afssa
AGENCE FRANÇAISE
DE SECURITE SANITAIRE
DES ALIMENTS

Nutrition and health assessment of organic food
Report summary

FOREWORD

This report on organic agriculture is the result of a review initiated by the Agence française de sécurité sanitaire des aliments [French Food Safety Agency]. The review was motivated by the fact that at the time no overall evaluation had been conducted in France of the specific practices of organic agriculture in terms of nutrition and health, even though an increase in these practices was desired by the professionals concerned, by consumers and by the public authorities and that, moreover, the link between organic farming methods and food safety concerns were being affirmed on a regular basis.

It was felt therefore that an examination was required of all the issues surrounding the control of health risks and also the specific or comparative nutritional properties of organically produced food. The objective was to gather together all the available scientific data, discuss them and put them into perspective. This also required a good description of organic farming methods and consideration of the accumulated experience of the professionals concerned.

The working group's brief was produced by the Agency's nutrition and health risk assessment unit and submitted to Afssa's Scientific Council, following discussion with the specialist expert committees most directly involved. It was decided, in view of the purpose of this evaluation, not to constitute a working group composed solely of scientific experts, but also to include a large proportion of stakeholders.

The work, which lasted six months, encountered several problems:

1 – The first problem concerned the paucity of available data, whether comparative scientific studies of the two production methods, data from surveillance plans sufficiently representative of organic agriculture or specific studies on organic agriculture.

2 – The second problem concerned the contrasting elements in the group, expressed in differences of approach: some members wished to restrict its work solely to the aspects established in scientific publications; others felt it was necessary to take account of data drawn from practical experience and which had not achieved objective status by publication in peer reviewed journals.

3 – The third problem concerned the fear, expressed on a number of occasions by organic farming professionals, that a report of this nature might cause disquiet among consumers, since it was discussing concerns on the control of health risks or on the vulnerability in health terms of certain practices or because observations based solely on scientific data underestimate the positive effects of organic agriculture which cannot be described in objective terms by the studies available.

4 – The fourth problem arose from the fact that the sector covered by the report objective involved a large number of the Agency's specialist expert committees. The standard procedure for validating a working group report by one or more expert committees was therefore more difficult to implement.

On that basis, the following choices were made in producing this report:

1 – In accordance with the Agency's rules, the report states precisely on which references the observations it makes are based; consequently, the report includes some data drawn from listed scientific publications and other data which better reflect the positions revealed by the group's work, based on all the contributions of the experts concerned.

2 – Each part of the report was submitted to members of the specialist expert committees concerned for their critical comments, which have been included in this report.

3 – An intermediary report was produced for observations and contributions on the Afssa website, offering readers the option of expressing a personal point of view, possibly disagreeing with all or part of the report. The comments received were discussed with the working group at the end of the consultation phase, with a view to including them in the final report. The contributions received by the Agency are gathered in annex.

Finally, it must be noted that in view of the Agency's competencies this type of project is not designed to examine the environmental consequences of different agricultural practices, even though the use of inputs can have indirect health effects through their presence in the environment. The report solely takes account of the direct influences of different practices on the characteristics of food products. It must therefore be borne in mind that no study was made of the favourable effects organic agriculture may have on the environment as a result of the restrictions on the use of chemical inputs.

These are the conditions in which this report has been produced, the conclusions of which have led to the identification of several areas for further work. We should point out that the same process, with similar objectives, has been engaged in a number of countries, with comparable difficulties and results. While the one-day conference on organic agriculture held on 18 October 2002 enabled an initial exchange of views, this process can perhaps be continued on the basis of this report.

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INTRODUCTION

1 DOCUMENT PRESENTATION - OBJECTIVES

The production and consumption of organic food is increasing rapidly in France (whilst remaining modest in comparison with food produced using conventional methods).

The characteristics of this production system[1], notably the restrictions on the use of synthetic substances (pesticides, veterinary medicines, food additives), the ban on GMOs and their derivatives and the use of environmentally friendly crop and livestock production techniques, are criteria which attract consumers to the consumption of organic foods.

Because no assessment of the possible consequences for health and nutrition from this production system had so far been carried out in France by any independent or public consultative bodies, Afssa decided to include such a study in its work programme, as a self-referral, and in October 2001 began an assessment of the benefits and risks for nutrition and health of organic food. Although the environment remains a fundamental aspect of an organic production system, the assessment of its environmental impacts does not fall within Afssa's remit or competencies, and for this reason it has been covered in this report purely insofar as it relates to the health aspects.

To ensure successful completion of the study, Afssa set up a working group composed of scientists, some from its own expert committees, and representatives from the organic sector. The background analysis has resulted in an assessment report based on two main areas, firstly, the nutritional aspects, and secondly, the health aspects. One chapter is also devoted to the consumption of organic products, which presents a study aiming to estimate the actual consumption of organic products.

2 DEFINITION OF ORGANIC AGRICULTURE

Organic agriculture is a system of production based on a set of agricultural practices which reflect a certain philosophy, respect the ecological balance and require farmers to restrict inputs from off the farm as far as possible. It requires the attentive observation of crops and animals, the use of innovative techniques and an integrated approach to farming. Organic agriculture includes some environmental aspects and soil conditioning is based on the use of natural materials.

Organic agriculture relies on the use of specific resources. Farmers, storage operators and processors work in compliance with strict standards and under the supervision of certifying bodies.

During the production process for the finished product, all those involved use techniques which combine to ensure that the consumer can be guaranteed that chemical residues are kept to a minimum, by either abstaining from their use or heavily restricting it, to achieve the following objectives:

- Environmental*: reducing contamination of seepage and run-off waters, maintaining or increasing biodiversity and impacting positively on ecosystems and biotopes, etc.*
- Reducing *chemical fertilisers and pesticides in crop production; of antibiotics and other synthetic molecules in livestock production,*
- Limiting contaminant *risk: use of sewage sludge as fertiliser (heavy metals) is prohibited,*
- Banning GMOs *and GM derivatives,*
- Prioritising *animal welfare and ethological needs,*
- Restricting *the use of* processing aids *in product processing,*

[1] The assessment of organic foods in this report concerns organic agriculture as defined in Council Regulation (EEC) No. 2092/91 with amendments and by the official French standards with its additional requirements for livestock.

