Organic food and health – status and perspectives

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Abstract

In a recent study it was investigated, through a well-controlled animal feeding experiment, whether conventional and organic food products showed differences in animal physiology of a type and magnitude that could indicate that organic products would affect humans differently. The primary, but still tentative conclusion from this study was that the most significant effects on rats was observed on health aspects that have rarely been assessed in prior studies: Immune status, sleep/activity pattern, accumulation of adipose tissue, liver function, and vitamin E status, while a large number of markers of "traditional" nutritional value showed no differences. Although the results of the present study could not directly be applied to organic and conventional production systems the observed differences were all in favour of the organic treatment, and thus pointed in the direction of potential health benefits when eating organically grown rather than conventionally grown food. However, this study like other studies related to the issue suffers from the fact that only one replication per food produce was used in the animal studies. Therefore the size of the effects could not be evaluated with respect to replication variation, which could have been determined by establishment of field trials. In addition, it was not possible to correlate the responses of the animals to the analysed diet composition due to the limited number of replicates, whereby the explanations of the effects were limited. Thus, it is of outmost concern that future investigations on the effect of organic food in relation to human health and well-being should be based on well-defined and controlled food produce system with replications.

Keywords: health, immunity, vitamin E, cultivation methods, animal models

Introduction

Many consumers perceive that organic foods in general are of better quality, i.e. have a better taste, and are healthier and more nutritious than foods produced using conventional cultivation methods. The consumption of organic foods has increased regularly during the last decade, particularly in Western countries (Schifferstein & Ophuis, 1998; Mann, 2003). However, according to a Danish knowledge-synthesis reviewing the existing scientific literature, evidence that can definitely support or refute such perception is not available in the scientific literature (O'Doherty Jensen et al, 2001).

The present study was conducted using a well-controlled rat-feeding experiment comparing three iso-energetic and iso-nitrogeneous diets composed of vegetables and a high content of rapeseed oil (13 %), produced according to each of three different cultivation systems ("Organically", "Minimally" and "Conventionally"). The purpose of the study was to investigate whether a difference in growing conditions of the feed plants would affect any of a range of physiological responses using a rat model, being characterized as non-insulin dependent diabetes mellitus, type II diabetes and non-obese.

Materials and methods

The experiment was performed with 36 rats that were fed on three diets consisting of potatoes, carrots, peas, green kale, apples and rapeseed oil. The difference between the three diets was the three combinations of cultivation strategies used to grow the used ingredients:

- "Organically": low input of fertiliser through animal manure and without pesticides
- "Minimally fertilised": low input of fertiliser primarily through animal manure and with pesticides
- "Conventionally": high input of mineral fertiliser and with pesticides

Each ingredient type was cultivated according to standard practice for the crop in terms of e.g. levels fertilizer and timing of pesticide applications. For each crop all treatments were carried out on the same or adjacent experimental fields, which were divided according to the three cultivation strategies, so that the cultivation took place in similar soils and under similar climatic conditions, and the ingredients were harvested and treated at the same time.
The three experimental diets had exactly the same formulation (300.0 g kg^{-1} potato, 50.0 g kg^{-1} carrot, 472.4 g kg^{-1} pea, 10.0 g kg^{-1} green kale, 10.0 g kg^{-1} apple, 130.0 g kg^{-1} rapeseed oil, 6.4 g kg^{-1} DL-methionine, 12.5 g kg^{-1} CaCO3, 0.7 g kg–1 salt, and 8.0 g kg^{-1} vitamin/mineral mixture), and the diets were iso-energetic (gross energy 21.2 ± 0.14 MJ kg^{-1} DM, metabolizable energy 18.0 ± 0.14 MJ kg^{-1} DM) and iso-nitrogeneous (crude protein 160.7 ± 0.2 g kg^{-1}), and contained in addition the following main nutrients (mean ± SD): dry matter 966.7 ± 5.0 g kg^{-1}, HCl-fat 156.5 ± 1.6 g kg^{-1}, ash 41.4 ± 0.5 g kg^{-1}, crude fiber 56.3 ± 1.6 g kg^{-1}, dietary fiber 179.3 ± 2.1 g kg^{-1}, calcium 6.8 ± 0.1 g kg^{-1}, total phosphorus 3.4 ± 0.1 g kg^{-1}, lysine 10. 8 ± 0.2 g kg^{-1}, and methionine + cystine 9. 7 ± 0.4 g kg^{-1}. The pesticide level was determined by the Regional Veterinary and Food Control Authority Copenhagen, Danish Veterinary and Food Administration, and was found to be below the detection limit.

