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Quality of organic animal products

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Abstract

Recent years have seen a sharp rise in demand for organic animal products. There is no evidence of consistent differences in flavour or nutritional qualities between organic products and conventional ones. However, organic animal products have lower levels of veterinary drugs and pesticides. There is no clear evidence to indicate that organic food is more prone to mycotoxin contamination than conventional food, and there is no firm evidence at present to support the assertion that organic animal food is more or less microbiological safe than conventional food. Fears of consumers may lead them to buy organic food, to avoid genetically modified organisms and food irradiation.

Keywords: Chemical residues; Food safety; Health; Nutritional and sensory properties

1. Introduction

Organic production systems are based on specific and precise standards of production. Requirements for organically produced food differ from those of other agricultural products in that production procedures are an intrinsic part of the identification and labelling of, and claim for, such products. Organic food can be defined as the product of a farming system which avoids the use of synthetic fertilisers, pesticides, growth promotors, and additives.

The recent European crises (bovine spongiform encephalopathy (BSE), dioxin, foot and mouth disease) in relation to livestock production, have frightened the consumers and some turn towards organic food. Many studies and surveys carried out in Europe have shown that consumers choose to buy organic food because they think that this food is safer and that organic production practices are better for the environment and animal welfare (Sylvander, 1999). In 1997, in the UK, the MORI (Market and Opinion Research International) Agency found that among the reasons for buying organic food, 'health' was by far the most important, 46% of those buying organic food gave it as their primary concern, and 40% claimed that organic food 'tastes better' (I.F.S.T., 2001). A French study carried out in February 2001 showed that for 61% of French consumers, the French logo 'AB' (Agriculture Biologique) is guarantee that the product does not contain any chemical residue (I.N.C., 2001).

At an overall persistent growth rate in the EU of around 25% per year, for the last 10 years, organic agriculture is without doubt one of the fastest growing sectors of agricultural production. However,

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organic agriculture still only accounts for a small proportion of overall agriculture land: an average of about 2% for the countries of EU, 0.1% for the USA, and 1.34% for Canada (FAO, 2000).

The real question is: is organic food better for us? As long as there is no epidemiological study about health effects of organic food among people, it is really difficult to answer the question. The existence of opposing trends within the food sector has given rise to some degree of polarisation among different interest groups. Some people think that organic food can be used in cancer therapy (Bishop, 1988), but these recommendations have not been proved in scientifically acceptable terms (Safron, 1999).

The production of organic food of animal origin is done in many ways and uses many different breeds. Therefore, a real comparison with conventionally produced food is difficult. From the limited number of published data, it seems that there is no clear evidence that organically produced food of animal origin is safer or more nutritious than conventionally produced food (Honikel, 1998).

This paper does not seek to make a value judgement on 'organic livestock production'. Rather it presents a critical and transparent overview of issues that relate to the quality and safety of organic food of animal origin. Besides safety, quality attributes include: nutritional value, sensory properties such as appearance, colour, texture, taste, and functional properties.

2. Nutritional, sensory and functional properties

It is a demand of the EU regulation that no claims may be made on the label or advertising material that suggests to the purchaser that the indication of organic production methods constitutes a guarantee of superior sensorial or nutritional qualities. However, explicit claims are unnecessary when, as a result of marketing, for many consumers the use of the word 'organic' itself is implicitly synonymous with such superior qualities.

2.1. Nutritional properties

Many of the studies that have so far been carried out to compare the nutritional quality of organic foods with the quality of those produced by conventional methods have suffered from flawed experimental design. This has undermined the validity of some of the results.

However, there is a trend in the data indicating higher nutrient content in organically grown crops (Hornick, 1992; Smith, 1993). Lampkin (1990) quotes a 12-year study, reported in 1975, of relative yield and composition of vegetables grown with composted manures, compared with mineral fertilisers, which found, in respect of the former, 24% lower yield but 28% higher dry matter accompanied by varying higher levels of macro- and micro-nutrients. The higher nutrient content in organic crops is possibly due to higher water content in conventional crops, which causes nutrient dilution (Lecerf, 1995; Worthington, 1998).