- Achieving traceability *of all foodstuffs throughout the food chain.*

Farmers and processors in the organic sector are committed to a complete approach designed to limit the harmful effects of agricultural practices and to promote alternatives to intensive farming methods by prioritising the relationship with the land.

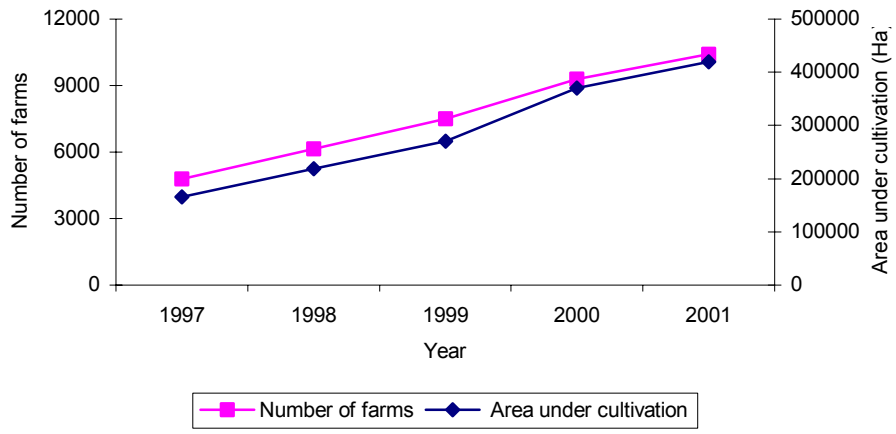
This production system lays the foundations for a *sustainable agriculture* defined as environmentally friendly, economically viable and socially equitable...

3 THE GROWTH OF ORGANIC FARMING

Organic farming is playing an increasingly important role in the agricultural sector as a result of the consumer interest in environmental and food safety. It is acknowledged as forming an integral part of a sustainable agricultural system and as a viable alternative to more conventional approaches in agriculture.

In France Until the 1980s, France was Europe's leading producer country in terms of organic farming. This growth then slowed due to a lack of interest from the public authorities and the agricultural industry and to a fall in the credibility of the commercial movement dominating organic agriculture.
Over the last five years, organic farming has seen a renewed expansion (Figure 1: Increase in the number of organic farms and the corresponding area under cultivation since 1997 in France. (Agence BIO, 2002)). In 2001, organic farms numbered nearly 10,400 or 1.6% of all French farms. Approximately 1,700 farms were in the conversion phase in 2000.

Figure 1: Increase in the number of organic farms and the corresponding area under cultivation since 1997 in France. (Agence BIO, 2002)



Organic farms on average cover 47 hectares compared with 42 hectares for conventional farms. They are generally more diversified. Field crops are more than twice as likely to be combined with livestock production and it would seem that in the future, due to the new regulations which encourage organic livestock farmers to produce most of their animal feed on the farm, this trend will increase.
The organic cattle herd saw a 30% increase in 2001 with a total of almost 90,000 head in organic production (46,500 dairy cows, 42,000 suckler cows). The sheep flock increased by 20%.

In Europe Organic farms in the European Union covered almost 4.5 million hectares in 2001 (approximately 3.3% of the total agricultural area). This sector has therefore shown annual growth of almost 25% in the European Union between 1993 and 1998 and some 30% since 1998 (Table 1)

Table 1: Agricultural area and number of organic farms in some Member States (SOEL, 2000).

Country	Agricultural area		Farms	
	Organic area	Proportion of national total (%)	Number of organic farms	Proportion of national total (%)
Luxembourg	1030	0.81	51	1.7
Belgium	22,410	1.61	694	1.03
Greece	24,800	0.48	5,270	0.64
Ireland	32,355	0.73	1,014	0.69
Netherlands	38,000	1.94	1,510	1.40
Portugal	70,857	1.80	917	0.22
Finland	147,943	6.60	4,983	6.4
Denmark	174,600	6.51	3,525	5.58
Sweden	193,611	6.30	3,589	4.01
Austria	285,500	11.30	18,292	9.30
France	**419,750**	**1.40**	**10,364**	**1.60**
Spain	485,079	1.66	15,607	1.29
Germany	632,165	3.69	14,703	3.39
United Kingdom	679,631	3.96	3,981	1.71
Italy	1,230,000	7.94	56,440	2.44

Italy is the European country with the largest organic agricultural area. Germany has the largest market in the world for organic agriculture. Spain exports 80% of its production, but is currently experiencing growth in domestic demand.

In 1999, Switzerland stood second in world organic agriculture in terms of the proportion of organic farms (approximately 8%), however it is continuing to import a large number of products, such as cereals, from Eastern Europe, the United States and Canada, which have 2 million hectares of organically farmed land.

Production and marketing practices for organic produce are more costly due to the low volumes marketed, the greater labour requirement and the extra costs generated by certification. Organic farming notably involves specific management of crop rotations and soil fertility and has to deal with the vagaries of production (annual variations).

Organic farming requires a labour input of between 20 and 30% more than conventional agriculture (Vérot, 1998) due to the use of fewer inputs (the land requires more work – e.g. manual weeding or more frequent passages with mechanical tools) and increased monitoring of crops and animals (the prevention principle is prioritised in organic agriculture).
For this reason the multi-year plan for the development of organic agriculture announced in 1997 planned for an annual increase of 25% in the market for organic produce, enabling more than 40,000 jobs to be created in production, processing, distribution, advisory services and training.

4 DIFFERENT ASSESSMENTS OF ORGANIC FOOD

A number of assessments of organic food have already been carried out, either by official bodies[2], or by research institutes or organic agriculture associations (Soil Association).

