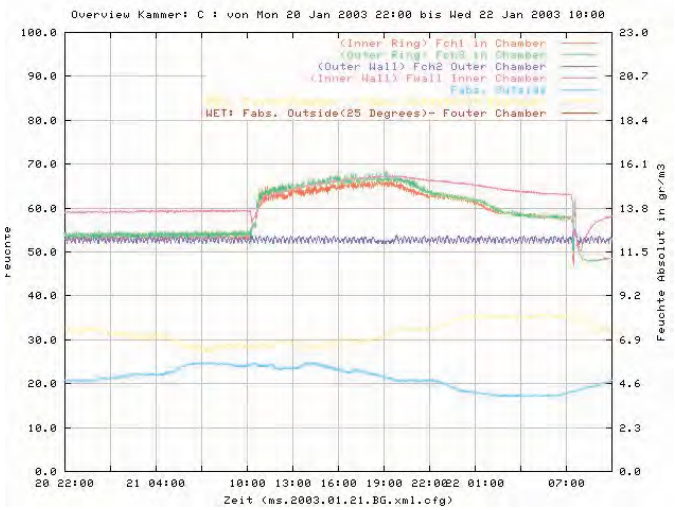
90mg substance
90mg CuCl2

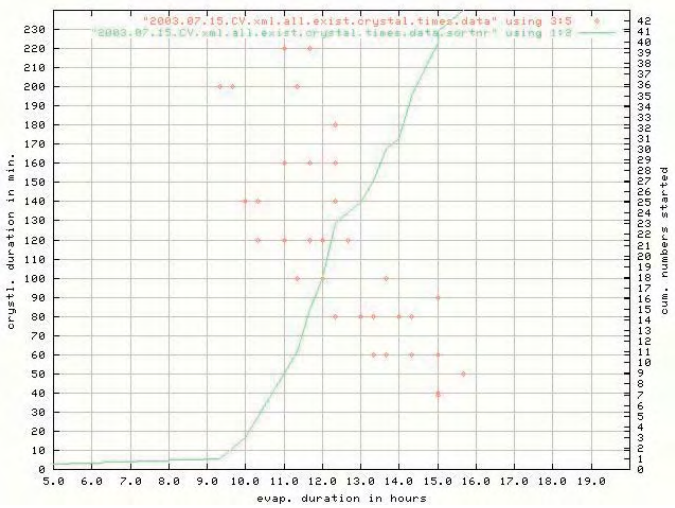
We started to test different mixing ratio of copper chloride and the extracts. You see that there is an influence of the mixing ratio so when we are thinking about characterising the method the climate conditions inside the chamber and the mixing ratio are important factors of influence.

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

Evaporation and crystallization process





On the left side, you will see on the y axis the relative humidity. The green and red lines are the relative humidity above the plates and, of course, when we pipette the solution in the plates then water starts to evaporate and relative humidity is increasing. It was very important for us to stabilise the whole system and standardise it because in former times people reported that they could reflect the year in that they get summer and winter pictures but this was just due to the relative humidity and after standardising we get the same pictures over the whole year.

On the right side you will see something we cannot standardise because that is random. On the y x axis you see the plates already started with the crystallization as the accumulative number and on the x axis you see the time after pipetting. That means that after about 8 or 9 hours after pipetting the solution the first plate of the 43 starts to crystallise. And after 16 or 17 hours the last, so that means we have a variation inside the chamber just to the random start of the crystallization. Therefore, we introduce a standard control over the year and developed a standard and we use this standard for every chamber to control the whole system.

The different evaluation approaches - we have visual evaluation and we make a methodology out of it by just looking at other methods like the sensory analysis and the computer based image analysis we have two different approaches as structure analysis, but that is very sensitive and the much more robust method of texture analysis and we are working with a grey level distribution, just looking at different patterns.

Evaluation: different approaches

Methodological approach for the evaluation of the patterns

Visual evaluation

Description according to morphological criteria (method adapted from ISO 11035:1994 and developed in the triangle)

Computer based image analysis

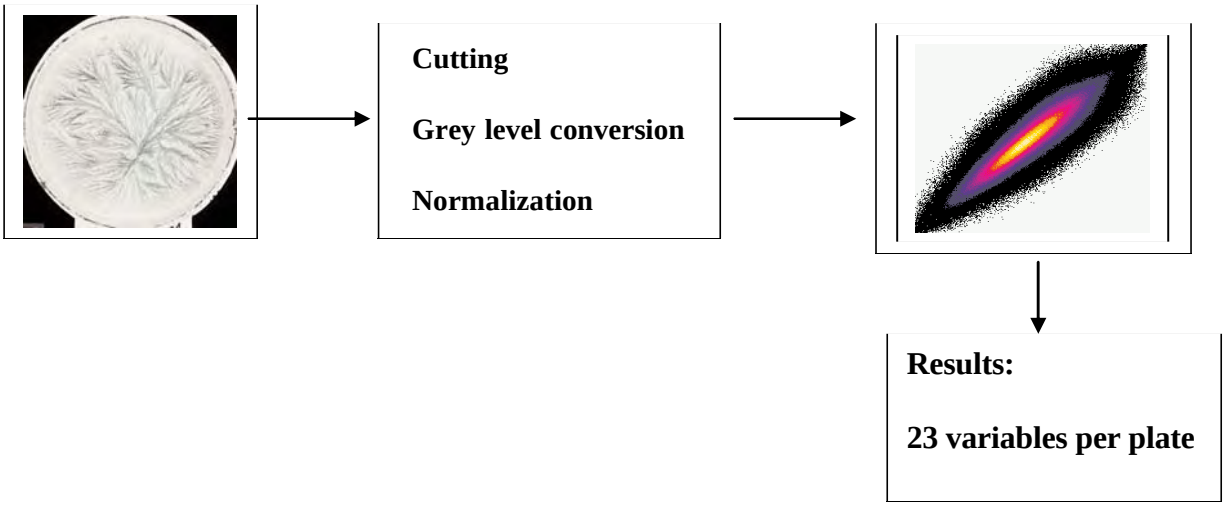
Texture analysis (grey level distribution and GLCM)

Structure analysis

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

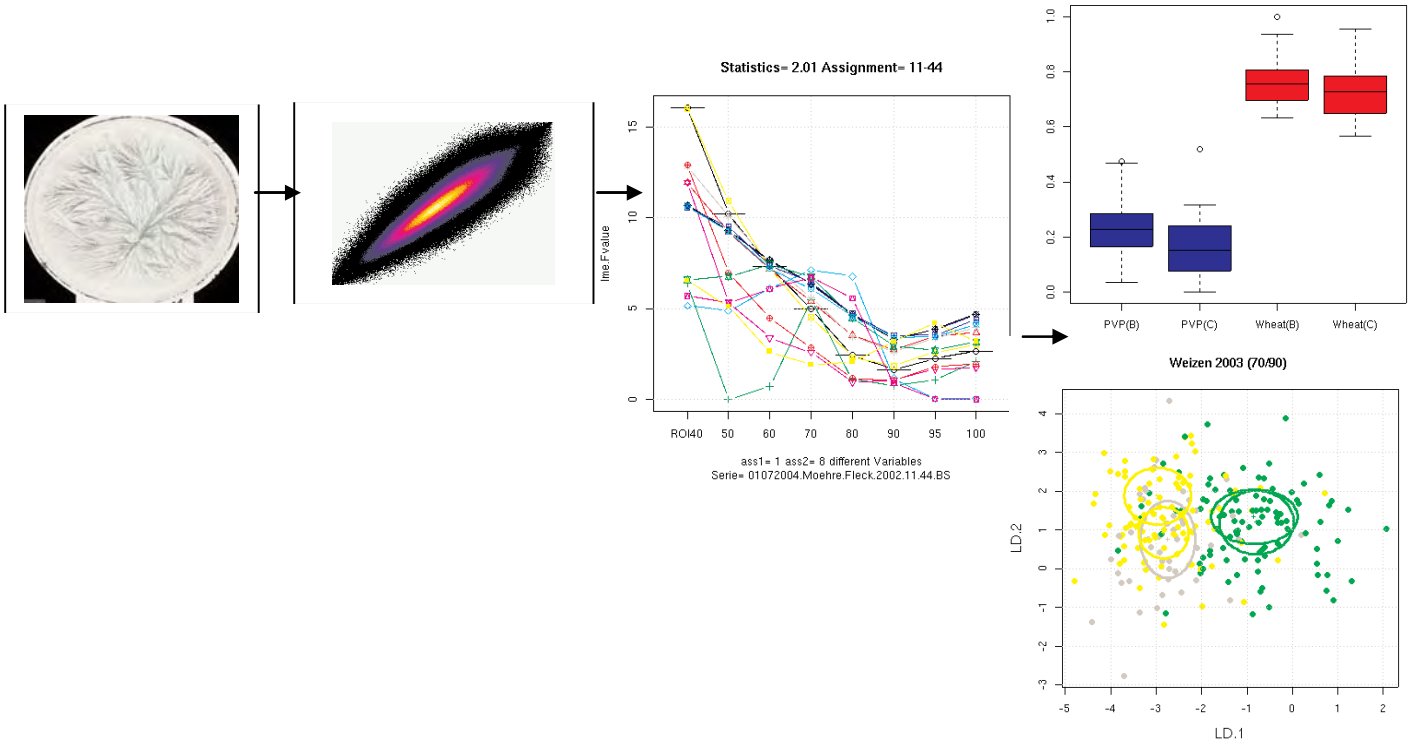
Evaluation: texture analysis



We just want to see can we differentiate the patterns due to the texture analysis results. What we do is we scan the pictures then we cut a part of it so we have a region of interest i.e. we can take the whole picture, 100%, or just the inner part, 10% or between, and we make a grey level conversion, a normalisation and then we have statistics first and second … and we get a result, several variables of this texture analysis programme is just looking for example at the nearest neighbours.

