Investigations of organic food and health

Numerous studies have attempted to elucidate if there is a difference in the effect on human health, between food produced according to the organic standards compared with conventionally produced food. While many studies support a few general trends of differences in food composition, none have provided any conclusive evidence for differences in the effects on human health. Most of the studies have been inadequate in size or focus to allow any definitive conclusions. The major problem is the complexity of the issue, and the general paucity of knowledge about the impact of food on health, which means that it is virtually impossible to tackle all relevant uncertainties in any one study. Instead a whole range of different types of studies are needed to provide a conclusion.

Presently, a study is in progress, which attempts to provide some of the missing key information on this issue. This study comprises controlled cultivation of plants in three different models of growing systems for two years, and feeding rats for 3 generations on diets composed of these plants. It will show if food from different growing systems can result in differences in health of rats, and if so, which aspects of health are affected. However, if differences are found, subsequent studies will be necessary to determine the applicability and possible consequences for human health. Still, together with other existing and planned studies it might soon be possible to determine some of the consequences for human health of the methods used for food production. This could result in increased demand for organic food, and it could at the same time lead to changes in the farming methods in either organic or conventional production systems. In any case, this type of research will improve crucial aspects of the knowledge base, which is needed also in other contexts, to support the efforts to improve food safety and quality.

Introduction

Organic food is produced according to the precautionary principle, where the use of pesticides, additives and other chemicals are kept at a very low level (Alrøe et al. 2002), and many consumers have the perception that organic food is generally better for health than corresponding food made using conventional methods. On the other hand, all pesticides, food additives etc. that are used by conventional food producers are thoroughly tested for indications that they pose any risk to health, and if such indications are found, they are not allowed any more. In conventional agriculture, pesticides and antibiotics are some times used with the aim to reduce the occurrence of certain toxins and pathogens in food, so concerns are often voiced that the risk of occurrence of these undesirable substances could be higher in organic food. Others believe that the organic production methods are at least as efficient at ensuring the health of consumers as the conventional ones, for example through positive effects on the general health of animals and plants, that would increase their ability to resist or overcome an infection in the first place, possibly reducing the risk of subsequent contamination of the food. The present food legislation only regulates measures to ensure safety of food in terms of absence of recognised risks. There are no requirements and very little knowledge about aspects of the production systems that could results in positive effects of food on health, effects which could in theory be equally important for the consumer as the known or anticipated risks (Brandt & Mølgaard 2001).

So for many different reasons, there is an increasing interest in investigating whether there is any difference in the effects of organic and conventional food on health.

Numerous studies have compared food produced according to the organic standards with conventionally produced food in attempts to elucidate if the difference in farming methods results in a difference in the effect on human health. These studies have been reviewed several times, for example by Woese 1997, O'Doherty Jensen 2001, Food Standards Agency 2002, Soil Association 2002, Williams 2002, AFSSA 2003.

The reviews all concluded that there is presently no definitive evidence for any direct health benefits nor risks associated with the consumption of organic foods. It was also noted that regarding food composition, significant differences exist in the average levels of a range of nutrients, undesirable compounds or pathogens, and that most, but not all, these differences appear to be beneficial on the part of the organic food, which for example tends to contain lower levels of pesticide residues and slightly higher content of vitamin C. However, for most measured compositional characteristics or pathogen loads the ranges of values overlap considerably among foods from the two systems, and the effects of the farming systems on the average values are smaller than typical differences caused by other agronomic factors, such as plant variety, animal breed or the maturity at harvest/slaughter. The most important problem is, however, that the general knowledge about the connection between food composition and health is not sufficient to determine if such moderate compositional differences are important for health.

To prove definitively that a farming method results in food that has a different effect on health than food produced by a different method, it is necessary to include a measurement of something that is known to be directly related to the health of those who eat the food. Due to practical, financial and ethical constraints the studies of this type reported to date have been made primarily as animal feeding studies, or as short-term human intervention studies. Still, the results of these studies have not been particularly definitive. Several animal feeding studies have shown significant effects on one or the other health related aspect, but the effects were not always consistent, and some effects, such as the capacity to bear large litters, are difficult to relate to the situation for humans. In short-term human feeding studies with measurement of a range of biomarkers, generally no or minor effects were found. However, it is technically very difficult to obtain high sensitivity and reproducibility in this type of studies, so this absence of significant difference has little information value. For example, a review of Dragsted (2002) shows how even major changes in dietary composition, such as doubling or nearly eliminating the intake of fruit and vegetables, often failed to result in consistent effects on most of the biomarkers commonly used in this type of studies, even though the long-term health effects of such dietary changes are fully recognised.

Overall, one of the reviews, carried out by the Soil Association, thus chose to conclude that while not definitive, the evidence was in favour of a benefit of unknown magnitude from eating organic food. The other reviews, by various agencies or expert groups financed by a government, preferred the more conservative interpretation of the same body of data, in accordance with the convention normally used in science, that the available evidence does not allow rejection of the null hypothesis of no effect. It must be emphasised that it is equally difficult to conclude that the two types of food have exactly the same effect on health. All that we really know for now is that no definitive problems of direct toxicity, pathogenicity or nutrient deficiency are present.

The major problems has been for the researchers involved to understand and handle the complexity of the issue, in a context of a general paucity of precise knowledge about the impact of food composition on health. In practice a range of different types of studies will be needed, each of them with a limited, manageable number of variables, in order to provide a conclusion that is sufficiently definitive to serve as basis for advice to consumers as well as for future regulations. Each study must be designed to provide information in its own right, while also leading to improved hypotheses to be tested in subsequent studies.