[2] The reports of some of these official bodies were presented during the one-day conference on 18 October 2002 organised by AFSSA on assessing the nutritional value and the health benefits and risks of organic food. The conference proceedings are available on the AFSSA website.

At European level, some assessments by official bodies have already been published. Some of these assessments considered both the nutritional and health (food safety) aspects (FSA, United Kingdom; FAO European Conference), others restricted themselves to the health aspects (AFSCA, Belgium; National Reference Centre for Agriculture, Netherlands) or the nutritional aspects (DARCOF, Denmark). Overall, these assessments reached similar conclusions:

- In terms of nutrition, they judge organic food to be comparable overall to food produced by conventional means;
- In terms of health and food safety, some differences are occasionally suggested between the two production systems and have led to some recommendations being made.

Literature reviews have also been conducted by scientific bodies on the comparison of organic food with conventional food. Of the principal literature reviews listed, most deal with the health, food safety and nutritional aspects (Bourn & Prescott (2002), Woëse et *al.* (1997), Soil Association (2001)). Only one study was restricted to nutritional aspects (Worthington, 1998). The conclusions of these literature reviews vary from author to author, some concluding significant effects from organic farming systems, others not finding significant differences between these two production systems.

METHODOLOGICAL ASPECTS OF THE ASSESSMENT AND LIMITS OF THE REPORT

The nutrition and health risks and benefits of organic food were assessed using comparative studies of organic and conventionally produced food products. Studies or projects which were not comparative studies or projects characterising organic foods were also examined for their capacity to explain the mechanisms involved and thereby provide a better understanding of the effects of a crop or livestock production system on the characteristics of the foods produced.

To complete this self-referral, Afssa used a methodology combining the following tools[3]:

- Working groups composed of scientists, some from Afssa's specialist expert committees, representatives from the organic sector (Ecocert, ITAB, FiBL…) to deal with the health, food safety and nutritional aspects;
- Working meetings with scientists, members of the specialist expert committees, representatives of government departments (DGAL, DGCCRF, DPEI, DGS) and organisations from the organic agriculture sector (SETRABIO-BIOCONVERGENCE, Agence Bio) to examine certain specific points more deeply;
- Analysis of documents submitted by the inspection services: results of DGAL and DGCCRF monitoring and control plans;
- Study of scientific articles published in peer-reviewed journals or other sources, selected based on defined criteria presented below;
- Analysis of minutes of specialist meetings, IFOAM documents;
- Inclusion of representative surveys at national and European level;
- Intermediary public meeting with institutions from other European countries.

1. SELECTION CRITERIA FOR SCIENTIFIC ARTICLES

A major bibliographic project was undertaken based on published scientific studies; this literature review constituted the principal source of data for completion of this assessment. Priority was given to articles published since 1980[4], with particular attention paid to finding studies conducted at international level. Section criteria for comparative studies, for inclusion in or exclusion from this assessment, were determined based on those used in the Soil Association study (2001).

☛ **Inclusion criteria** for the selection of articles on the characteristics of organic and conventionally produced foods and on the mechanisms explaining certain properties of organic foods:

- Sampling must be done in such a way as to permit statistically valid conclusions;
- Data on organic products must originate exclusively from certified farms and processing units;
- Crop and livestock practices must be properly described and relate clearly to either organic or conventional production systems;
- Production methods must indicate the practices used by producers (for example: fertilisation, rotation, plant protection, animal feed, animal health, use of additives, etc.);
- Levels are expressed clearly in terms of fresh and/or dry matter;
- Comparative studies must relate to criteria relevant from the standpoints of food safety and nutritional value.

[3] Some trends in organic agriculture refer to "morphogenetic" methods as an analytical tool for differentiating between production systems. These methods, not scientifically validated, have not been used in this assessment.

[4] Even though harmonisation of practices in organic agriculture did not occur until 1991 with Regulation 2092/91.

☛ **Exclusion criteria** for the selection of articles on the characteristics of organic and conventionally produced foods

- The trial was conducted on land whose history is unknown (condition: a minimum of 2-3 years after conversion);
- Practices are incorrect, notably in terms of the organic standards, or information on crop trials or on samples is insufficiently documented;
- Data is not presented in such a way that validated data can be separated from non-validated data;
- The studies repeat an article already published.

The article search was based on bibliographic journals but the assessment was based on article initially selected using the above criteria.

2. APPROACHES USED

Several approaches were planned for completion of the assessment: experimental, deductive, overall. The experimental approach is the most rigorous scientifically. However, due to the lack of data available on organic products, the assessment was often based on a deductive approach. In order to achieve homogeneity between the different areas in this report, a fairly general description of each area was provided in each chapter (e.g. in the case of eggs, a description of their nutritional characteristics; for bacterial risk, bacteria which are the cause of mass food poisoning outbreaks in Europe) then one or more of the approaches presented below was introduced, before a conclusion as to any risks or benefits.

2.1 The experimental approach

This consists of to comparing compare certain some nutritional or health parameters for animal or plant-based foods using a single rigorous experimental protocol for two farming systems: organic and conventional.
For example: two batches of wheat grain, the same variety and harvested at the same stage of maturity, grown in similar conditions (same type of soil, same climate, etc.) one using conventional methods, the other following the organic standard.

2.2 The deductive approach

This is also based on a scientific system enabling estimation of the nutritional or health impacts of a production factor based on knowledge of the crop or livestock production techniques and variation factors.
For example: the nutritional value of milk is well-known but subject to a certain number of variation factors (notably the animal's stage of lactation, breed and feed). The diet of animals reared using organic methods is defined in the specification (positive list of raw materials, restriction on the percentage of concentrates included in the ration…). For the same dairy cow and at an equivalent stage of lactation, the nutritional value of the milk produced by a cow fed with organic feed may or may not be found to differ from that of milk produced by a cow fed with conventional feed.