Our goal is to differentiate pictures so we are working with qualitative methods not quantitative. We have no absolute scale until now so we want to differentiate samples. We do this in that we create this single variable of the texture analysis and you will see on this diagram.

Differentiation of samples:



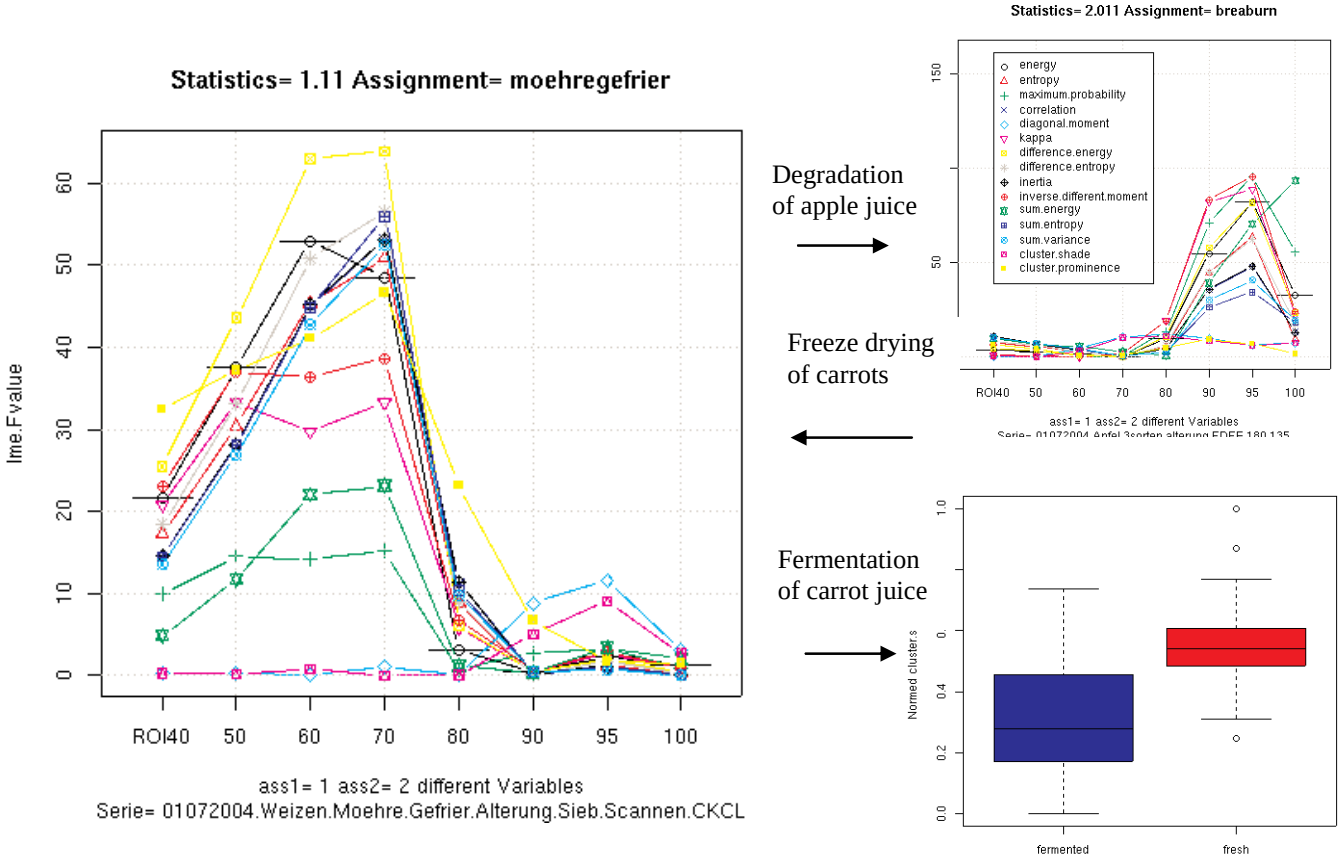
CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

You will see the information when we look at the F value which gives the results, if we can differentiate samples or not, that the F value is - for this example - decreasing when we take the whole picture so that means the information depends on the size of the pattern we are using and using that, we can just take out a single variable, and here we differentiate an organic molecule polybdon and weed samples, we use this as standard as statistically significant independent from the two chambers we are using and the other pictures shows a linear discriminatory analysis so a multivarious statitistic applied.

Now I want to show the results of the linear discriminate analysis because these are much more picture-like.

Texture analysis:
Goal: Differentiation of samples



On the left side you see the F value and on the x y you see the ROI and what we want to test if dry matter has influence on the picture. We know that when we play with the mixing ratio, yes of course there is an influence but what we want to know is the process of freeze drying to a carrot, how it can be best reflected to the method because normally when we look at polyphenols we freeze dry the whole sample and then we make the analysis.

Here, when you look at the F value of freeze drying versus fresh carrots we see that of course there is a tremendous influence of freeze drying on the results of the method. This depends on the path of the pattern we are looking at. On the right upper part we look at degradation of apple juice because we want to look at the stability of the solution and here once more, the F value of an anova of fresh and 6 days degradated apple juices, and of course we find a tremendous influence of the degradation of the product. The other part of this slide shows the fermented and fresh carrot juice compared and of course there is also a statistical significance based on one single variable and making an anova and of course we introduce a repeated measured model.

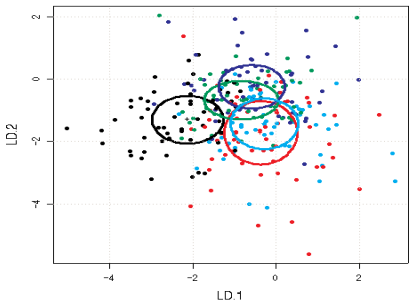
Now in the next slide we look at the first samples. On the left shows 5 DOC samples in 2002, the control, 2 organic and 2 conventional and on the right side, the samples after decoding.

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

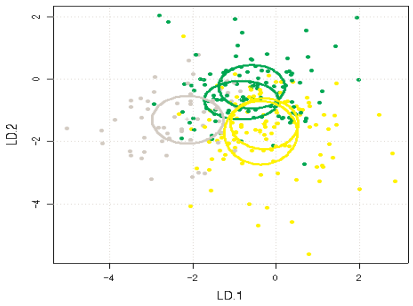
3. Results from measurements on coded samples

Wheat: 5 DOC samples harvest 2002, measurements spring 2003



before decoding: LD2 against LD1

For 5 DOC samples, harvest 2002



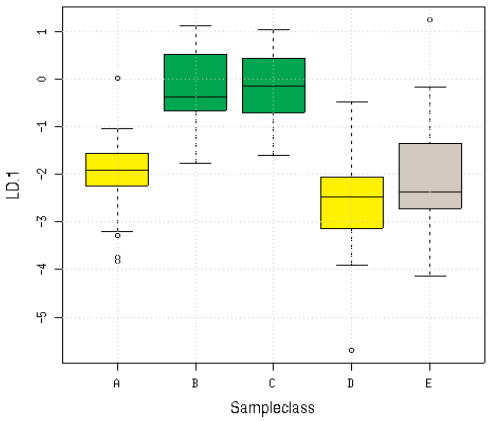
after decoding: grey = control,

conventional = yellow, organic = green

You will see that we can separate the organic and the conventional from the control and this is statistically significant on the basis of the single variable. This is just the linear discriminant analysis results so the circles are reflecting the samples, and the dots the different pictures we make. We can separate the organic from the control and we can separate the organic from the conventional. When we did this in 2003 this is only the first linear discriminant faction and you will see the same - green is the organic, yellow the conventional and the grey is the control.

3. Results from measurements on coded samples

Wheat: 5 DOC samples harvest 2003, measurements fall 2003



LD1 value against sample classes for all

5 DOC-samples harvest 2003

(after decoding: grey = control,

yellow = conventional, green = organic)

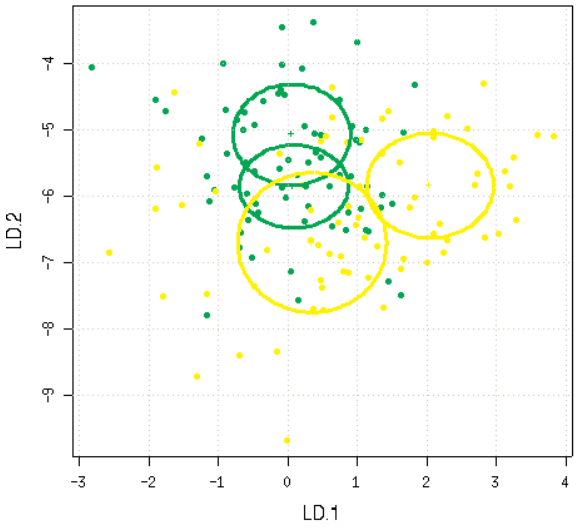
You really need to think about what the picture is saying. As an analytical chemist you start to want to correlate the pictures with other stuff, with amino acids or secondary compounds, dry matter, falling number or whatever - so we start immediately not to stick on the phenomenon and to refer this to concepts like self organisation but to compare. Of course let's start to compare.