The rats received the same diets throughout their entire life and the measurements of their health status started after weaning of their first litter (age, 19 weeks; weight, 212 g). The following measurements were used to assess rats' health status:

- Clinical health and disease
- utilisation of nutrients
- energy metabolism
- physical activity
- functions of organs and intestine
- post mortem evaluation of organs
- analyses of biomarkers and nutritional status in blood and tissues
- analyses of immune response

Results

Analyses of the primary nutrients showed no differences between the three diets. However, with regard to the analyzed contents of vitamins and acids, differences among the three diets

appeared as the content of vitamin E and C18:2 were lower, and the C18:1 higher in the "minimally fertilised" than the other dietary treatments.
The rats thrived on all three diets, only showed minor differences with respect to utilisation of energy and nutrients. Even though the rats were genetically disposed for diabetes, there was no visual sign of this disease among the rats. The rats had only a slight increase in weight after eating the diets for 25 weeks. However, the data showed a tendency towards a lower weight and a lower content of adipose tissue in the rats that were fed on the organic diet as compared to the other diets.
Concurrently with the measurements of energy utilisation, the physical activity of the rats was measured using infrared sensors. Rats are active at night, and there were no differences between the dietary groups with respect to activity at night. However, during daytime, when the rats are supposed to rest, the data indicated that rats fed on the organic diet were more relaxed (less active) than rats feed on the other diets.
Rapeseed oil comprised 25 % of the energy content of the diets, and due to the observed dietary differences, inclusion of the rapeseed oil caused some differences in the fatty acid composition of the serum and the tissue of the three dietary groups of rats. Also, the vitamin E content was lower in blood plasma from rats that received the minimally fertilised diet. The content of vitamin E in the "organically" and the "conventional" diet was similar. Yet, there was a higher content of vitamin E in the blood of the rats that were fed the "organically" diet. This could be health beneficial as vitamin E is an antioxidant protecting the cells from oxidative injury. There were no differences in the vitamin E content of liver and adipose fat tissue between rats from the three dietary groups.
Immune status of the rats was measured as the total content of immunoglobulins in the blood serum. The results showed that rats fed on organic and minimally fertilised diets had a higher content of immunoglobulin G (IgG) than rats fed on the conventionally grown diet. There were no differences in the serum contents of immunoglobulins A and M. At present, no explanations are available with regard to the lower content of IgG in the rats that were offered the conventionally grown diet. Yet, it is noteworthy that the conventional diet had a higher content of the secondary metabolite falcarindiol than the other diets. Carrots are the source of falcarindiol and other closely related polyacetylenes, such as falcarinol, in the diets with falcarinol clearly being the most bioactive of the carrot polyacetylenes having for example immune stimulating properties (Hansen et al, 1986). However, as the physiological effects of falcarindiol, are expected to be qualitatively similar but quantitatively less than for falcarinol (Kobæk-Larsen et al, 2005), it cannot be excluded that falcarindiol may interact with falcarinol in an antagonistic manner thereby affecting its bioactivity. This could explain the lower content of IgG in the rats that were offered the conventionally grown diet, as the content of falcarinol was not significantly different in the three diets. Further, it cannot be excluded that falcarindiol by it self can have an inhibitory effect on initiation of the immune response (Seon et al, 2002).

Conclusion

Even though most of the measured variables showed no differences between the experimental diets, and that the results of the study could not directly be applied to organic and conventional production systems, the actual recorded differences were all in favour of the "organically" diet contrasted with the "conventionally" diet, and thus pointed in direction of potential health benefits when eating organically grown rather than conventionally grown food. Future research is needed to provide more information on the effects of organically grown compared to conventionally grown food products, with respect to nutritional quality and health promoting properties, with special emphasis on both the systematic and random variation between different systems of food produce. Special emphasis should be given to explore links and explain overall relationships between the nutritional quality and biomarkers of health.

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