Several comparative studies focus on the quality of milk from conventional and organic production (Gedek et al., 1981; Arnold, 1984; Knöppler and Averdunk, 1986; Gravert et al., 1989; Guinot-Thomas et al., 1991; Lund, 1991). The way of production differs mostly in respect of the feed given to the animals. A major problem is, however, the inclusion of animals of different breeds within individual studies. No major differences have been established in terms of composition between milk from conventional and organic production (Table 1).

In 1989, Plochberger showed that in the case of genetically identical but differently kept hens, there were some differences in egg composition (Table 2).

2.2. Sensory factors

Many sensory analysis studies (mainly on crops) have been carried out to investigate differences in selected sensory parameters between organically and

Table 1
Compositional difference (in percentage) of organic milk compared to conventional

	Guinot-Thomas et al., 1991	Lund, 1991
Dry matter	− 0.2	+ 4.5
Fat	− 3.5	+ 7.0
Protein	–	+ 7.5
Calcium	+ 4.9	+ 3.5
Vitamin C		+ 15.2

Table 2
Egg weight (g) and distribution of egg-albumen, egg-yolk and egg-shell (%) (Plochberger, 1989)

	Organically fed hens	Conventionally fed hens	*P*
Weight of eggs	55.1	51.9	**
Egg-albumen	54.6	55.7	*
Egg-yolk	35.0	33.8	*
Egg-shell	10.4	10.4	NS

*$P < 0.05$; **$P < 0.01$; NS, not significant.

conventionally produced food, and on the whole these indicate that there is no clear evidence of a difference between the two systems (Conklin and Thompson, 1993). Some studies, however, have shown significant differences, such as Sundrum et al. (2000) who found that in organic pig production, the exclusion of synthetic amino acid supplementation resulted in an increase of intramuscular fat content, which is an important positive aspect of eating quality characteristics (Table 3). Another study carried out by Woodward and Fernandez in 1999 showed that steers in organic finishing system had higher marbling than steers in conventional finishing system, but Hansson et al. (2000) found that organic cattle had a lower fat content than conventionally reared animals. So, it is difficult to conclude on the effect of organic production on animal fatness.

Does organic food taste better? There is no evidence to state unequivocally that this affirmation is always and invariably true. That needs to be properly evaluated in order to help consumers to make their own judgement on the benefits of organic products. Indeed, the organic movement itself, in general, is careful not to assert such claims as provable.

3. Chemical residues

With respect to chemicals, organic agriculture differs from conventional agriculture as it refrains from using synthetic agricultural inputs, such as synthetic pesticides, herbicides, fertilisers, fungicides, veterinary drugs (antibiotics, growth promotors), synthetic preservatives and additives. Thus, potential hazards posed by synthetic input residues are prevented, to the extent possible. Organic food is therefore likely to contain lower residues of agricultural chemicals than its non-organic counterpart. However, on a global basis, a rating of health risks arising from foods shows that risks due to food additives and pesticide residues are relatively minor (both acute and chronic effects) as compared with microbiological and other naturally occurring toxins (Kuipper-Goodman, 1998).

3.1. Contaminants in animal feeds

Studies carried out to investigate the relative presence of pesticide residues on organic as opposed to conventional products show lower presence of pesticide residues in organic food, although organic food may not be defined as pesticide-free (Lecerf, 1995; Maruejouls and Goulard, 1999) (Figs. 1 and 2). A possible presence of pesticide residues in organic food may due to environmental contaminants. However, other studies conclude that there are no differences in pesticide content between organic and conventional food (Woese et al., 1997).

The limited amount of chemical residues in organic food underlies consumer expectations that organic food is healthier. However, this amount seems limited in both production systems. European

Table 3
Pig carcass and longissimus muscle characteristics as affected by different diets. (Sundrum et al., 2000)

	Conventionally fed pigs (with synthetic AA supply)	Organically fed pigs (on a basis of peas + lupines, without synthetic AA supply)
Slaughter weight (kg)	93.1	91.2
Carcass yield (%)	77.9	76.7
Lean meat (fat o'meter) (%)	56.0[a]	54.3[b]
Backfat thickness (cm)	2.4	2.4
Intramuscular fat (%)	1.2[a]	2.9[b]

Values within a row with different letters differ ($P < 0.05$).