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

3. Results from measurements on coded samples

Carrots:Different varieties, harvest 2003, measurements fall 2003



LD2 against LD1 for all 4 FIBL-samples harvest 2003

(after decoding: yellow = hybrids, green = open pollinating)

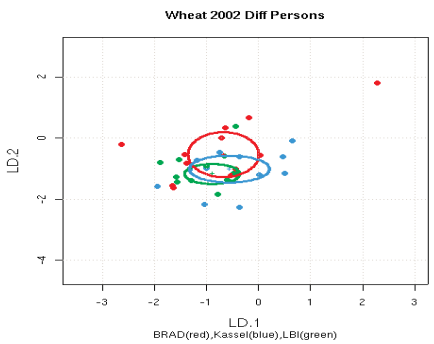
Normally you would put the control to the organic because organic is just a little bit more than control doing nothing. When we look at the total nitrogen and the amino acids, yet it is true. The control belonging to the organic can be separated from the conventional but this method and also Jurgen Stube's fluorescence excitation spectroscopy shows it differently.

We are grouping the control to the conventional and not to the organic. In both years we can separate the organic from the control. This was the question of different varieties, open pollinating versus hybrids and we can group the hybrids and open pollinating together, these are the greens and as Jurgen Strube showed, also here the method one of the hybrids is belonging to the open pollinating.

The repeatability, the intermediate precision and the reproducibility are shown on the next slide.

4. Characterization results

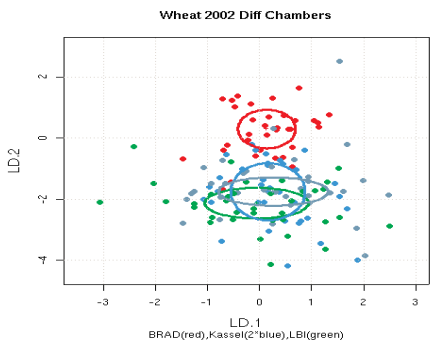
Reproducibility and Repeatability



LD1-value for 1 wheat sample (2002)

3 different people, trained, in 1 chamber

in Kassel (Ks = blue, LBI = green, BRAD = red)



LD1 value for 1 wheat sample (2002)

4 chambers in 3 laboratories, 3 different people

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

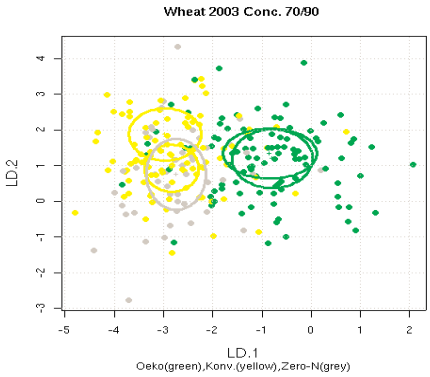
Dr Johannes Kahl

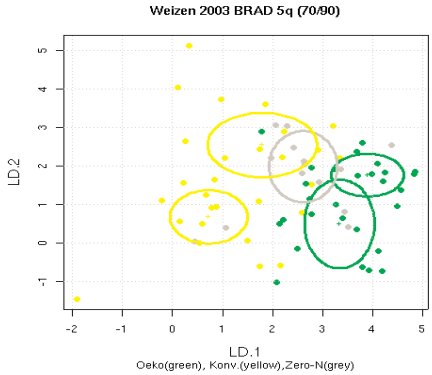
You will see on the left side the result of the LEA when we put different technicians together in one lab with different machines. To look at what is going on - if people are doing it in parallel and you see it is quite the same and we make statistics on the basis of the single variable and there is no statistical significance between the people. On the right side we make reproducibility tests so we sent one weed sample around to three different labs with four chambers and then measured in repeatability tests so 6 times sample preparation. We can see three chambers are belonging together, one is a bit apart and this is of statistical significance so the red lab is a little bit apart but because we have no absolute scale we cannot measure the accuracy of the method and we don't know who is right, and therefore we send the same DOC samples we could differentiate, to that red lab to look at if it depends on the place or if this lab which is in total a little bit apart, can also differentiate.

In the next slide on the left side you see once more the results produced in Kassel and on the right you see the results produced in Denmark and you see also in total that they are different. They can separate the organic from the conventional samples testing the discriminatory ability of the method in different places.

4. Characterization results

Reproducibility and Repeatability III

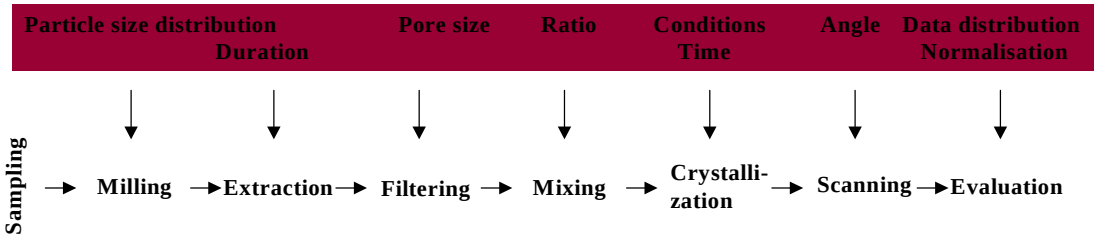




In the next slide of course characterisation of the method means that you really have to know about your methods and the details and therefore we just put the whole chain in the lab together and then we looked at the different factors of influence - how those factors are influencing the variation and the results. We look at repeatability, intermediate precision and reproducibility so as soon as we increase the amount of labs to aid we can fulfil the international requirements for the validation of the method.

4. Characterization results

Characterisation of the method (wheat)



Tested:

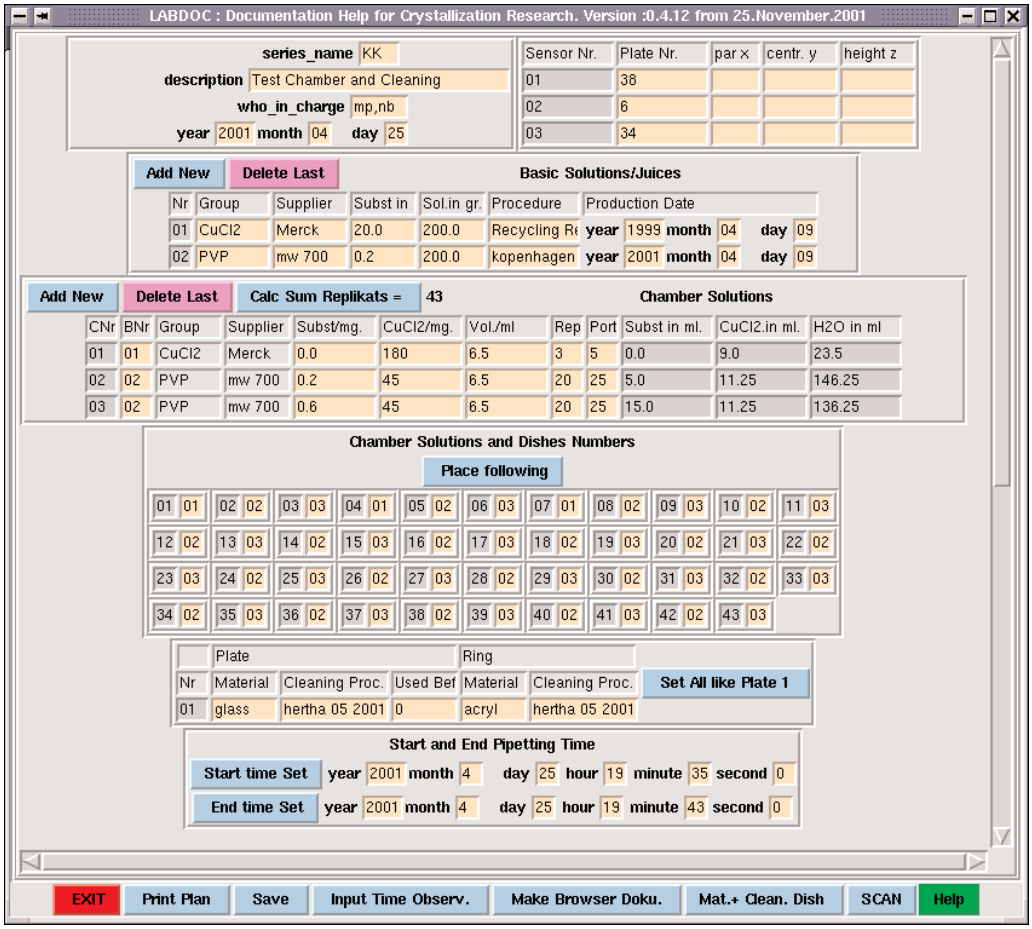
1. **Repeatability**
2. **Intermediate precision**
3. **Reproducebility**

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

In the ISO 70 025 of course there is the requirement that you need a quality management in all labs that are accredited due to this norm and we are working with a computer assisted lab documentation system. Here you see the front page that every sample entering the lab is connected with the sample preparation procedures with the chemicals used, the place on the crystallization unit and with the climate conditions and the results from the texture analysis or even visual evaluation.

Documentation: computer assisted laboratory documentation



In conclusion, the biocrystallization method including the texture analysis can be documented and used as a lab procedure and a lab method but it is a qualitative method so we are working on a nominal scale. We can group and differentiate the 5 different wheat samples from the DOC trial in a 2 year repetition. We did the same for the 4 variety samples of carrot and the nitrogen fertilisation samples and we can characterise the method according to international standards so that we measure the repeatability, the intermediate precision, reproducibility and look at the factors of influence.

Conclusions

1. **The Biocrystallization method including texture analysis can be documented as a l laboratory procedure**
2. **The 5 wheat DOC-samples can be grouped in control, conventional and organic in a 2 year repetition**
3. **From the 4 varity carrot-samples the open pollinating can be grouped together and one hybrid can be separated**
4. **The Biocrystallization method can be characterized according to international standards and therefore is able to be validated**

CHARACTERISATION OF THE BIOCRYSTALLIZATION METHOD USING COMPUTERISED IMAGE ANALYSIS

Dr Johannes Kahl

The next steps for routine analysis we have to reduce the variation coming from the chamber because of this random crystallization start. Then we have to look if we can use the time information about the different crystallization behaviour to include this in the evaluation. We have to optimise the evaluation tool and that we introduce multivarious statistics and of course then what is the method saying, so we have to develop a model for a scientific understanding of the process.