2.3 The overall approach

This is based on analytical comparisons of a series of samples of foods taken from different production systems in conditions which are not strictly comparative. Its validity is undeniable when it is restricted to verifying the absolute quality of a food, in which the result of a product as presented to the consumer is evaluated (for example, no pesticide residues, nitrate content, etc.). However, it does not permit a comparison, in the strictest sense, of the results of two types of production unless the production conditions are known, particularly when these are foods sampled on the market: while Organic Agriculture certification can guarantee the production system, the same cannot be said of non-quality marked products produced using a very wide diversity of agricultural practices (from products from small producers to those from intensive farms) making the comparison difficult. When this is applied to quality marked products (notably Label Rouge (Red Label) for poultry) or certain

foods produced using techniques based on moderate use of treatments and processing, however, the comparison becomes more valid since production conditions are more closely defined.

3. EXPRESSION OF DATA RESULTS

3.1 Dry matter *vs.* fresh matter

The levels of some nutrients in foods produced organically or using conventional methods have been expressed in terms of fresh matter or dry matter, based on the comparative studies available. The nutritional value of foods given in the food composition table is expressed for fresh matter, as is standard. Nonetheless, the expression of levels based on dry matter is also useful for assessing nutritional value and for making rigorous comparisons between some plant samples.

3.2 Interpreting the results

The comparative results gathered from the different studies analysed have been grouped using a simple classification:

- AB > AC: the statistical results in the study show significantly[5] higher levels of the element under consideration in the organic products compared with those produced using conventional methods.
- AB = AC: the statistical results in the study do not show any significant differences between the organic products and those produced using conventional methods.
- AB < AC: the statistical results in the study show significantly lower levels of the element under consideration in the organic products compared with those produced using conventional methods.

Where possible, reviews were conducted in which the number of results corresponding to each category (>, = or <) were counted, enabling certain trends to be identified, without statistical significance.

4. LIMITS OF THE REPORT

An assessment of the health and nutrition risks and benefits of organic foods could only be completed successfully with a sufficient amount of data.

The nutritional aspects. Most of the studies used only deal with the quantitative aspect of the nutritional value of foods, restricting themselves to comparison of the levels of a nutrient or family of nutrients in one or more foods. There is no data available which permits an examination of the influence of the agricultural system on the bioavailability of nutrients, on their metabolism, their physiological roles or their impact on consumer health. Similarly no studies compare the influence, on consumer nutritional status, of a complete diet of organic foods with another diet based on conventional foods.

Finally, some themes have barely been covered in the literature, some not at all. This is the case for example with the effect of an organic production system on protein levels in eggs or milk, or on levels of vitamins K, D or B group vitamins (with the exception of vitamins B1 and B2) in foods or on any changes to the fatty acid profile of organic butter and oils.

The health aspects. The lack of comparative data on organic and conventional farming systems has led the assessment of risks and benefits to be based mainly on knowledge of crop and livestock production techniques using a deductive approach.

Furthermore, as indicated in the introduction to this report, organic farming methods as a whole result in a total production system which is very different in many ways from conventional production systems, especially the most intensive ones. However, for reasons of scientific rigour, essential in an

[5] The term "significant" is used when the difference observed was validated by a statistical test. In the context of this report, there is at least a 95% chance that the difference exists.

experimental approach, many comparative studies involve a simplifying approach (e.g. comparison of identical varieties or breeds, crops over relatively short periods, etc.). The data produced by these types of comparison may not always reflect the effects of the different and complex farming systems on all the products available on the market.

We must also add that the organic farming sector is not an homogeneous sector:

- in terms of time: regulations have become stricter over the years, consequently, observations from earlier periods have been placed in perspective;
- in space: the requirements in the Community regulations are minimum requirements. Some Member States, including France, have stricter regulations.

For its part, conventional agriculture is even less homogeneous. It includes a large number of production systems which have points in common with the organic sector (for example, in fattening units, access to the outside…).

Organic fish farming production, a recent development in France, was not covered by this report. This point requires assessment as part of an evaluation of the fish farming sector.
The environmental aspects, which constitute one of the fundamentals of organic agriculture, do not fall within Afssa's remit and were not included in the brief for this report[6]. Animal welfare in organic farming and the organoleptic qualities of organic foods were not assessed in this report.

[6] Reviews are also underway within AFSSA on the impact of certain environmental contaminants, such as pesticides and nitrates, on drinking water quality.

CONCLUSIONS

Organic agriculture is defined as a particular production system based on an overall approach respectful of the environment and of animal welfare, which on the farm prioritises management practices rather than the use of external inputs. This system is based on crop and livestock production practices closely regulated by Council Regulation (EEC) 2092/91 and supplemented in France by a national specification. The Agence française de sécurité sanitaire des aliments [French Food Safety Agency] initiated a study to evaluate the nutrition and health risks and benefits of foods of plant and animal origin produced using organic methods compared with foods produced using conventional agricultural methods. Consideration of the environmental dimension, an important characteristic of organic systems, was restricted to the impacts of certain practices in terms of food safety.

It must be emphasised that, while certain practices are particular to organic agriculture (such as the ban of the use of synthetic plant protection products and GMOs, restrictions on the medical treatment of livestock and on the use of fertilisers, etc.) others, imposed by the organic farming specification, also apply to conventional agriculture.
In view of the heterogeneity of practices, particularly in conventional agriculture, it is important to evaluate the points of impact in the systems with similar crop and livestock production practices, but also to redefine the extent of these practices within the diversity of methods particular to each system. This second aspect, not covered in detail in this report, requires further in-depth consideration within the context of specific reviews of each sector.

Evaluating these aspects in organic agriculture using a systemic approach taking fully into account all the practices involved in this system would provide a better picture of the different cultivation and livestock production methods, but remains difficult to implement.

Processing practices must take into account the obligations set by the specification: the prohibition of ionising radiation, of GMOs and their derivatives, of fortification, except for products in which it is compulsory. Moreover, a very restricted list of additives and technological auxiliary requires adaptation of any processing procedures.

