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Chemical safety of conventionally and organically produced foodstuffs: a tentative comparison under Belgian conditions

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Abstract

This paper goes through the chemical risks able to affect the organic and the conventional agro-food products. For each type of contaminant a tentative assessment has been made in considering not only the levels of exposure but also the toxicological data when available. When comparing both production systems with regards to food safety, it appears that, for the well-known toxicants (pesticides, nitrates), organic products present some clear advantages, but it is also recognized that natural toxicants need to be better identified within this mode of production. Environmental and food processing contaminants are present in both organic and conventional products. It is recommended to improve the monitoring programmes by paying more attention to the mode of production as well as to the whole array of relevant contaminants.

Keywords: Chemical contaminants; Organic agriculture; Conventional agriculture

1. Introduction

A growing part of the European population gives preference to organically produced agricultural products (i.e. in accordance with the European regulation on organic production EEC Reg. no. 2092/91), due to the alleged absence of chemical contaminants within this mode of production. The recent food crises which have struck Europe over the last years (BSE, dioxins, PCB, ...) have contributed to reinforce the establishment of organic production in lots of European countries: in 2000, about 3% of agricultural acreage was devoted to organic agriculture. It is, however, important to remind that organic agriculture does not keep within the limits of a production system in which one forbids (or reduces drastically) the use of certain chemical inputs such as fertilizers, plant protection products, veterinary medicines, etc ... but that this production system intends to respect more accurately a balance between man, production and environment. Of course, organic production aims at meeting health requirements but, in addition, it wants to meet global quality requirements, i.e. not only in integrating the organoleptic and nutritional properties of the produced food but also socio-economic and environmental aspects linked to the whole production system.

In this review we have tried to identify hazardous chemicals that could be present in foodstuffs taking into account all steps in the production of foodstuffs from the field to the fork. Then, we have performed a tentative risk assessment of both the conventional and organic modes of production based on known databases for residues and contaminants as well as on scientific studies published in the literature. For practical reasons

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we have mainly focused on the situation in Belgium and surrounding countries. We have also performed some comparisons with the situation in the USA where considerable efforts have been devoted to the analysis of pesticide residues databases.

Lots of studies published in the scientific literature cannot be used because the comparisons are distorted: inadequate sampling methods, a too large number of parameters to be considered, too large variability of the measured parameters. For the same reasons, there are numerous studies with contradictory results.

In some cases, it seems that organic products present specific risks because they are obtained according to "natural" or "home made" production modes (lack of professionalism of the growers, no clear hygienic requirements in the EEC regulation). On the other hand, the organic production is currently developing in such a way that it requires the move to a larger scale than the family farm (large scale trade of cereals and feeding stuffs within the organic food market, internationalisation of the exchanges). It is important to cope with this new scale within the business area of organic products because it brings new consequences for massive contaminations (e.g. the nitrofen case in Germany in 2002). Equally, it is important to know that what we call conventional also means several production systems, which have very different technical specificities (classic production with the requirement of intensive inputs but also alternative systems based on Integrated Pest Management (IPM), production under label or with market claims, production according to technical specifications set by the distribution sector). Hence, one must be aware that by distinguishing only two production modes (namely organic and conventional) one can adopt a much too simplistic behaviour with regard to the reality which can be much more complex.

2. Tentative comparison between the conventional and organic production systems

2.1. Pesticides and nitrates

Recent reviews provide information on pesticides residues found in foodstuffs obtained from conventional, organic and other production systems such as Integrated Pest Management (IPM). Table 1 summarizes results obtained in the USA and in Europe on a very large database (94 000 samples in the American database) as well in Belgium on a smaller dataset (a few thousands samples).

It appears from Table 1 that products from organic agriculture contain less pesticide residues than conventional ones. Products from IPM (Integrated Pest Management) hold an in-between position. However, the frequency of detection and the pesticide contents are, as a whole, higher in the American study than what they are in the European Union, for so far the official reports are considered (European Commission, 1999a). It is not possible however, to establish whether these differences are due to different plant protection practices or to some differences in the sampling and analysis methodology (longer or shorter list of traced molecules, higher or lower detection limit). This second hypothesis seems to be as much plausible as the first one when one sees that, depending on the nature of the database used in USA, the authors underline significant differences in the residue detection frequencies (less residues in the California DPT database obtained using less sensitive analysis method) (Table 1).