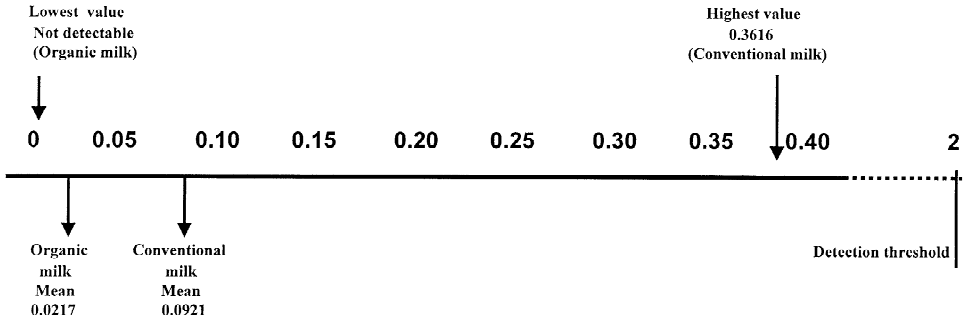

Fig. 1. DDT residues (in ppb) in organic and conventional milk samples (Maruejouls and Goulard, 1999).

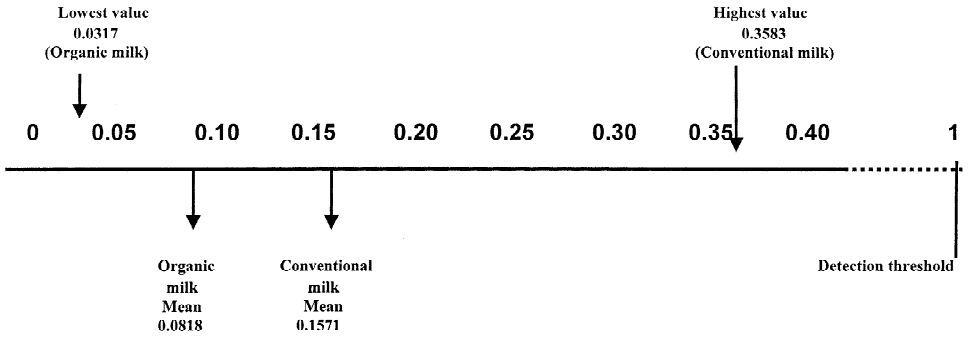

Fig. 2. LINDANE residues (in ppb) in organic and conventional milk samples (Maruejouls and Goulard, 1999).

data on pesticide residues in total diet studies show that calculated intakes are very low, often below 1% of the acceptable daily intake, as determined by toxicological studies (FAO, 2000).

Some studies have shown that sperm concentration was higher among organic farmers and organic consumers than among other men (Abell et al., 1994; Jensen et al., 1996), but recent studies have not confirmed these results (Juhler et al., 1999; Larsen et al., 1999) (Table 4). Ratcliffe et al. (1987) indicated that pesticide exposure may increase the risk of reproductive impairments (Table 5). A recent study (Oliva et al., 2001) also shows that exposure to pesticides and solvents is significantly associated with male infertility.

Table 4
Sperm concentration (million/ml) among organic producers and consumers, compared to conventional ones

	Organic population	Conventional population	*P*
Abell et al., 1994	100	50	**
Jensen et al., 1996	69	48	**
Juhler et al., 1999	75	62	NS
Larsen et al., 1999	64	58	NS

$^{**}P < 0.01$; NS, not significant.

Table 5
Sperm concentration (million/ml), viability, motility and morphology among workers with long-term exposure to ethylene dibromide (mean 88 ppb, peak up to 262 ppb), compared to unexposed workers (Ratcliffe et al., 1987)

	Unexposed workers	Exposed workers	*P*
Concentration	59.4	48.4	NS
Viability (%)	85.5	68.1	**
Motility (%)	46.6	35.2	*
Normal forms (%)	82.7	78.9	NS
Absent heads (%)	1.4	2.1	***
Abnormal tails (%)	5.7	6.5	***

$^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$; NS, not significant.