Here we started with micro molecules like glycogine or some others to look at what is about this self organisation concept. Can we relate that to the method? And then of course we have to correlate the results derived from the copper chloride crystallization or biocrystallization method with results achieved from other methods to know if this is some addition or what is the method about and we do this in the next governmental project we are running and we increase the amount of samples so that we also look at market samples. Then of course we are waiting for questions so we have to look to which extent the method can be applied for different questions in processing and organic farming.

5. Next steps

1. **The conditions during evaporation and crystallization have to be optimised in order to reduce the variation of the patterns.**
2. **The time information has to be included into the evaluation.**
3. **The evaluation tools have to be optimised (multivariate statistics).**
4. **A model has to be developed for the scientific understanding of the process.**
5. **The results from the biocrystallization method have to be correlated with the results achieved from other methods on the same material.**
6. **It has to be proven to which extent the method can be applied for different questions (e.g. influence of processing) on crop and food products.**

When one is working in the fields of organic and holistic methods you know that to get a platform running is a huge amount of work and normally people are not able to work together. They have their own systems and this is right. They are not coming together so we built a platform in this organic field of holistic methods with colleagues from the Biodynamic Assoc in Denmark, from the Louis Bolk Institute and the University of Kassel where we work together in an inter-disciplinary group to be able to measure this reproducibility for example and, of course, without money we can do nothing so I would like to thank our sponsors.

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RESPONSES

Edited from the transcription of the speeches.

Dr Raph Bundy:
Hugh Sinclair Unit of Human Nutrition, University of Reading

We come from a clinical nutrition background - both clinical researchers in human nutrition and, obviously, we have been asked to give a response at this seminar today.

I was thinking - What does quality really mean? - but then Prof Meier-Ploeger gave us the Hexagon of quality which gave us 6 criteria of quality - authentic; functional; biological; nutritional; ethical and sensual. From my point of view, the nutritional side would be my part of the quality.

We have heard some very interesting talks today and it has been really good with a mixed bag of people. Specifically the two methods which have been developed and really show being able to distinguish between organic and non-organic food based on these different methods of crystallography and fluorescence really.

But of course I have to be honest, from a nutritional point of view, they can't actually say anything about the food having an extra nutritional quality because what they are doing at the moment is giving an observation that they can distinguish between one and the other. We don't really know what that means or we don't know what that means at all in terms of nutrition. I am not saying that they are not important in other sides of quality and maybe authentication; they have a role at the moment for quality.

In nutrition you glean evidence by looking at epidiology trials, looking at the associations between diet and health and you might have an epidemiological trial or data like saying the Mediterranean diet is good for health and disease based on observation - but to look at cause and effects obviously you have to do one step further and do a clinical trial. To give strong evidence by looking at quality in terms of nutrition for organic food or non-organic food, the one way in the conventional scientific framework, would be to run a trial where you have a group of people given an organic diet and a group of people given a non-organic diet and then observe them and measure certain criteria for outcomes which will then relate to health and that would be the general way to do it.

Dr Steve Hicks:
Hugh Sinclair Unit of Human Nutrition, University of Reading

I am very interested in these ideas presented here today of delayed luminescence and bio-crystallisation and I would be particularly interested as a scientist how these concepts actually relate to the biological functioning of organisms and particularly the organisms that consume these products. By that I mean, animals and us as humans who eat organic produce.

I would want to ask particularly two questions about the differences between organic and non-organic produce. One, is there actually the phenomena we have spoken about here today, do these actually cause effects in us as consumers? And two, are these effects actually beneficial on health?

When I say do these phenomena cause effects in consumers what I mean here is, after we have ingested these foods, are these phenomena still actually going to affect our physical bodies or are they destroyed with the food as one digests it - so in the end the digested food whether organic or not is very similar. One way to test this maybe is, I have read about Dr Popp in Germany who has done tests on humans on bio-photon emission and don't know whether it is possible maybe, to feed humans organic produce and actually see if they have an altered bio-photon emission compared with people who have non-organic produce.

These factors might be not necessarily have a nutritional effect, they might be just something related to the food but doesn't give us any biological benefit e.g. organic foods might differ in size and shape to non-organic foods so they might have different bio-crystallisation or different delayed luminescence. We need to actually show that they have effects on humans. Are these measured phenomena just reflective of chemical content? I think it is probably important to show that there is something different and they are not just an association of the underlying chemistry behind them. For example, the luminescence might be just a different way of measuring ht pigment content of the produce.

RESPONSES

Edited from the transcription of the speeches.

If we were to go about actually trying to measure whether organic produce has a beneficial effect on health scientifically this is not as easy as it might first seem. The way we would do it is to set up an intervention study or a clinical trial and one of the first difficulties we would have is how would we actually measure health? What would form our health outcome? There are various things I could think of that you might want to look at - weight, cholesterol levels, or antioxidant status - this kind of thing. But then more sceptical people will always ask 'are people who show differences in these measures, are they actually more healthy? Do they live longer? These sorts of issues always come up.

Another problem in clinical trials is people are very variable, you don't have a standard person and this means you really need large numbers of subjects to actually demonstrate anything in a clinical trial which makes them very expensive and hard to conduct, to get a really positive meaningful result.

One final point I would like to say is that if we ask the question 'Does organic produce result in good health'? I actually think that by a person taking the choice to consume organic foods and eating food considered good for us, which might cost a little more, they are positively influencing their own health. I am hinting here at the effects that a positive and healthy mind appears to have on the body as science is now beginning to discover.

Alex Smith *from Alara Wholefoods* gave the views of a food manufacturer:

These presentations today gave us some interesting hints. Unfortunately nothing there is going to allow us to build adverts extolling the new virtues of organic food tomorrow and I think that is going to be true for more or less any food manufacturer.

What was very interesting for me on a slightly different level was to hear the differences that were extolled for organic food, especially the fact that it is more stress-resistant than non-organic food, that it seems to have better property for self-organisation than non-organic food and the property it seems to have for disease-resistance as opposed to non-organic food. These are three very important properties that I think were brought out in this morning's presentations.

I don't think the science is robust enough for me to be able to make anything from that other than my own innate sense that this is actually the case. Having considered this case then, I can't do anything other than extrapolate that further and to consider if organic food does have an extra quality that is not really even in that hexagon, in that I think we are now actually in as very exciting and interesting time of developing in society.

I think there is agreement now that the old ways we have organised society are actually breaking down and that something new needs to arise from it. If we have got a food system that is producing food that is more stress resistant, more self organising and more disease resistant and we apply those general principles to how society is organising, then we need a society that is more stress resistant, that is more disease resistant and that is much more capable of self organisation.

So it does seem to me from the speech we were given this morning is that organic food and the systems that are inherent in it and attributes we have had described, actually do make it a food that is a food fit for the future and it seems to me that that is an extra quality that I've taken from this morning's session and it is kind of crystallised that view in my mind. Quite what the ramifications of that are I am not quite sure, but it has in ay reinforced my view that out of all of those developments that we need now, organic food agriculture is the one that does provide those coherent elements that will allow society to reform in a sustainable way.

Lynda Brown, *food writer and campaigner*:

I wanted to really make just a couple of very general points. I would like to say that I have been following the progress of this work for about 5 years now and I wish to declare my hand. I find that it excites me scientifically, intellectually and emotionally. It also seems to me that this work opens up a Pandora's box of potential opportunities and threats, not to mention heated debate but I think that is one of its great virtues also. It does generate food for thought but I thought probably the best contribution I could make was almost to take a human perspective.

RESPONSES

Edited from the transcription of the speeches.

The first point I want to air is that it seems to me from a consumer point of view that any serious scientific work which helps us to understand both what makes and keeps us healthy is a GOOD idea. From my point of view it is a total no-brainer. As a nation we are obsessed with health. The problem is because of the huge lifestyle changes, very few people are prepared to bother to nourish themselves with the right kind of food that will not only avoid bad health but will significantly encourage good health. That's the problem that we face and it seems to me that approaches that help consumers to think about health in a more qualitative and holistic way just might nudge them in a different and more constructive direction than the plethora of confusing nutritional advice we have had the misfortune to labour under in this country in recent years. At some level I just don't think people believe any more.

Where diet is concerned, there is widespread disillusion with conventional thinking, we are all hopelessly confused and I think the sooner we face that then the sooner we might begin to do something about it. I think these kinds of approaches just might capture that spark we are going to need to move things on. Indeed, you could argue that it is precisely this kind of approach whose time has come and I think that is for two reasons.

Firstly, at an emotional level I do believe it resonates with us as human beings or at least it has a much better chance of doing so which is another way of saying that it just makes good commonsense. We do all taste stress every single day of our lives. You can get a handle on the kind of self-realisation or self-organisation concept, indeed there is a multi-billion dollar industry out there just getting us all to self-realise ourselves every single day of our lives. We can understand that. There are those of us, like myself for example, who have spent half our lives feasting on seasonal home-grown fruit and vegetables. Now we absolutely know that they make and keep us healthy. My vegetables have a vital quality that shop-bought produce doesn't and it is not just because they are fresher. It is the soil, it is the way they are grown. You only have to look at my soil to know it and to coin that phrase 'it's not magic, it's muck' - and it is.