Evaluation of the nutritional value and the health risks and benefits of organic food was based on the available studies, with priority given to comparative studies with conventional products providing an assessment of the influence of the method of production and processing alone. When these data were missing or insufficient, a deductive approach was also used. This approach enabled the estimation, in the absence of specific data from organic production, of the possible impacts and/or overall effects of a production factor, based on, and limited to, the scientific knowledge available. It relied, for the nutritional aspects, on information on the production techniques and the different variation factors in chemical composition and nutritional value and for the health aspects, on information on the risks and an evaluation of the influence of production factors.

The small number of available studies in some of the areas examined as part of this review has led to a recommendation that additional studies should be carried out.
Organic fish farming production was not covered by this report. This point requires examination as part of a wider evaluation of the fish farming sector.

[7] In this report, the working group defines as conventional agriculture or conventional products, anything which is not defined as falling within organic agriculture. This definition reflects the one used in Council Regulation (EEC) 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. This very wide definition of conventional agriculture therefore also includes all the certified sectors other than organic agriculture, such as Red Label, Product Conformity Certification (PCC) and Protected Designation of Origin (PDO). These certified sectors also comply with specific specifications concerning cultivation or rearing methods but permit the use of synthetic plant protection products and fertilisers or veterinary medicines, unlike organic agriculture.
[8] Some sectors, such as quality marked products, are also subject to specifications in conventional agriculture.

4.1 NUTRITIONAL ASPECTS

1.1 Impact of the agricultural system on the nutritional value of foods for human consumption

The data examined during this evaluation showed, as a general rule, very little significant or reproducible differences between the chemical composition of raw materials produced using organic methods and those produced using conventional methods.

Study results are sometimes contradictory. The many variation factors affecting the chemical composition and nutritional value of foods (variety/breed, season, weather, stage of maturity or development, storage, livestock management methods, etc.) are often more important than the impact of the factors associated strictly with the agricultural system (type of fertiliser, health treatments, etc.).

The main conclusions are as follows:

- ***Dry matter.*** For root vegetables, bulbs, tubers and leaf vegetables, studies show a slight tendency towards a higher dry matter content in organically produced vegetables. This tendency is not found in fruit.
- ***Carbohydrates.*** The results show contradictory variations in content depending on the food studied, even in the same food. The data available do not therefore enable any influence of the production system to be shown on carbohydrate content.
- ***Proteins.*** The protein content of organically produced cereals seems to be lower than in cereals produced by conventional agriculture; this lower content is probably related to the restriction on nitrogen inputs in organic farming. The essential amino acid balance of these proteins was also better.
- ***Fats.*** The livestock management and crop production methods used in organic farming seem to result in variable changes in total fat content. Increased physical activity due to free range, the use of forage and/or grazing contribute to reducing growth rate, carcass fat coverage and intramuscular fat content in ruminants, pigs and poultry. Notable changes in fatty acid profiles, in particular an increase in levels of polyunsaturated fatty acids in animal products were also observed. These are principally due to the type of fatty acids consumed by the animal.
- ***Minerals and trace elements.*** A sizeable majority of the many comparative studies analysed agree on the absence of significant differences in levels of minerals and trace elements resulting from the production system. A slight positive tendency for iron and magnesium and negative for manganese was reported for some organic vegetables.
- ***Vitamins.*** Very few data are available for vitamins other than Vitamin C and β-carotene. These data show that an organic growing system can have a slight positive effect on the Vitamin C content of potatoes but has apparently no effect on levels of β-carotene in vegetables.
- ***Plant microconstituents***. The method of production does not seem to influence the lycopene content of fruit and vegetables. As regards polyphenols, most of the validated data available found a higher content in organic fruit and vegetables.

In the current state of knowledge and in view of the variability of the results of the studies examined, no conclusion can be drawn as to the existence of notable differences, in terms of the available reference intakes (RNIANC), between the nutrient contents of foods produced using organic methods and those produced using conventional methods. Concerning polyphenols, studies show an interesting potential in organic agriculture to be taken into account in the context of a more general examination of this category of microconstituents.

It would be helpful to carry out an overall review on the application of nutritional criteria in the varietal selection of plants for human consumption (in addition to the DUS and VCU criteria).

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[9] The term "tendency" is the result of the comparison between the number of results of available studies showing a significant increase for organic products, the number of results showing a significant reduction for organic products and the number of results not showing any significant differences between organic and conventional products (*cf.* Chapter 2 – 3.2.).

[10] Distinctness, Uniformity, Stability

[11] Value for Cultivation and Use

1.2 Impact of processing technology on the nutritional value of processed products

Very little information on the specific technology used in organic agriculture is available.

Some technological process are likely to have consequences for the nutritional quality of foods. For example, organic agriculture prefers the use of wheat milling processes enabling better preservation of the germ and bran in the flour, resulting, in yeast-based breadmaking, in breads richer in minerals, fibre and vitamins.

The technological approach in organic agriculture prioritises, for certain foods (notably first cold pressed oils) processing technologies likely to preserve a maximum of the intrinsic nutritional qualities of the raw material, by limiting the elimination of micronutrients.

1.3 Importance of the global diet

The impact of diet on an individual's nutritional status or health cannot be restricted to the study of one nutrient or food in particular, but must take into account the global balance of the diet. Moreover, if dietary balance, as it is now defined by nutritionists, is respected, the nutritional needs of the population are covered. A number of studies have shown, however that certain population categories still do not have a sufficient and balanced intake.

As regards foods, although most validated studies do not show any significant differences between nutrient levels, some studies enable tendencies to be discerned towards higher or lower contents of certain nutrients depending on the production system. In the current state of knowledge, the differences, where they exist, seem however to be too small, even negligible, to be able to induce an effect on the consumer's nutritional status as part of an overall diet. However, one cannot prejudge the additional or synergetic effect of differences in intake, however small, of nutrients beneficial to health or the indicators for nutritional status in the context of an overall diet. Such an effect could be researched using observation studies or, preferably, intervention studies.
In terms of processed products, regular consumption of certain less refined products, such as wholemeal bread, whatever its production system, made using a yeast-based breadmaking process, may offer nutritional benefits due to the increased intake of fibre and minerals compared with white bread.