Even if the figures vary a lot in absolute values, all the databases show nevertheless the same trends and, when adequate breakdown has been applied according to the production methods, they agree on a lower presence of residues in the following order: organic agriculture < integrated pest management < conventional (intensive) agriculture.

Gross figures isolated from their context are meaningless: the rate of positive samples will increase, whatever the production method, if we stick to lowering detection thresholds and to widening the spectrum of the pesticides to be analyzed (bear in mind that the environmental pesticides can be present everywhere is small amounts). From a toxicological point of view, what is most important and most relevant is the respect of the maximal limits of residues (MLR). Let us remind that, over the last years, the exceeding percentage of MLRs was under 5% for all the European Union (in Belgium, for example, it was of 4.5% for the year 2000).

Globally, one should remain vigilant with respect to the problem of pesticide residues because the number of chemicals to trace is very high. The most commonly

Table 1
Pesticide residues: frequency of positive samples (i.e. above the limit of method detection) in various databases

	USA (Baker et al., 2002)			EU (European Commission, 1999a)	Belgium (AFSCA-FAVV, 2001)	
	USDA 1994–1999	California DPR 1989–1998	Consumers Union 1997	DG-SANCO 1999–2000	Federal State 2000	Large-scale distribution 1995–2001
Organic	23%	6.5%	27%			12%
IPM	47%		51%			
Conventional	73%	31%	79%	36–39%	46%	49%

used products are not the only ones to be concerned. One should, indeed, also pay attention to the old products that, in most cases, are no more authorized or, on the contrary, to the very recent ones, which are not yet integrated in the monitoring strategies currently under use. In addition, the recent experience of nitrofen in Germany has shown that no production system is totally free from accidental or fraudulent contaminations. In every case intensive controls are necessary safeguards to guarantee the production quality and safety.

According to Woese, Lange, Boess, and Bögl (1997), organic products contain less nitrates than their counterparts obtained with the conventional methods. Data obtained under Belgian conditions (provided from the large-scale distribution sector) permit to extract some interesting information on nitrate residues in conventional and organic productions as they are found on the Belgian market (AFSCA-FAVV, 2001). The mean value in nitrate content is 1703 mg/kg for the organic products and 2637 mg/kg for the conventional ones (significantly different at $p < 0.0001$). Nitrate contents are lower in organic broad-leaved vegetables mostly because, during winter, they are imported from Mediterranean countries (lack of sunshine in the rest of Europe). Since the absence of light is a well-known factor explaining nitrate accumulation in vegetables during winter (less photosynthesis), it is normal that locally produced vegetables show higher nitrate levels. For other goods such as potatoes, differences have not appeared.

2.2. Natural contaminants

It is feared that organic production could be more affected by mycotoxins (no use of synthetic fungicides) and by phytotoxins (plant defense mechanism against insect attacks, diseases or as a reaction to stress). Table 2 gives an overview of the most important mycotoxins and plant toxicants able to contaminate both organic and conventional productions under European conditions. Cereals and derived products are by far the most important agricultural commodities susceptible to be contaminated by mycotoxins in Belgium. Trichothecene contamination starts in the field as a consequence of *Fusarium graminearum* and *F. culmorum* attacks during flowering of the cereals. Wet weather years are known to accentuate contamination by DON (deoxynivalenol), one of the most important trichothecenes (European Commission, 1999b). The TDI of DON is set at 1 μg/kg b.w. and the proposed limit in unprocessed cereals is 750 μg/kg.

According to Jennings and Turner (2000), the use of fungicides belonging to the chemical group of triazoles (e.g. epoxyconazole, metconazole, tebuconazole) are able to decrease DON contamination by 30–50% when applied at full dose during the flowering of the cereals. This is not the case with other fungicides such as strobilurins which are commonly used to protect cereals against many fungal diseases during the vegetation period. Hence, a judicious use of fungicides may help to limit DON contaminations in a significant way. As far as organic productions are concerned, it is now demonstrated that characteristic traits of this mode of production will help to reduce the risks of contamination in the field (European Commission, 1999c). These are: long crop rotations, obligation to plough the soil (as a weed control technique), absence of maize as preceding crop. No use of growth regulators and better lodging are also common practices in organic agriculture that can help to prevent fungal infections. Last but not least, in conventional agriculture, some of the varieties commonly used are very sensitive to *Fusarium* attacks and to subsequent contamination by DON.