Now as a consequence my empirical, and as it happens I did go to university to become a scientist, and my experiential experience plus my bionic health is all the proof I need to know that you are what you eat. Of course, if I could prove it I would be so elated that that would immediately boost my immune system by 200% as far as I am concerned, job sorted! Nor do I think that I am unusual in this. I do not believe that we should ever discount the feel-good factor. It is something I am always banging on about and Steve Hicks has just hinted at this. Why do you think that organic food has finally taken off? You can't blame it all on the media or food scares, however horrendous they might have been. At some fundamental level we know it makes sense and my hunch is that this kind of approach towards diet, or what I prefer to think of as nourishing ourselves, will hit those same kinds of buttons.

The other reason why I believe now is the right moment for this kind of approach is pragmatic. Health , or rather the consequence to the NHS in this country of ill health, which is due primarily to the de-vitalised food we actually eat, instead of the nourishing and vital food we should be eating has now hit the political fan big time. Like so many of today's issues, time is running out fast and if we really are to have any chance of reversing the decline we are going to have to radically re-engage and reassess the whole health debate. I don't think the old paradigms are working, as consumers we are not heeding the message and we do desperately need to 'spin' the role of food in health in a different and literally fresher way, the point being we simply can't afford not to anymore.

I wanted to make one more point which is slight heresy but never mind. I am very acutely aware that this research is fuelled by a desire and a necessity to substantiate whether or not organic food is better for you. The debate between organic and conventional food, as some of us know, is so loaded that I personally think that this brave bunch of scientists should be congratulated for even trying . Anything to do with organic versus conventional is a David and Goliath scenario. It may be heresy but what I would like to see, and what I most hope for, is that the word "organic" is taken out of this particular equation and that this kind of approach be incorporated into mainstream scientific nutritional thinking and research. If the nation's health predominates society which it will do, then we are going to need all the help we can get and as many different viewpoints on how to tackle it as possible.

We also need to invest in non-conventional approaches. They do provide an injection of fresh air and, if you like, act as antioxidants in their own right. The inequality of funding in any kind of research which tries to think outside the conventional box continually frustrates me and I find it immensely narrow minded and protectionist and I actually think that consumers and society as a whole deserve better.

RESPONSES

Edited from the transcription of the speeches.

It is not any threat to the consumer to pursue these kinds of approaches whatsoever, only to the establishment and the status quo, which undoubtedly sounds emotional but let's not forget Galileo had the same trouble too and hopefully we have moved on a bit! I just think we should get on with it and I think in the course of time if it really does appear that food produced using a certain system of agriculture has nutritional, or what I prefer to define as nourishing benefits, then I sincerely hope that the politicians and the food industry will be man enough and open-minded enough to embrace it. I want to finish with the following quotation from Albert Einstein (seen in The Kindersley Centre's female toilets!); "If at first an idea isn't absurd there is no hope for it".

It is not any threat to the consumer to pursue these kinds of approaches whatsoever, only to the establishment and the status quo, which undoubtedly sounds emotional but let's not forget Galileo had the same trouble too and hopefully we have moved on a bit! I just think we should get on with it and I think in the course of time if it really does appear that food produced using a certain system of agriculture has nutritional, or what I prefer to define as nourishing benefits, then I sincerely hope that the politicians and the food industry will be man enough and open-minded enough to embrace it. I want to finish with the following quotation from Albert Einstein (seen in The Kindersley Centre's female toilets!); "If at first an idea isn't absurd there is no hope for it".

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A SHORT REPORT ON THE EFRC *FOOD QUALITY AND HEALTH - CONCEPTS INTO PRACTICE* CONFERENCE.

Laura Davis, EFRC

The EFRC Conference last November contained a hugely significant UK first. A German research team headed by Angelika Meier-Ploeger has succeeded in gaining government approval for two innovative and holistic methods of determining food quality. This is a very important achievement as these methods - presented in their full, validated form for the first time in the UK at the conference - open up the possibility of holistically investigating the links between food quality and health. The conference also heard a comprehensive review of available mainstream methods.

EFRC advisor Laura Davis attended and was also present at our very first meeting on the subject in February 1989. Here are her observations….

About 16 years ago, motivated by its concerns about food quality, EFRC held a Food Quality Colloquium at Sutton Courtenay in Oxfordshire, which resulted in the publication Food Quality - Concepts and Methodologies. At this meeting, presentations on novel methods of determining organic food quality, including fluorescence excitation spectroscopy and bio-crystallisation methods, were considered by the invited delegates. A consensus was reached which agreed that any assessment of food quality or any claim of 'quality' should rest on scoring highly against six criteria: authenticity (which was thought to be important with the advent of genetic engineering); functional: biological; nutritional; sensual; and ethical (which included social and environmental considerations).

The 2004 Food Quality and Health - Concepts into Practice conference at the Sheepdrove Organic Farm Centre, speakers revisited the ideas and methods that originated, at least in part, at the earlier colloquium. The conference opened with a short presentation from Lawrence Woodward, 'Towards Whole Food Quality', in which he argued that organic farming is the only farming system that has as its underpinning philosophy the achievement of positive health. This philosophy is captured in the words of Lady Eve Balfour who wrote, "the health of soil, plant, animal and man is one and indivisible" (Balfour, 1946). From this perspective, a narrow sensory definition of food quality is inadequate, and a definition of total or 'holistic' food quality is needed. But although such a definition has been formulated and set out, as above, it has yet to be widely taken up, and, although valuable, it does not address the core question of whether health is a dynamic state where its components are "one and indivisible".

The conference heard about the "notable progress" that has been made in using both mainstream and alternative methods in assessing some characteristics of food and their relationship to production methods, and considered questions arising from the potential to determine whether organic food does have an "extra quality" that may be important to health. If this is the case, how can we manage production and processing systems "on the ground" to consistently deliver this extra quality and improved health?

Kirsten Brandt of the University of Newcastle considered the relationship between production methods and food quality using mainstream scientific concepts. She pointed out that almost all research on food and health has focused on avoiding harmful extremes such as deficiencies or toxic effects, which means that we know almost nothing about the consequences for health of differences in food composition when it is clear that neither deficiencies nor toxic effects are involved.

Even given the immense difficulty of establishing causal relationships with measured characteristics (such as a modest change in dietary composition), it can be concluded that existing, generally accepted knowledge on this topic is clearly inadequate, indicating a need for development of new methods for evaluation of food quality. The question is then whether this should be done by a critical revision of the interpretation of existing and new data within the framework of existing scientific concepts, or if radically different scientific concepts are needed. Distinguishing between good and bad science, and highlighting the resilience of "established scientific dogma" and the "continued struggle of reason against authoritarianism", Brandt argued for a constructive challenge to existing dogmas and paradigms whenever their predictions are "shown not to fit with actual observations"; that is located within the mainstream scientific concept; and which is built upon the same overall understanding of the laws of nature and generally accepted scientific principles.

Angelika Meier-Ploeger of the University of Kassel, who was one of the delegates at the earlier food quality colloquium, presented on complementary methods of food quality determination - their value and validation. Pointing out that when the term "quality" is used with respect to food, different value judgements are made by different actors or "partners in the market" such as producers, processors, retailers and eaters. Earlier scientific work in Germany, Switzerland and Britain, based on the premises that "the whole is greater than the sum of the parts"; that "life is bound to forms/structures and their maintenance; life is bound to light; life is linked to communication; life is reproduction"; leads to the necessity to verify the validity of these premises through the development and testing of new methods for the determination of food quality.

A SHORT REPORT ON THE EFRC *FOOD QUALITY AND HEALTH - CONCEPTS INTO PRACTICE* CONFERENCE.

Laura Davis, EFRC

Presenting the results of a validation process for some novel, holistic methods, Meier-Ploeger observed that such approaches in organic food quality analysis require a strict co-ordination, well defined samples, good sample storage and delivery, comparative samples, scientists "willing and able to understand the principles and language of alternatives", and scientists eager to discuss results and willing to argue about concepts and interpretation. Challenges exist to compare and correlate data from chemical analysis (e.g. of single nutrients) to those of the "holistic" methods, and questions need to be addressed as to whether these holistic methods do show more that 'the sum of different single nutrients from chemical analysis". And, perhaps most crucially, the challenge is to determine whether these "pictures, structures, forces and energies" shown by the use of holistic methods are important for animal and human health.

Jurgen Strube followed with a fascinating presentation of progress made with florescence excitation spectroscopy (FES), one of the "holistic methods" considered at the earlier food quality colloquium. The method, which has clearly been refined and validated over the intervening years, is used to distinguish culture or growing conditions of plant samples. The sample is excited by light and the total light emitted by the sample is measured after the end of the excitation. The results clearly show that it was possible, under experimental conditions, to differentiate between fertilised and non-fertilised samples of carrots and wheat, and which sample were grown under mineral fertiliser and organic conditions. Using the same methods, it is apparently possible to differentiate between qualitative differences in other products such as seeds according to their culture methods.

Johannes Kahl then presented on 'characterisation of the bio-crystallization method on using computerised image analysis'. This was also one of the methods discussed at the colloquium, and, as with the FES method, much progress has been made. The bio-crystallization screening technique is based on the crystallographic phenomenon that when adding organic substances to an aqueous solution of dehydrate CuCl2, reproducible patterns are formed during crystallization. The technique has been applied successfully to comparative studies of the effects of different farming systems on crop and product quality. Recent efforts to standardise the method have included optimising the crystallization technique, and developing computer software for image analysis of the patterns, and the method has been tested and compared in laboratories in Germany, the Netherlands and Denmark.

Steve Hicks and Rafe Bundy of Reading University's Unit of Human Nutrition gave a brief perspective from a clinical nutrition perspective. Christine Williams, the head of the unit, is the author of one of the major literature reviews which suggests that there is no evidence that organic food is any healthier than non-organic food. While impressed by the previous speakers, Hicks and Bundy observed that from a nutritional point of view, the two methods "can't actually say anything about the food having an extra nutritional quality". Acknowledging that the methods can distinguish between different farming systems, they observed "we really don't know what it means, and we don't know at all what it means in terms of nutrition for organic or non-organic food." Clinical trials and intervention studies are, of course, difficult if not impossible in human populations, even if it were possible to measure "health". Apart from the difficulties in choosing which factors to measure, science is now beginning to discover the beneficial effects that a positive and healthy mind has on the human body.