DARCOF research on organic food and health.

DARCOF (http://www.darcof.dk/research/index.html) has initiated several such component projects in Denmark. In the ongoing DARCOF II programme (http://www.darcof.dk/research/darcofii/index.html) the following projects are relevant: "Preventing mycotoxin problems" (Susanne Elmholt, DIAS), "Use of antimicrobials and

occurrence of resistance in organic cattle herds" (Frank Møller Aarestrup, Danish Veterinary Institute (DVI)), "Bacterial infection risk associated with outdoor organic pig production with special reference to Salmonella and Campylobacter infection" (Dorte Lau Baggesen, DVI), and "Organic food and health – a multi-generation animal experiment" (Kirsten Brandt, DIAS). The last project is described in detail below:

Organic food and health – a multi-generation animal experiment

This study aims to determine if it is possible to detect effects on health of rats that are fed with food produced in carefully controlled models of cultivation systems.

The study comprises controlled cultivation of 6 species of food plants in three different models of growing systems for two years. The plants are potato, mature peas and kale (that are boiled before use) rapeseed (only the oil is used), carrot and apple (which are used fresh). All material except the oil is freeze-dried and ground to a powder before the entire diet is mixed and frozen until use. The diet is composed to provide adequate amounts of all known nutrients and to have a higher than optimal fat content.

The three models of cultivation systems are:

1. Cultivation with low rates of nutrient supply using organic methods, without pesticides (model of "ideal" organic system).
2. Cultivation with high rates of nutrient supply using conventional synthetic fertiliser and standard conventional pesticide treatments (model of conventional system).
3. Cultivation with low rates of nutrient supply using organic methods, and standard conventional pesticide treatments (model defined to increase the degrees of freedom and maximise the explanatory power of the experiment).

The rats are of the inbred GK/mol strain, resulting in very uniform rats, so even small differences in rate of development, behaviour or other aspects of health are likely to be detected. Like humans, this rat strain is known to tend to develop obesity when supplied with a diet with more than adequate fat content. After an initial run-in period of one generation on feed from the first year of cultivation, during summer and autumn of 2003 two generations of rats will be fed with plant material grown in either 2001 or 2002. The reproductive characteristics as well as a range of health indicators will be recorded on these rats, and some of them will be subjected to additional tests such as recordings of digestive processes and levels and patterns of activity.

In addition to the testing of the rats, the composition of the plants and diets are analysed for a large range of nutrients, secondary metabolites and pesticides.

This project is coordinated by Kirsten Brandt, and the following scientists participate:

– Charlotte Lauridsen, Henry Jørgensen, Rikke Nørbæk, Ulrich Halekoh, Kristian Thorup-Kristensen, Jens Peter Mølgaard, Hanne Lindhard Pedersen, DIAS
– Susanne Bügel, Jens-Otto Andersen, the Royal Veterinary and Agricultural University, Copenhagen
– Inger Marie Jegstrup, Merel Ritskes, University of Southern Denmark, Odense
– Lars Frøsig, Risø National Laboratory

The results will show if plant derived food from different growing systems can result in differences in health of rats that are detectable with this assay, and if so, which aspects of health are affected. They might indicate whether the nutrient supply or the use of pesticides is the most important aspect of the chosen model systems. The study will provide very important information on how to design a range of future studies with different, broader scopes. These studies can then be made cost-efficiently, with a much smaller range of recordings. The experience gained from the present study will also be applicable to other questions of similar type, for example testing of possible effects of the use of genetically modified organisms or of so-called functional foods.

However, the project cannot on its own show if organic food in general is more or less good for health than conventional food. If the differences among model growing systems result in significant differences in health of the rats, it will of course be a substantial indication that the same types of effects may operate in the real world, but subsequent studies will be necessary to determine the applicability and possible consequences for human health before a definitive conclusion can be made.

Participation in ongoing and planned EU projects.

In addition to the national projects, Danish scientists participate in the ongoing Concerted Action entitled "Recommendations for improved procedures for securing consumer oriented food safety and quality of certified organic foods from plough to plate" (Organic HACCP), www.organichaccp.org which a.o. aims to describe differences in methods of production and quality control for organic production chains in various regions of Europe. Also an application for a 6th framework programme Integrated Project named "Improving quality and safety and reduction of cost in the European organic and "low input" food supply chains (QualityLowInputFood) has been evaluated and is expected to commence in 2004. This project is planned to comprise several studies relevant for the issue of organic food and health, some of which are expected to take place in Denmark, including: "Effect of dairy management on quality characteristics of milk (survey approach)" (Jacob Holm Nielsen, DIAS)," Effect of pig management on the risk of pathogen shedding (survey approach)" (Jan Tind Sørensen, DIAS), "Analysis of the composition of food as affected by crop management practices (organic, "low input" and conventional)" (Lars Porskjær Christensen, DIAS) and "Effect of CCC treatments of feed wheat on pig reproductive performance" (Martin Tang Sørensen, DIAS).

Once it becomes possible to determine some of the consequences for human health of the methods used for food production, and if the organic methods turn out to have positive impact, an immediate result would very likely be increased demand for organic food. At the same time such knowledge is also likely to lead to in changes in the farming methods in either organic or conventional production systems or both, since both farmers and regulating authorities are motivated to try to optimise the health value of all agricultural products, once it becomes known how to do it. In the slightly longer run this could easily diminish or even abolish any advantage presently existing for organic food, by enabling other systems to improve up to the same level, so it is quite impossible to predict the long-term consequences of such research for agriculture. However, in any case, it will lead to improved food safety and quality for the consumer.

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