4. Microbiological hazards

4.1. Contamination from natural fertilisers

Farmyard manure (FYM) and other animal wastes are widely used in agriculture, both organic and non organic. This use of FYM as fertiliser gives rise to concerns about possible contamination of agricultural products with pathogens (especially *E. coli* O157) and possible contamination of ground and surface water. A recent English report concludes that there is insufficient information available to state categorically if the risk of pathogen transfer from organic farms differs significantly from the risk associated with conventional farming practices (Nicholson et al., 2000).

Recent research indicates that some pathogenic organisms can survive up to 59 days under compost conditions (Droffner and Brinton, 1995). In fact, knowledge of the critical periods and temperatures needed to make composted manure microbiologically safe is incomplete (Tauxe, 1997). Even if composting is effective in destroying vegetative pathogens, it will not destroy spore-formers such as *Clostridium perfringens* and even *Clostridium botulinum*. The question of survival of viruses and protozoa during composting may also need to be considered.

4.2. Bacterial contamination

In terms of bacterial contamination, results are quite contradictory. In 1998, studies carried out at Cornell University have demonstrated that organic farming would potentially reduce the risk of *E. coli* O157:H7 infection in ruminants like cattle and sheep, because their diet is based on grass, silage and hay instead of starchy grain used in conventional production (Couzin, 1998; Diez-Gonzalez et al., 1998). A recent study reported by Sundrum et al. (2000) found no differences between the microbiological count of organic and conventional milk. However, a report presented in 2001 by the EU shows that, compared to conventional agriculture, organic production leads to a higher *Salmonella* contamination in eggs, poultry meat and pork meat (Europa, 2001).

4.3. Mycotoxins

Mycotoxins are toxic compounds, produced by the secondary metabolism of toxic moulds in the *Aspergillus*, *Penicillium*, and *Fusarium* genera occurring in food commodities and foodstuffs. Mycotoxin production is dependent mainly on both well-defined ranges of temperature and other favourable environmental conditions. The relevance of mycotoxins to human health is rather well established and includes a wide variety of toxic effects (carcinogenic power, immunosuppressive action, etc). It has been suggested that organic food may be more prone to contamination by toxins (mycotoxins) produced by moulds than conventional food, because they are not treated to the same extent with anti-fungal agents. However, the study of the specialized literature by the FAO (2000) has led to the conclusion that there is no evidence to indicate that organic food is more prone to mycotoxin contamination than conventional food (FAO, 2000). Some studies even show opposite results. For example, Woese et al. (1997) reported two studies which found that aflatoxin M1 levels in organic milk were lower than in conventional milk. Skaug (1999) found the same result for ochratoxin A in Norwegian milk.

4.4. Parasites

At all ages animals may be exposed to parasitism and in organic animal production systems, the animals are particularly at risk due to outdoor rearing and ban of prophylactic medication. So, in organic livestock production, parasites are likely to represent the biggest challenge in terms of animal health and consequently in terms of product quality for the consumer. So, several studies in northern temperate climate have indicated that outdoor production of pigs, primarily sows, and laying hens, results in heavier and more prevalent helminth and ascaris infections compared to conventional intensive production under indoor conditions (Permin et al., 1999; Thamsborg et al., 1999) (Figs. 3 and 4). Even if these parasites do not threat human health, because they are destroyed either when the digestive tract is removed or by cooking, their single presence in