The reviews of published studies reporting contamination by trichothecenes (especially DON) of conventionally and organically grown cereals are contradictory (Tamm & Thürig, 2002). Some of the studies come to the conclusions that organic cereals are significantly more contaminated than their conventional counterparts while others come to the inverse conclusion. It seems, actually, that more recent data and systematic compari-

Table 2
Mycotoxins and other natural contaminants able to affect agricultural products under European conditions (Mediterranean countries not included)

Type of contaminant	Agro-food products that can be contaminated under conditions prevailing in Europe
Trichothecenes (DON, Zearalenone,...)	Cereals and cereals derived products such as flour, bread, muesli but also beer
Ochratoxin A	Cereals and cereal-derived products (even in some animal productions like pork meat—mostly in offal)
Patulin	Mostly in apple juice and, to a lesser extent, in other fruit juices
Toxic compounds in plants and crops (glyco-alkaloids, glucosinolates, furanocoumarins)	Toxins present in seeds from some weeds able to contaminate cereals, peas, etc Phytotoxins produced by plants under stress after fungal or insect attacks (potatoes, carrots)

sons performed on field trials under scientifically controlled conditions lead to a more favourable situation for organic cereals (Tamm & Thürig, 2002). This could be explained by the fact that, in the past, there were numerous organic growers and retailers who were less experienced and not really aware of good agricultural and manufacturing practices. As a consequence, some dramatic contaminations might have occurred in some farms especially during wet years.

Ochratoxin A (OTA) is a toxin produced by some *Penicillium* and *Aspergillus* species during the storage of the cereals. OTA contamination will be more intense when the grains are not sufficiently dry (i.e. 14% moisture or less). In Europe, the TDI for OTA is set at 5 μg/kg b.w. and the proposed limit is 5 μg/kg in unprocessed cereals and 200 ng/l in beer. It seems irrational to think that the use of fungicides could lead to reduced OTA contaminations of conventional cereals because the amount of residue at harvest is so tiny that no control can be made on the OTA producing molds. On the other hand, insect attacks during storage could favour fungal development in the inner part of the grains. When looking at the databases of cereal contamination by OTA, it also appears here that one can find contradictory results in the published literature. In Denmark, for instance, it has been observed that organic cereals (and especially organic rye) were much more contaminated, and this, more specifically during the wet years from 1986 to 1992 (Jorgensen & Jacobsen, 2002). Thereafter, an improvement of the situation has obviously taken place. Here again, one can think that the general improvement of the practices has contributed to avoid excessive contaminations in specific cases that were probably more frequent within the organic agriculture community. The production of spoiled agricultural goods, however, is not a prerogative of the sole organic sector. Czerwiecki, Czajkowska, and Witkowska-Gwiazdowska (2002a, 2002b), for instance, have shown, that atypical severe contaminations of cereals by OTA (up to 1000 μg/kg) in Poland could be linked to bad storage conditions in individual farms either from the organic (or in this case "ecological") or from the conventional side.

Beer can be considered as a product derived from locally or imported cereals (mostly barley but also wheat for the so-called white beers). Tangni, Ponchaut, Maudoux, Rozenberg, and Larondelle (2002) have recently conducted a survey on beers found on the Belgian market. From this study, it appears that the level of OTA contamination is very variable either in the organic or in the conventional brands. The highest variability was however found to occur in organic beer with one sample reaching a maximum level of 175 μg/l (proposed legal limit = 200 ng/l). Obviously, there is a need to increase the monitoring of beers taking into account the numerous factors able to influence the contamination and the large variability due to a high number of brands and brewing processes existing in some specific countries like Belgium.