In nutritional terms, the balance of the global diet and the coverage of nutritional requirements remain the key points for consideration.

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[12] Observation studies comprise two types of study: ecological studies and analytical studies.
Ecological studies (descriptive epidemiology) enable the demonstration of a statistical correlation between the dietary intake of populations differing either geographically (international correlation studies) or temporally (migrant studies) and one or more diseases. They are based on aggregated data and it is not possible to state a cause and effect relationship.
Analytical studies are based on individual data enabling better control of confusion factors, but the cause-effect relationship remains subject to unknown or poorly identified confusion factors: a random or selected population group is classified according to exposure to one factor under examination (and to the factors which could be associated with it). By comparing the exposed or non-exposed subjects in terms of the occurrence of a disease, an association can be demonstrated between this factor and the disease.
E.g.: the incidence of cancer or cardiovascular disease, or mortality, would be compared between one population eating exclusively organic products and another which had never consumed any, all other lifestyle factors being measured as well, for statistical adjustment.

[13] Intervention studies are the only ones which can possibly demonstrate a causal link in humans between a nutrient and a disease. The ideal method is a comparison between a treated group and a control group as closely matched as possible, using a double blind approach. These are most often carried out using a micronutrient acceptable in the form of a capsule, as this is easier. But in that case, they do not reflect the usual situation of a nutrient intake in a food and as part of a complex diet. The nutritional approach, which currently seems the best, is harder to apply (For example: a sample of volunteers is subjected for 15 days to an organic diet and nutritional indicators are measured. After a period of 15 days, they return to a conventional diet and the same indicators are evaluated. The two sets of measurements are compared. This type of intervention is generally conducted using a cross-over protocol, meaning that in the same time period, a comparable sample would start with a conventional diet and finish with the organic diet.

The small differences or tendencies taken individually, which were able to be demonstrated for a few nutrients and in certain studies between the chemical composition and the nutritional value of products produced using organic methods and those produced using conventional methods, do not appear significant in terms of nutritional intake with regard to the nutritionnal diet.

For polyphenols, in the absence of a reference value (such as an RNI) or of sufficient information on polyphenol intake in the population, it is difficult to evaluate the physiological impact of the values observed, which were higher in organic fruit and vegetables. This area of potentiality remains to be further explored.

Therefore, given the multiple variability factors affecting the chemical composition of plant products, it does not seem appropriate to recommend the setting up of comparative composition studies since a great many analyses of a large number of foods would be required and it would not be possible to deduce from them a functional expression in the consumer.

On the other hand, the acquisition of new composition data, including precise variation factors (variety, degree of maturity, etc.) would, in particular, enrich the food composition database for targeted elements and vector foods, such as polyphenols or certain minerals and trace elements in vegetables (Ca, Mg, K, Fe, Zn).

In terms of the chemical composition of animal products, the impact of diet is a more discriminating factor than the production system itself. Research studies are currently underway to describe more precisely this impact on the nutritional quality of foods (notably qualitative and quantitative modifications of the fatty acids). The development of this type of research should be continued.

Research into a long term nutritional impact would require comparative studies in consumers (heavy consumers of organic products vs. consumers of conventional products), based on relevant biological and/or clinical indicators. This type of study appears difficult to set up, but they are achievable on a more short term basis, especially intervention studies, using validated biological indicators of nutritional status.

4.2 HEALTH ASPECTS

4.2.1 Risk from cross-contamination

The production, storage and transport of raw materials as a general rule constitute critical points as regards the risk of cross-contamination, as has been demonstrated by the various health crises that have occurred over the last few years. These points require particular vigilance.

One of the principles of organic farming prioritises the production of most animal feed on the farm, limiting the risk of cross-contamination. Moreover, organic agriculture functions on short production and distribution channels with the intervention of a limited number of intermediaries. It is therefore probable that the risk of accidental contamination is lower in organic agriculture than in conventional agriculture. However, all food production is geared towards foodstuffs which are more and more prepared and processed. It is for this reason that product traceability from farm to consumer must be well documented and controlled by certification bodies.

4.2.2 Risks from contaminants

The principles which guide organic production systems are based on an environmentally friendly approach with an obligation to use certain inputs and techniques only.

4.2.2.1 Pesticides

The regulations on organic crop production prohibit the use of synthetic chemical plant protection products. Organic production methods therefore enable elimination of the risks associated with them and contribute to a reduction in environmental pollution, notably of water resources through run-off or soil absorption.

[14] Managed by AFSSA as part of CIQUAL (Centre Informatique sur la qualité des aliments- Food Quality IT Centre) for the publication of food composition tables and for the definition of the nutrition intakes of the French population.

Protection of plants produced organically is based on preventive cultivation methods and curative treatments using permitted products included in a positive list defined at the Community level. These treatments are used in the event of an immediate threat to the crop. The natural character of these pesticides does not, however, exclude their potential toxicity for humans, even though their high degradability may reduce this risk. The small number of studies examining the presence of pesticide residues of natural origin and the difficulty of determining these residues are grounds for the development of additional studies.

All the available studies show that the great majority of organic products contains no residues of the pesticides permitted in conventional agriculture. The positive results observed in organic products are at levels close to the detection limits of the analytical methods used and very much lower than those detected in conventional products (residue levels in conventional products remain, in the great majority of cases, below Maximum Residue Limits). The rare occurrence of a contamination incident involving organic products can be explained by the history of the plot, environmental pollution, subsequent accidental technological pollution, even misuse. It would therefore be appropriate to continue the surveillance of possible contamination incidents by means of control plans designed better to distinguish environmental type pollution incidents either post-harvest or caused by misuse which would indicate a lack of vigilance (cross-contamination) or a voluntary act.

Moreover, certain pesticides of natural origin, such as copper salts, sulphur, rotenone and the pyrethrums should be subject, in the same way as a number of other synthetic pesticides, to a toxicological re-assessment based on current requirements.

4.2.2.2 Heavy metals

Soil pollution by heavy metals (mainly of industrial or agricultural origin) constitutes a source of contamination of the food chain.