Alex Smith of Alara Wholefoods observed that the morning presentations, while they had not shown clearly "the new virtues of organic food", did indicate that it was "more stress resistant, seems to have a better property for self-organisation and disease resistance than non-organic food". He considered that these three very important properties could be applied as organising principles to society itself. Organic agriculture is therefore an important and coherent approach that has a role in reforming society in a sustainable way.

Lynda Brown, a food writer, took an individualistic rather than a population perspective on food and health, based on her own experiences of growing and eating her own 'vital' fruit and vegetables, emphasising the choices made by consumers to eat healthily or unhealthily and the plethora of confusing nutritional advice. Suggesting that "as a nation, we are obsessed with health", she observed that "very few people bother to nourish themselves with the right kind of food that will not only avoid bad health but will significantly encourage good health." Approaches that help consumers think about food in a more qualitative and holistic way "just might nudge them in the in a different and more constructive direction". However, this perspective does assume that all consumers are equal, operate on a level playing field, and that individual consumer choices will ultimately aggregate into better public health. This seems unlikely, given that people's access to healthy foods, and so-called choices about whether to consume such foods, are heavily influenced by economic, physical, cultural and social factors well beyond the individual eater's control.

A SHORT REPORT ON THE EFRC *FOOD QUALITY AND HEALTH - CONCEPTS INTO PRACTICE* CONFERENCE.

Laura Davis, EFRC

The conference then moved on to a question and answer session, which began with one delegate commenting on the progress that has been made in developing and validating the methods discussed in the presentations. Comparing these to the limited Food Standards Agency (FSA) approach, which is reducing the characterisation of organic and conventional only to the source of nitrogen, and which is only one small part of the "system difference", the FSA approach was attacked as being a waste of public money, without any real explanation as to why this approach was being used. Meier-Ploeger commented that although funding had been granted for further research into 'complementary methods', the timescale was too short to do proper work, "but that is how it is now for research". It was generally agreed that the need and ability to test for differences for a certification and control system for organic produce was different to the need assess the "value for health". One delegate commented that if the issue was food and health, the context is a completely different one. "It would be a pity if we start mixing up those things and start saying that one method is bad because it can't do everything, because it can't do everything because no method can do everything". Specific methods are needed for specific purposes.

In the context of a discussion on the nutritional content of organic food, and people's perceptions about this, a delegate from the McCarrison Society asked if we were being over-optimistic that the general public can think that organic is more nutritious, and better for us, when the majority of the population don't even make a connection between the general quality of nutrition and the quality of health. He also asked, "while we are agonising over which method of analysis is accurate, will the genetic modification movement negate everybody's efforts?"

There was general agreement with the observation made by Kahl that "it is very important that we succeed in going from the systemic approach in agriculture to the systemic approach in food quality analysis and a systemic approach in health." The matrix type approach was discussed and agreed to be valuable, in particular in countering the health claims of functional foods and 'nutraceuticals'. One delegate commented "there is nothing in nature ever that is presented without it being in the matrix form that is, fully bonded". In a recent case in the US Supreme Court, it was "proven to everybody's satisfaction" that the food matrix form is closest to "what might be termed food of anything that is currently on the market", and until that is fully understood we won't be able to make the progress that is desirable.

To close the conference, Lawrence Woodward drew out the importance of the progress made with the mainstream and holistic or complementary methods, commenting that this "moves the organic sector significantly forward". What we are seeing for the first time, he observed, "is actually the fact that we can differentiate between farming systems in a way that science has never been able to do before, on a consistent and repeatable basis". But despite the aspirations of organic farming there are some "very poor" farming systems and some "atrocious" processing systems, which let us down in terms of meeting our aspirations. It is time to get a handle on the link that we believe is there between the life in the soil, linking the life and vitality of plants right through animals and into humans. The need is to roll out the methods discussed and meet that challenge, which will be an immense job because of the variability in the system.

"Let's be clear," Woodward stated, "chemical industrial agriculture is not built on any concept of health; it is not based on any concept of interconnectedness with health, whether of soil, plant, animal or man. The one system of agriculture that aspires to build its world-view on those issues is organic agriculture. There may be some differences in approaches to methodologies, but what we all believe or share is the perspective that production methods - how we produce food - is critically important to not just our own health but the health of all the other organisms on this planet". This concept is so important that it should drive a wide range of policies, be framed in legislation, be the organising principle of commerce and trade and the basis of our social organisation.

ORGANIC FOOD QUALITY - DEFINITION

Six criteria, from Elm Farm Research Centre, for food quality:

Authentic Food which is traditional and/or natural:

- Regional and artisanal
- Not synthetic
- Not including the products of genetic modification
- Free from adulteration in production, processing or storage

Sensual Food which appeals to the senses:

- Taste and smell
- Texture
- Visual appearance
- Aesthetic appeal

Ethical Food which is produced in a way which meets ethical standards:

- Environmental impact of production, processing, distribution
- Social conditions on the farm, factory or shop floor
- Morality of the food production system
- Political effects on the country or region of production

Functional Food fit for the purpose intended:

- Cooking
- Storing
- Processing

Biological Food which interacts with the body's functioning, both positive and negative:

- Possible protection against cancer
- Stimulation of the immune system
- Maintenance of a healthy gut flora
- Allergic reaction

Nutrition Food which contributes to a healthy and balanced diet, both positive and negative:

- Balanced protein, carbohydrates and fat
- Vitamin, minerals and trace elements
- Excess sugar or fat
- Excess nitrate or sodium
- Potentially harmful pesticide residues

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THE AFTERNOON DISCUSSIONS

(taken from the transcriptions - with apologies if some areas are not too clear!)

Christopher Stopes

First I want to reflect on the conference Lawrence organised with EFRC and in which I was involved nearly 20 years ago on this same subject. Angelika was there as was Hardy Vogtmann and I would like to report that from my perspective that things have moved on enormously. At that time we had Ursula Balzer-Graff's crystal pictures with only her interpretation - some of you may know who I am referring to. 20 years on we have got a validated method. The photons described then were a completely whacky idea that Popp had come up with and have moved on and validated that method also. So the progress that has been made over the last 20 years I think is remarkable

What I wanted to ask was a reflection on what the **Food Standards Agency** is doing in this country and to think about the fact that they spent something like £0.5 million on the method of determining organic and conventional food through enisotope dilution. What I want to ask the speakers from this morning is to think about the error of the FSA's approach which is reducing organic or conventional only to the source of nitrogen and to contrast that with the way in which the holistic methods are perhaps trying to encapsulate a coherent component of the whole system in the way that Angelika identified five dimensions - growth, light, differentiation, reproduction and one other which I can't remember!

Each of the holistic methods is somehow a metaphor for a way of discovering each of those principles and that is of course, building up to a whole system whereas the FSA approach is reducing the characterisation of organic and conventional only to the source of nitrogen which actually is only one small part of the system difference. We need to attack the FSA head on in the public money they wasted in this country but also build up a better understanding of the way in which the whole system is more than the sum of its parts and the sort of novel approaches that have been described today are a way in to those sorts of attributes.

Lawrence Woodward responded to the FSA question. First of all I completely agree with Christopher's characterisation of the money that is completely wasted on this approach without actually, any real explanation as to why they are doing it, and in terms of transparency from government and from it agents, the failure to explain to anybody in any coherent terms why they have wasted some millions on this programme, is a scandal.

The one thing one might say they are using it for is to use the method in terms of verification or authentication of what is organic and what is conventional. But in fact, anyone who knows anything about organic systems or anything indeed anything about biological agricultural systems, knows that that way is fundamentally flawed. The whole problem with the FSA approach as opposed to the approach that we have heard about today, is that actually they have no concept of health and it is questionable as to really whether they have valid concept of food safety but the certainly have no concept of health. Therefore, they have no concept really about nutrition and where health fits in either a farming system or nutritional policy. As a result they really are all at sea and not only in my view making a number of painfully wrong decisions in many areas and not just this N15 area, and I think all of the speakers this morning, in different ways, reiterated the fact that organic agriculture is a system that in order to assess it, evaluate it, for whatever reason you are doing that, whether it is authenticate the process, or whether it is to understand it in order to further develop it, then you have to have an approach which is holistic or multi-faceted and looks at the complexity of the whole system not simply at one factor. So the FSA approach - cul-de-sac, blind alley, scandalous waste of money *(Melchett interrupted here to say but if it works what is all the fuss about)* …

First of all it isn't working *(Melchett interrupted again, but you don't know that it isn't - unusual situation here for me to be standing up for the FSA! - but you don't know as they haven't finished their research)*

LW: There is no theoretical basis for expecting the movement of nitrogen through soil into plants can be differentiated by N15 analysis that can show whether you have got an organic or conventional system.

Peter Melchett again - this was first done by an eminent German scientist - is the German government interested in discriminating through N istope work between organic and non-organic?
It is not true that there is no discrimination whatsoever but it doesn't show anything like good enough discrimination for use as a test which is why they are now adding in isotopes or something else.

Angelika Meier-Ploeger said that of course our Min for Agric Food and Consumer Affairs has an interest to develop new methodology to increase the market for organic products. But the way it is going now is to find a common platform for

discussion about research topics and research areas so the next step now is that we have to combine our complementary methods to research done in the field of nutrition and health so there is a project about allergic reactions coming from food and Johannes Kahl is to be the coordinator of this whole project. He is linking the research of the complementary methods together with the results from the medical treatments so there will be a study for allergic reactions and one for children using the same foods that we are using for our complementary methods. This is new research started 2 months ago and will last for the next 2 years but as our colleagues from University of Reading have already told us normally you are using clinical studies or intervention studies and this costs a lot of money and our government is cutting short the research money and therefore we only have a short period of 2 years now for the next step so we are just a little bit out of breath, always following the lines of the politicians. We would like to have the money for say 10 years to do proper work but that is how it now for research.