Patulin is a common mycotoxin produced by *P. expansum* in apples. There are reports about studies carried out in Europe (France, Italy) mentioning that organic apple juices contain more patulin than the conventional products (Beretta, Gaiaschi, Galli, & Restani, 2000). However, it seems that the real problem lies more in the management of rotten fruits than in the intrinsic mode of production characterizing organic agriculture. Therefore, in a recent study carried out in Belgium (Tangni et al., 2003), attention was paid on the influence of several possible confusion factors such as industrial versus handicraft juices, clarified versus trouble juices, local versus imported juices and, to a lesser extent, organic versus conventional juices. All of the 43 samples analysed showed contamination levels under the legal norm of 50 μg/l and the mean content was of 9 μg/l. However, no significant differences could be found looking at the various factors able to affect contamination, even if it appeared that the mean content in industrial juices was lower than the one found in juices of handicraft origin (7.0 μg/l versus 14.6 μg/l, respectively). In addition, the number of organic juices (four) included in this study was too low to make valid comparisons. In contrast, in another study carried out in Belgium on 22 organic and 36 conventional apple juices, Baert, Kasase, De Meulenaer, and Huyghebaert (2003) reported that, whilst all samples were under the legal limit of 50 μg/l, the organic juices contained significantly higher amounts of patulin (mean = 33.4 μg/l in organic versus 8.1 μg/l in conventional). However, the latter results were not analysed with a focus on the industrial and handicraft character that could have led to an even more important difference assuming that the careful elimination of rotten fruits is the key factor controlling apple juice contamination by patulin.

2.3. Environmental contaminants

Heavy metals, dioxins and PCB are some of the most important chemicals that are found in the environment, especially in the most densely inhabited and industrialized countries (Northern Germany, The Netherlands, Belgium, . . .). Recent studies have shown that the exposure of the population through the consumption of food could lead to health problems for some parts of the population (Ahmed, 1999; Wells & de Boer, 1998). Some examples of agricultural products at risk are presented in Table 3.

It is noteworthy to mention that both conventional and organic modes of productions are at risk. It seems, however, that in some instances organic food might present an increased level of risk. It has indeed been established that eggs produced by hens in free range (which

Table 3
Environmentally transmitted contaminants and nature of the agro-food products that can be contaminated

Type of contaminant	Agro-food products that can be contaminated
Heavy metals	Mostly in urbanized and industrialized zones Both production systems are vulnerable
Dioxins	Mostly in urbanized and industrialized zones Both production systems are vulnerable (especially animal products) Free range poultry and eggs may contain more dioxins than under indoor production Special exposure due to fish consumption
PCBs	Mostly in urbanized and industrialized zones Both production systems are vulnerable (especially animal product) Special exposure due to fish consumption
Environmental pesticides (DDT, drins, HCH,...)	Mostly animal products (milk, meat, fish) due to bioaccumulation Both production systems are vulnerable
PAH	Mostly in urbanized and industrialized zones Both production systems are vulnerable Problems with some modes of cooking and preservation (barbecuing, small scale curing)

constitutes the rule in organic agriculture) contain more dioxins due to a more intense contact with the soil, which is an important sink for this kind of contaminant (Fürst, Fürst, & Wilmer, 1993; Pussemier, Mohimont, Huyghebaert, & Goeyens, 2004; Schuler, Schmid, & Schlatter, 1997).

2.4. Contaminants produced during food processing or released from package

Some characteristic contaminants produced during the processing of foodstuffs or released from packaging materials are presented in Table 4. It seems, from the data summarized in this table, that either the conventional or the organic modes of production can be affected by the presence of such contaminants. Some of them have been known for a long time (polyaromatic hydrocarbons (PAH) and nitrosamines) while others such as acrylamide are newcomers as food contaminants (European Commission, 2002). This chemical is classified as probably carcinogenic for man; it is produced during cooking processes requiring high temperature, whatever the food production system. The production of PAH (carcinogenic chemicals) is a similar problem even if, here, one can think that the traditional or home-made production methods are more particularly at risk (bad control of the temperature in barbecues, for example). It is also noteworthy to mention that the organic sector prohibits the use of certain materials such as aluminium but encourages the use of recycled packaging materials that could lead to contamination by some heavy metals and/or endocrine disruptors.