The few studies available do not permit the demonstration of a difference in the concentration of heavy metals between organic products and those produced using conventional agricultural methods. However, the restrictions given by the specification (plot conversion period, prohibition on the spreading of sewage sludge, restriction on inputs of mineral fertilisers - a restriction which is stricter for copper salts) help to limit the risk of heavy metal contamination of plant and animal foodstuffs. Most phosphates (natural phosphates, superphosphates) are major sources of cadmium.
The possibility of the contamination of foodstuffs by heavy metals of industrial origin cannot be discarded and concern both organic and conventional production if they are located close to the pollution source.
Whatever the production system, exposure to heavy metals still remains lower than the toxicity reference values.

4.2.2.3 Mycotoxins

Mycotoxins are a current subject of concern in terms of food risk and are the subject of a number of studies (toxicological, analysis-based methodology, level of consumer contamination and exposure). These families of contaminants, secondary metabolites secreted by moulds, can appear in foodstuffs due to the effect of different factors (humidity, temperature, etc.) notably during harvest and storage.
Storage conditions can be controlled while harvesting conditions are subject to a number of random factors, climatic in particular.

Organic farming methods restrict the use of fungicide treatment but prioritise techniques unfavourable to mycotoxin contamination, such as crop rotation, awareness of the previous crop, soil working, low nitrogen inputs and the non-use of growth regulators.

Some of the data available on the mycotoxin contamination of organic products show variable levels of contamination with a few cases of heavy contamination without any major differences overall being demonstrated from the contamination of conventional products.

In view of the diversity of mycotoxins, the factors influencing their appearance and the highly heterogeneous nature of the contamination of foodstuffs, the representivity of the results available

[15] Self-referral by AFSSA

remains disputable and justifies a continued attentive surveillance of contamination incidents through the implementation of new control/surveillance plans for both systems. The data from the control and surveillance plans do not currently provide enough information for either system. Controls could be targeted on the basis of a more detailed analysis of the most contaminated products in terms of their consumption.

The analysis results observed justify the value of putting in place a good practice guide aimed at the whole agricultural sector, similar to those currently being prepared by the Codex Alimentarius. The development of such a guide, tailored to the specificities of the two systems, could enable the identification of critical points and ensure improved control of mycotoxin contamination.

4.2.2.4 Nitrates

Nitrates accumulate in plants through the effects of several factors (sunshine, temperature, rainfall, irrigation, use of nitrogenous fertilisers). The use of nitrogenous fertilisers and sunshine are determining factors in nitrate build-up in vegetables, which contribute up to 80% of human dietary nitrate intake.

Analysis of the data available shows that vegetable production methods in organic farming result in lower total nitrate levels than can be explained by the ban of the use of synthetic nitrogenous fertilisers (nitrate, ammonium nitrate, urea) and their replacement with organic fertilisers and soil improvers (manure, compost, etc.) and restrictions on the amounts used. This reduction appears interesting insofar as average daily intake of nitrates is close to the ADI and that an increase in vegetable consumption is being recommended at national level (PNNS, 2001). This would, however, need to be confirmed by new studies taking account of the changes in agricultural practices (notably in the use of nitrogenous fertilisers) and examined in the light of the conclusions of the reassessments underway on nitrate toxicity.

A number of measures could contribute to a reduction in nitrate content:
- improvement of the use of nitrogenous fertilisers through a restriction on the use of organic fertilisers high in rapidly leachable nitrogen, monitoring nitrogen mineralisation and nitrate retention,
- restrictions on greenhouse crop production.

4.2.2.5 Dioxins and other environmental pollutants

Animal feed and food products of animal origin are subject to regulatory limits on dioxin contamination in particular. Animals in free range systems can be exposed directly or indirectly through the soil or plants to environmental pollutants (dioxins for example) when they are close to sources of contamination. These contaminants can then accumulate in the animal products (eggs, meat, milk). Animals in confined systems can also be exposed to this type of contamination indirectly through the feed (raw materials produced locally in exposed areas). This type of pollution is not specific to a particular agricultural system.

4.2.3 Veterinary medicines and plant-based substances

The use of veterinary medicines in organic livestock systems is regulated by a very restrictive specification. The use of veterinary medicines for preventive purposes is prohibited with the exception of vaccination under certain circumstances. Only a very small number of synthetic chemical allopathic treatments for curative purposes are permitted every year for each species in an organic system and in these cases, the waiting periods applicable in conventional agriculture following treatment are doubled. Antiparasitic treatments are permitted at appropriate rates.

The specification prioritises the use of plant-based substances and homeopathic treatments.
The increase in the use of these products requires careful monitoring as they are offered to farmers in many cases without being licensed for use (as a medicine or additive) following a dossier-based evaluation covering their quality, safety and effectiveness for the uses being recommended.

[16] In 2003 the JECFA published a summary document on nitrates (Safety evaluation of certain food additives, WHO food additives series: 50, 2003). Two questions are currently being processed at AFSSA, concerning the consumer health risk from the presence of nitrates in water and concerning the nitrates and nitrites used as preservatives in meat products.

Therefore, in addition to the lack of information on the potential residues of these substances, their use may delay the use of a medicine whose effectiveness has been evaluated and demonstrated and result in the animal developing a chronic disorder.
The use of plant-based substances in animal feed is not unique to organic agriculture, but is also observed in conventional agriculture, notably since the recent ban on a number of synthetic anti-coccidial additives.

As regards antibiotics, curative treatments only are permitted in restricted quantities in organic agriculture; their use as a growth factor is prohibited in this system. In view of the problems associated with antibiotic resistance, restrictive measures covering these products are gradually being adopted at Community level. The relationship between antibiotic resistance and selection pressure is complex. The use of antibiotics in organic agriculture solely for curative treatments may contribute to reducing antibiotic selection pressure.

4.2.4 Microbiological and parasitic risk

There are very few scientific studies available on the incidence of pathogenic bacteria and parasites in organic agricultural systems and in organic products. Whatever the system, the viral risk essentially concerns foods of plant origin contaminated by contaminated water. The risks associated with poor hygiene practices during the handling or processing of foodstuffs are not covered in this report.