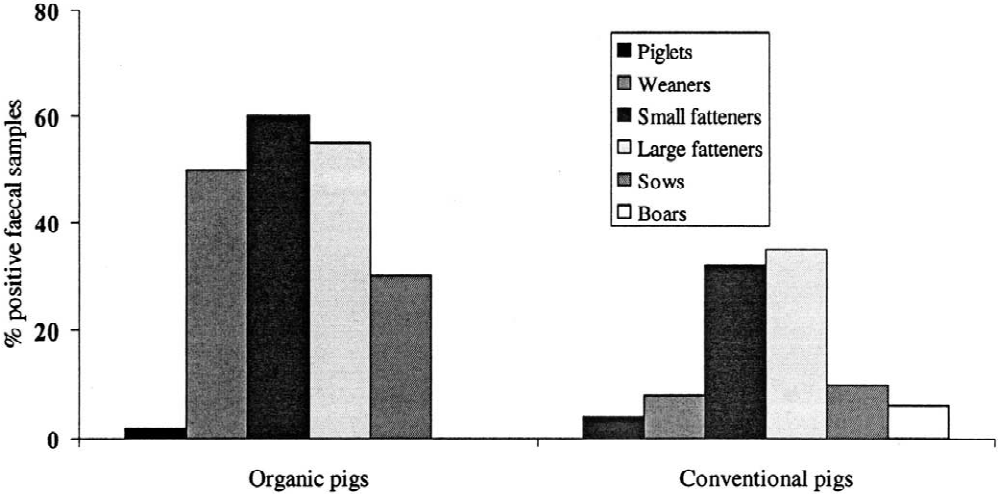

Fig. 3. Ascaris infections in pigs in different production systems (after Thamsborg et al., 1999).

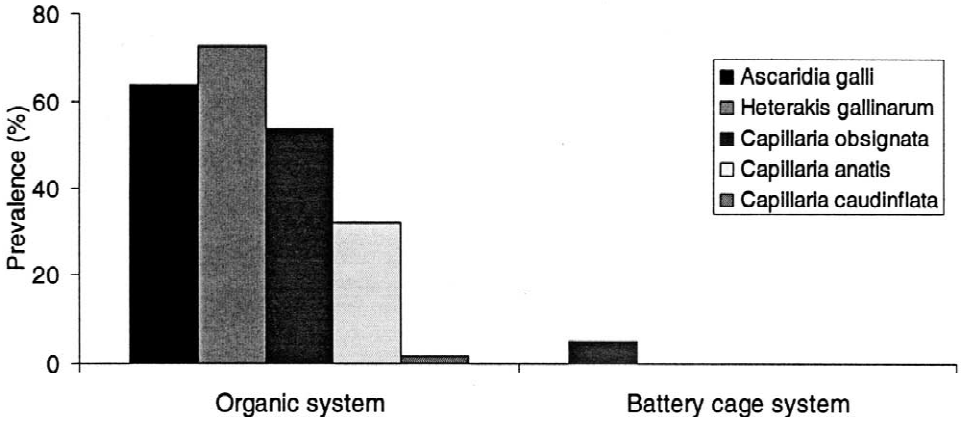

Fig. 4. Prevalence of gastrointestinal helminths in Danish chickens (Permin et al., 1999).

animal products is perceived quite negatively by consumers.

5. Other aspects of organic food quality

5.1. Food poisoning

European consumers still rate BSE as their number one food safety worry. As organic animals are only fed with organic diet, it is for the consumers the assurance to avoid animal flours and consequently the BSE disease. However, a case of BSE was discovered in a French organic farm in March 2001. The cow came from a conventional farm.

5.2. Food irradiation

Food irradiation is the process of exposing food to a carefully controlled amount of ionising energy. ''Irradiation is commended as a safe and effective food processing method that can reduce the risk of food poisoning and preserve foods without detriment to health and with minimum effect on nutritional quality'' (WHO, 1997). However, many consumers have misconceptions about the technology, such as

that it alters food quality or even that it makes food radioactive. As irradiation is prohibited in organic production, consumers can buy organic if they do not want to eat irradiated food.

5.3. Genetically modified organisms (GMO)

Organic farming and genetic engineering are two contradictory world views. Genetically engineered organisms and products containing GMO are categorically excluded from the organic production system. For many consumers, the best assurance that their food has not been genetically modified is to buy food that is organically produced.

6. Conclusion

Market demand for organic products has expanded rapidly over the past decade. Healthiness and nutritional value are reasons given by some consumers for purchasing organic foods, although there is no scientific evidence that such foods possess additional benefits which conventional food does not possess. Taste is another consideration but difficult to quantify objectively. More importantly, the organic process itself is not a sufficient condition for guaranteeing the absence of contamination from pesticides, mycotoxins, bacteria, parasites, etc. Organic farming is a way to protect the environment. This is maybe the highest quality of organic production systems, that will in the future benefit to everybody on earth.

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