Kirsten Brandt responded. This isotope method is similar where you want to have a method where you can measure, for example in plants whether they have been grown using compost and manure on the one hand, or with synthetic fertiliser on the other hand. I would put that kind of method in the same brackets as, for example, to detect residues of pesticides. It is a routine thing for organic foods to be tested for pesticides to check if somebody along the chain has been somehow breaching the regulations and using pesticides. And just because some companies say "well if we buy organic food then we want to take these tests because that is a routine method", does not mean to say that this company necessarily reduces organic food to just a matter of pesticides or not. But they could still have a objective of making sure that the one person out of how many who try to cheat, that there is a chance they could be caught.

I don't see that you need to say that, even if we have a good control system for certification, one element of a control system can be that people think that they can get caught and that does not necessarily mean that the food is of any less quality than if you don't have an extra control in the system. It doesn't say anything whatsoever about the value for health of those products that you test for authenticity or not, these two things are separate things. Of course we can always discuss how much effort to use in control at the production stage or later stages and so on, to organise the chain to decrease incentive for cheating so there are a lot of things you can discuss and how to get the most out of the money but the issue of the food and health context is a completely different one and I would find it would be a pity if we start mixing up those things and saying that one method is bad because it can't do everything because no method can do everything. We need specific methods for specific purposes and would be better having a method we have to validate it for that particular purpose which is supposed to be showing.

Peter Melchett -Let's move on to the theme of the conference which is **Does Organic Food have Extra Quality?** because I must say that Kirsten and Lawrence dealt with the FSA and the real problem was that they didn't talk to anyone and didn't think about it and approached it without really knowing what they were trying to do and it is a particularly British problem. Did anyone in the audience feel that Rafe and Steve were unfair when they said that what you heard this morning didn't tell you about whether organic food did actually have any extra quality, may be different, produced different sorts of shapes or crystals or react differently to different tests - does it tell you anything about the quality of the food let alone its impact on human health?

Matthew Adams - Good Gardeners Association

I have been doing some research myself into food quality and I have been looking at comparative methods of conservation and nutritional components of minerals because I believe they relate more directly to health and are the building blocks of good health - the starting point. Perhaps some of the techniques being explained today are perhaps more advanced techniques and I would like to hear from the panel actually how they see the relationship …. between their methods and the relationship with health which is the point of the whole thing.

Dr Strigner

There is a point about minerals which I think is pertinent - I am a physician by the way and hope to look after wrecks and try to resurrect them - one of the things that has happened in this country is that there were five surveys done, first one in 1941, second in 1946, another in 1972 I think, and a couple in the 90s - of the mineral content of food in this country. Every single survey showed a successive drop until some of the mineral content of foods and I am talking about meat, dairy products, grains, vegetables - all showed a drop some of the mineral content is now 50% of what it was 50 years ago. The only food in which the minerals haven't dropped is marine food - fish and marine vegetables and that's all I really have to say about that.

THE AFTERNOON DISCUSSIONS

(taken from the transcriptions - with apologies if some areas are not too clear!)

Juliet Davenport, Good Energy

As an individual, my impression is that the public awareness of feeling that health and organic food go together is far in advance of where the science has got to in terms of the proof of that, and I think one of the dangers probably in terms of politics and funding of a lot of this science, must be in terms of what you are doing, that people would assume that you had already found that out that organic food was better for you and is there a problem in terms of admitting essentially by doing this research you don't actually know yet. In terms of where the public is in terms of their perception - they go in, buy their organic food and are OK, thank you very much? I think it answered the question that we seem to be way behind in the science of where the perception in the public is.

Matthew Adams - Good Gardeners Association

In relation to the minerals - in the research we have done which is only year 1 we have doubled the mineral content in potatoes and got 60% more in carrots. Now that is actually within an organic garden which does beg the question what is the difference between organic and organic, but in the relation to the gentleman's concern about minerals declining over the last 60 years, yes it is true and I agree with that - I follow that research - but within a very short space of time we have put some of those minerals back into the food and that's through working with the life in the soil which it also gives it energy print as well which perhaps is part of the crystallisation technique.

David Marsh, The McCarrison Society

Are we being over-optimistic that the general public can think that organic is more nutritious and better for us than inorganic when probably 75% of the public today don't even make a connection between the general quality of nutrition and the quality of health? The second question is whilst we are agonising over which method of analysis is accurate will the genetic modification movement negate everybody's efforts?

Paul Gosling, HDRA

All the methods we have heard about this morning are very interesting but from the perspective of trying to encourage people to buy organic food, I am not sure they move us on any further from the more reductionist methods such as mineral analysis. Even if we can prove that they, the bio-photons or crystallisation, can be connected to health, what I think was omitted by all speakers this morning is that we do not have a consistent difference between organic and conventional. Yes, we can differentiate but it is not always there and perhaps sometimes the difference between two different organic systems or two different organic products, are as large as the difference between and organic and conventional, and if that is the case then that is exactly what we have at the moment in the more traditional analysis of minerals and vitamins. Yes, we can show a difference between conventional and organic but it is not consistent so I am not entirely sure that we are moving any further on with these new analyses.

Richard Blacklaw-Jones / Pembrokeshire Organic Group

One of the methods talked about this morning indicated a greater ability in organically raised produce for structure building or self replication. To me this seems to have a connection to fertility. There is in Great Britain, a charity called Foresight who routinely advise people who are having difficulties in getting pregnant to switch to an organic diet amongst other things. They claim an 80% success rate when IVF has a 20% success rate and incidentally costs an enormous amount of money. I wonder if the panel have anything to say about **organic and fertility**.

Johannes Kahl

We presented our results at the conference in Berlin. There were a lot of federal institutes there and before they said there was no difference between organic and conventional. We presented our methods and results and as we said, yes our methods can also show a difference. So I think now we are starting to discuss if there is a difference or not, and we are not starting from the position that it makes no difference. We just look at how we can measure this difference and how we can relate this difference to nutrition and human health.

I think it is very important that we succeed in organic to go from the systemic approach in agriculture to the systemic approach in food quality analysis and systemic approach in health because if you make nutritional or clinical studies and that is what we discussed over lunch, just minerals in blood pressure or the quality of the faeces (!!) and not how I behave. As the WHO definition says: the social and mental wellbeing so I think this kind of parameter - social and wellbeing - are very important when I want to eat something. It is not only because I want to hear sleepy coma patient, because I am also alive but I cannot express myself so there is not a good and a bad method. It is a validated method or a not-validated method..

THE AFTERNOON DISCUSSIONS

(taken from the transcriptions - with apologies if some areas are not too clear!)

Jurgen Strube

One of the questions we heard was: is it not possible that the different substances make the differences in the measurement, especially for the human measurement, pigments etc. If one thing offers food as composition of substances it may be correct if we measure differences in substances but if you look on the big nutritional studies of the last years, it shows up that substances like metacarotine or licopine which were identified as giving certain health benefits, they failed. If they were added to the diet furthermore they caused opposite than what was expected and though the thinking that special substances cause special health in certain ways must be wrong. It may be that in a certain food a certain composition of substances is necessary so that every element his its counterpart and if one has organic food then the final composition is different and in the conventional way - and that is why we always measure differences. One of my explanations is why we measure always differences between organic and conventional - but we have also differences between organic and non-organic in different varieties, locations and so on. It may even be bigger than from organic to conventional, but one difference may be caused by the photo level of substances, but what makes the real difference is what the inner composition is. If one accepts this model then it is not so important what the total content of the substance is but what the relation of the substance is to each other and so in this way I think in a lot of science we have these methods like crystallisation and the luminescent measures can be interpreted because there is a certain correlation between substances and measurements but to only about 60-70% ….

The next question was what is the result in health? We look most of the time to short-term effects and we think to the rabbits this morning and the studies go back to 30 years of the last century. We have indicators that long-term effects are more important and the other point, which is difficult to be exact, is maybe the real effect of short-term during one life of the people is that it is more the mental effect you can feel but we have no instrument to measure that precise in which way organic food effects our mental health or ability. For example, if people talk to each other you hear the sound but what was before the sound is the thinking, you hear the sound and you make your own picture and so there we have some what before makes the truth in a special form and we see only the result and we measure this side of the composition. Maybe in the future we find ways to demonstrate this in a better way but I know in Germany at least there are a lot of people who are concerned with this kind of research which may sound a little bit esoteric but it is quite reasonable I think and in the next 10-15 years I think there will come out a new direction of research which will become more important than the classical methods maybe.

Angelika Meier-Ploeger

I would like to stress the point of fertility that was made. Of course there was the study by Mr Steiger in 1988 and since then we have some report in Germany stressing the point that one has residues of pesticides in the sperm for male humans. There was one report and the other report stressed the point that having residues of heavy metals. Then we have nearly the same observation in Germany, that you can alter your food habits to more fresh food and to more organic products then the conception will be better. But discussing it with scientific people, then you have the problem that they say yes but there is another point that it is stress, lifestyle and so on, then you have to prove that food habits or the nutrition is the main point that has changed. So talking about that, you do not have clear evidence that organic food increases the fertility.