Organic production methods are based on the implementation of specific practices, some of which may limit or induce the microbiological or parasitic risk to the animal itself, even, in the case of some pathogens, to the consumer of foods of plant or animal origin produced using these methods.

- Undoubtedly the ban in organic agriculture on the use of sewage sludge or wastewater as soil improvers eliminates these risk factors for crops and pasture;

- However, fertiliser use can be a source of contamination. Manure and slurry represent vectors for the spreading of microbial and parasitic agents, particularly where there is infestation on the farms from which they originate. Composting enables, by means of a rise in temperature for a sufficient time, the reduction or even elimination of unsporulated pathogenic bacteria. The resistance of parasites to composting varies depending on the free stage of the parasites (oocysts, eggs, larva). Bacterial spores probably survive composting;

- Organic livestock systems restrict the use of medical treatments and prioritise a health management system based notably on the selection of hardy breeds, access to free range, low stocking rates and pasture rotation of animals. Free range systems, based on open access or grazing, increase the probability of the animals' exposure to the different parasites and vectors, intermediate hosts and infectious agents which persist in the soil. These risks are not specific to organic agriculture but also concern conventional free range systems. However, if a farm becomes infested, the restrictive therapeutic approaches required by organic agriculture probably constitute a restriction on risk control in terms of certain pathogenic agents.

4.2.5 Genetically modified organisms

The use of GMOs and their derivatives is prohibited in organic agriculture. As result of this prohibition, the issues surrounding the potential risks from GMOs do not directly apply to organic products. They may only arise indirectly through accidental release originating from conventional GM crops, cross-contamination (c.f. AFSSA Opinion of 23 July 2001) and the difficulty of obtaining GM-free additives (vitamins, lecithins…).

4.2.6 Bovine spongiform encephalopathy

The prohibition of meat and bone meal in organic livestock systems and the existence of specific production and distribution channels restricting cross-contamination on farms probably contributed to limiting the direct emergence of this disease in organic agriculture. Moreover, the few and very rare

[17] The four growth factor antibiotics currently permitted are to be banned in 2006 and it is envisaged that anti-coccidials will be reclassified as veterinary medicines (some are currently permitted as feed additives).

cases of cows from organic livestock systems diagnosed with bovine spongiform encephalopathy in France have all been cows born on conventional farms where the contamination was discovered after their conversion to an organic system.

Organic systems, by proscribing the use of synthetic plant protection products, eliminate the human health risks associated with these products and contribute to a reduction in environmental pollution, particularly of water resources.

All the available studies show that the great majority of organic products contain no residues of the pesticides authorised in conventional agriculture.

In view of the low number of contamination incidents reported concerning organic products, product surveillance based on appropriate monitoring plans should be continued in order to identify environmental pollution and pollution resulting from cross-contamination or from misuse.

As regards mycotoxins, while the available data show variable levels of contamination but which are similar overall between the two production systems, the diversity of mycotoxins and the factors influencing their appearance requires an in-depth examination of these contamination incidents and the collection of new control data in order to ensure results are more representative.

Moreover, the production of a guide of good practices aimed at the agricultural sector as a whole and identifying the critical points in both systems in terms of this type of contamination should be encouraged.

Concerning nitrates, the ban of the use of synthetic nitrogenous fertilisers results in lower levels of environmental pollution. The available data show lower overall nitrate levels in organic vegetables. These results nonetheless need to be backed up by new studies.

The use of certain crop or livestock production methods is liable to limit or induce microbiological or parasitic risk without necessarily being specific to one production system.

• In terms of the fertilisation of soils and grassland, the ban in organic agriculture of the use of sewage sludge removes the risk of contamination associated with this practice. The use of livestock manure or slurry, whatever the production system, constitutes a vector for the spreading of microbial and parasitic agents (particularly when there is infestation of the farms from which they originate). The practice of composting, strongly recommended in organic agriculture, contributes to the reduction or elimination of some infectious agents if it is carried out properly.

• Free range livestock systems, whether organic or conventional, increase the probability of animal exposure to different parasites.

The restrictive therapeutic approaches recommended in organic agriculture limit the control of parasitic risk as a result of the prohibition on using preventive treatments and the emphasis on curative treatments (homeopathy and phytotherapy in particular), few of which have been evaluated in terms of safety and effectiveness for the recommended uses and for which the appropriate studies and research projects should be put into place.

The plant-based treatments and products offered to farmers should be submitted to a rigorous evaluation of the recommended uses within the regulatory framework for obtaining marketing authorisations, based on the submission of a supporting scientific and industrial dossier.

It remains difficult to quantify microbiological or parasitic risk due to the lack of available data. Although in the current state of knowledge, no reports have as yet been received of an epidemiological outbreak of microbiological or parasitic disease originating from an organic crop or livestock production system, it would be useful to implement a surveillance plan for the pathogenic agents which are most sensitive in terms of health risk to humans and to carry out studies to define better the impact of all the practices and measures employed in organic agriculture.

4.3 THE CONSUMPTION OF ORGANIC FOOD PRODUCTS

There are still very few consumption studies on organic food products. The data currently available enable certain features to be highlighted:

- Two categories of consumers of organic products are identifiable, occasional consumers (consumption of 1 to 5 different organic products per week) corresponding to almost one third of the general population and regular consumers (consumers of 6 different organic products per week) corresponding to less than 6% of the general population;
- Organic foods of plant origin represent 3% of all plant products consumed. Organic food products of animal origin represent 1.7% of all animal products consumed with the exception of eggs (3.5% of egg consumption);
- Data from the INCA survey indicate differences in the quantities of food consumed (irrespective of whether they are organic or conventional) between consumers of organic products (regular or occasional) and non-consumers of organic products.

It would be useful to include the full monitoring of purchases of organic products in the public system for surveying household food purchasing (the INSEE survey for example) in order to obtain more specific information on the consumption of organic products.

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