I am very grateful for the remarks of Lynda Brown. She told us that nowadays people have not taken over the duty or responsibility of their own nutrition and they would like to put it in the hands of pharmacists or medical doctors, and therefore they are buying functional foods. My personal view - and of course each scientist has a personal driving force while he or she is working - is that I think putting nutrients to products will not improve the health of the person eating that product and I think our research will be joined by protesting companies and scientists being in the processing business because then you have to prove that matrix bound already grown foodstuffs and nutrients matrix bound have another impact. I think that will be one of the topics we are going to research in the next few years just to say to the people you have to do it yourself, take on the responsibility for your own life, you cannot put it in the hand of pharmacists.

Lynda Brown

One of the things I wanted to raise was that for me what we are talking about is: **is organic food healthier?** What we do know for example in this country is that people who take box schemes eat more vegetables, start cooking more vegetables, start thinking about their diet differently, start cooking more, they then move on to the meat, etc. So you could say, I believe passionately that we do have to take the responsibility for our own health on our own shoulders, everybody needs to do that and if you really want good health you basically have to eat real food, produced in ways which are not going to cause ill health and it is as simple as that. Inadvertently although we can come up with every single cutting edge method under the sun, in the long

run if through eating organic food sets off that chain of events, that says to me personally that organic food has more than justified its presence on earth.

It is the same with school meals, if you think about it, we have now had a huge interest all of a sudden in school meals and it is the organic movement which has fuelled that interest and if you look at the recent food issues in this country, again it is the organic movement which has been a catalyst for addressing those issues, so I would say very definitely organic food and farming has already proved itself in the health stakes and the more we can do to encourage everybody - wait a minute, this is me, this my body, this is my food I am putting inside my body - the buck starts and stops with me, then I think the faster we will move the whole debate forward.

Dr Strigner

I want to pick up a couple of things. Angelika, your comment about the significance of the food matrix is possibly the most important things that has been said today. Part of the reason that the recent research on mineral and vitamin supplementation is coming up with a string of negatives and in some cases, even toxic effects, is because what is pharmaceutically derived and fed back by a very small cartel of companies, is actually dead. There is nothing in nature ever that is presented without it being in the matrix form that is, fully bonded. It was recently taken to the Supreme Court in the US and it was found and proven to everybody's satisfaction that the food matrix form is the closest to what might be termed food of anything that is currently on the market and until such time as that is fully understood we won't be able to make the progress that you are talking about, and it is for that reason that a lot of the research has been leading nowhere.

I wondered whether if you are all aware of some of the other methods of visualising the living nature or content of both food and living organisms gas discharged visualisation for example, and by infra-red spectroscophy , some of which are generating very interesting objective repeatable and measurable images and mathematical formulations of the differences between organic and non-organic foods. I am a physician and at the end of the day what counts is whether people get better.

One of the greatest stories that I have is of the most senior community psychiatric nurse in Glasgow who came to me having had three re-sections of colon for ulcerative colitis. She is now drug-free, she has no symptoms and the only thing that was done in the first instance was to change her to an organic diet. She was a totally sceptical individual but she was willing to try with us and within 4 months the symptoms had turned around and I think there are probably a number of physicians who are in this position. We ignore, at our peril, the wellbeing and experience of our patients and there is a wealth of scientific technology that enables us to monitor that, especially in the psychological fields so I would behove everybody to look at what we are already doing.

Jason Gathorne-Hardy

One point which seems to have come up several times and that is the use of organic farming as opposed to conventional farming - the language. I would argue that it is a real misnomer to call what most farming is at the moment "conventional". It is not, it is a very recent phenomenon and I don't think it should be used. I think what is being described as conventional farming would be more appropriately described as modern chemical farming and what people are describing as organic is actually very traditional with a very longstanding history which has a lot of repercussions.

I think another point that has come up is that food is essentially about nutrition and I would say that a lot of modern processed food may be edible but I don't know if it has much nutritional value.

Peter Melchett - there is an argument for saying that chemical farming is now becoming a bit old fashioned.

A delegate

I think I need a bit of help from the audience and the panel as well. We have touched on it several times - the thing about organic food is that is that jumbles up or links up with cooking and with a positive attitude and with learning how to do interesting things with cabbage and all kinds of interesting things that reductionist scientists would call "variables" that they want to exclude from the research in order to get at what the real thing is with organic food and I am locked in this circular thing because I believe as Lynda does and as Juliet does, and as I am sure all of us do, that the thing about organic food is that it is not just the food, it is everything that goes with it. But when you talk to reductionist scientists about that they say no they are

extraneous variables and try to get rid of all of that. I don't know which is why I need everyone's help - how to get out of that round and round argument that I keep having with reductionist scientists.

Robert Duxbury, True Food Values

I just wanted to pick up on this point that was raised about organic and conventional. I think Lynda also raised it earlier on and I am not sure about this setting against one against another that we seem to have here. I see maybe that it is more to do with a continuum from intensive to extensive and I am just wondering whether there is an element of barrier creation in setting this up as an organic-only project and perhaps by opening up this wider vista of extensive to intensive might just bring in conventional interests and engage them more fully than might otherwise be the case.

One further point is that I have heard no mention of the word value or worth today and I am not quite sure how it does fit in, only to say that clearly there is a whole section of consumer base that doesn't buy organic food because it is too expensive. I would like to see some kind of linkage here to creating more justification for the value of organic food, yes nutritional value, health value but also maybe to do with the price value. I made my business - True Food Values - partly because of an indulgence of that interest and it will be interesting to see if that theme can be developed as well.

Kirsten Brandt

I think I will come back to one of the things which was mentioned several times about the understanding of the supplements and minerals and vitamins and isolation on the one hand, and then the health value of food on the other. If we have food, like my example of carrot, and we do lots of experiments and we find out that this orange piece of carotene vitamin A precursor in the carrot, if we give that to people in isolation then it does not reproduce the effect of the carrot. Everybody in science knows that is the situation. There are, in principle, two different explanations. One is that the nutritional value of the carrot is simply the sum of the chemical constituents that there would some other chemical constituents in the carrot than the betacarotene - and that is a reason why if you have isolated betacarotene that is one effect and if you have another because the whole carrot has some other constituents. That is one way of looking at it.

The point is that this is one possible explanation but if it is not the case then of course the other possibility is that the health effect of the carrot is not directly related to the chemical constituents. The way it is looked at from the rule of thumb in science says that normally the simplest explanation is likely to be the right one so that is the reason why I prefer the one with the simple chemicals because it is simply easier to grasp for someone like me.

The other thing about why I like to see it this way is that for science it is very disappointing that we somehow have taken on the responsibility to understand how nature works and when we realise that we do not understand what is going on, well it is very dissatisfying. You feel that you are not doing your job properly so this is quite important for us to find out these things but we don't just do it for our own vanity. If we can for example find out that it is either some chemical component in the carrot or it is some picture forming property which can be measured in some way, either explanation which is directly proportional to the effect of the carrot on the health. Then we can go out and we can look at different production systems whether comparing organic and conventional or compare different ways of doing organic agriculture or conventional agriculture and say which one is better for health and which is not . To me, understanding how the food you eat affects your health does not take anything away from the joy of food that tastes good and I like cooking just as much even though I know a lot about how these different molecules change after cooking. It doesn't take anything away fortunately.

Of course while you are doing your experiments you have to exclude the extraneous factors but that doesn't mean that you don't think they are important, it is just that you can only have one at a time. But if after you have taken them one at a time if you cannot then put everything back together and if the puzzle doesn't fit then that you have not been doing your reductionist science well enough and you have to go back and start all over again. It is only if it all fits together and then that is a holistic situation where we do understand that both the whole and which is more than a sum of the parts so I don't really see this as a confrontation, I think what is important is to get down to the bottom end of it to find out how do these things fit together, where are the crucial differences, so that we can go out and say we understand how the food affects health and then we can make say one kind of food is better than the other. Then we can improve organic food and also improve the conventional food and first of all, that is one of the things which I think will come as soon as we can explain why plants would grow and mature slowly, why they have a different constituent which affects health, and why people have to pay them extra money for food which is grown in a slowly normal way rather than food which is being paced along and ends up being mostly water. That is one of the things we will be able to document once we get to the bottom of it.

THE AFTERNOON DISCUSSIONS

(taken from the transcriptions - with apologies if some areas are not too clear!)

Peter Melchett on GM

I think it is not going to undermine any of this or be a threat to any of it partly because the first generation of GM crops have now clearly failed and they failed to the extent that what was supposed to be the hot bed of GM enthusiasm has prevented the next GM wheat crop being developed at all. It has been banned in the US and Canada and because pesticide use is now clearly rising quite rapidly in the US, on the back of what were meant to be pesticide-resistant crops which would reduce spray use.

But more interestingly in the context of today's discussions, I think is to think about the second generation of GM crops, for example the Golden Rose which had betacarotone gene added to it in the theory that this would then deliver vitamin A very efficiently and have the same effect as people eating vegetables rich in vitamin A. If what Kirsten said is right then there does seem to be good science emerging on this but that things do not work in isolation in that way, in terms of affecting human health and in terms of what we eat.

The whole of the second generation of GM crops are doomed to fail because all of them depend on moving very precise characteristics expressed by a particular gene. This is the theory which geneticists have into something where it will then express successfully and impact positively on human health. Now everything I think you have heard today suggests that that is flawed fairly seriously. There are other reasons why it probably won't work, to say nothing of the dangers and risks and uncertainties, but what you have heard today is a very good argument against second-generation GM crops.

Peter Melchett closing said that it had struck him that an awful lot depends as it always does in science and politics and everything else, that how you frame the question and the question we were talking about today was essentially, is organic healthier, there is another way of addressing that question, which is to say something along the lines - lots of people eat organic food and we know that many of them do it because they believe that it is much healthier than non-organic food. There is absolutely no scientific evidence whatsoever to suggest that people are wrong in that belief.

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- **Transdisciplinarity**
- **Open discussion among Scientists**
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- **Joint Research approach is needed**
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