3. Discussion

Pesticides are mostly used in conventional systems but the products of natural origin that are allowed in

Table 4
Contaminants specific to packaging, transformation and preparation of food

Type of contaminant	Contamination conditions and links with some production systems
Heavy metals	Old ceramics, ancient instruments and earthenware crockery used in the kitchen (tagines, tea pot made from Pb)
Nitrosamines	• Produced during curing, drying and other processes with foodstuffs (true for organic as well as for conventional)
Chemicals released from packaging materials	• For both conventional and organic systems, contamination after contact with plastic materials (phtalates, bisphenol A, ...) or recycled paper and cardboard (dioxins, heavy metals) • In organic system, Al and PVC materials are forbidden but recycling of packaging is favoured
PAH	• All production systems are vulnerable • Mostly in urbanized and industrialized regions • Care with some cooking and preservation processes (barbecuing, curing)
Acrylamide	• Favoured in both production systems by cooking processes requiring elevated temperatures (frying, oven-baking)

Table 5
Hazard characterization for some characteristic chemical contaminants; estimation of their intake via food and links with the production system (conventional or organic)

Type of contaminant considered	Hazard characterization	Estimation of the intake via food	Comments related to the production system and/or environment
Pesticides	Large knowledge available (registration dossier); ADI determined for each authorized pesticide	Globally less than 1% of ADI	Essentially in conventional; only traces of synthetic pesticides in organic; high amounts of natural pesticides can be present in organic
Nitrates	ADI value available but still controversy due to possible confusing factors (e.g. role of microbial contamination on nitrite production in baby food)	~20% of ADI	Less in organic (especially for broad-leaved vegetables in winter time)
Mycotoxins	TDI available for the best studied toxins; large uncertainties for a large number of less studied chemicals	Evidence for some exceeding of TDI for some toxins in some vulnerable consumer's groups.	Both systems are comparable provided that good agricultural and manufacturing practices are respected
Phytotoxins	Toxicological data available for some well studied toxins; large uncertainties for a large number of less studied chemicals	Evidence that intake levels for some toxins might present adverse effects for some vulnerable consumer's groups (e.g. phyto-oestrogens and infants)	Evidence that organic products present higher contents but global effect on health is still unknown (either beneficial or adverse effects can be expected from glucosinolates, phyto-oestrogens, ...
Heavy metals	Toxicological studies available; TDI determined for the most relevant compounds; uncertainties related to chemical speciation	Evidence for some exceeding of TDI for some chemicals (Cd, Pb) in some industrialized regions of Europe	Globally same impact on organic and conventional systems; Additional intake of Cu can be expected for consumers of organic products; Specific problems could arise in industrialized regions
Dioxins and dioxin-like compounds	Toxicological studies available for 2, 3, 7, 8-TCDD; Group toxicity for other congeners assessed using equivalent factors; WTI (Weekly Tolerable Intake) proposed for the group of dioxin-like chemicals	Evidence for some exceeding of TDI for excessive consumers of fish, milk and meat products in Europe	Globally same impact on organic and conventional systems; Specific problems could arise in industrialized or densely inhabited regions. Some evidence that eggs from free range hens may be more contaminated
PAH	Genotoxicity established for specific chemicals of the group	Exposure must be reduced as much as possible (ALARA)	Globally same impact on organic and conventional systems Importance of some risky practices during, ...
Acrylamide	Possible carcinogenic chemical; Lack of information about toxicological properties when present as food contaminant	Exposure must be reduced as much as possible (ALARA)	Globally same impact on organic and conventional systems
Chemicals released from packaging materials	Largely unknown; Still a lot of unidentified chemicals; Possible endocrine disruption effects (oestrogen-like chemicals)	More information on intake needed	More information needed on risks linked to recycled packaging materials

organic farming are not necessarily totally innocuous for man or for the environment (e.g. accumulation of copper in terrestrial environments). In addition, some chemicals are used at very high dosage (sulphur) and little is known about the long-term toxicity of some plant extracts. Moreover, piperonyl butoxyde, a synthetically obtained synergist used to increase the efficacy of pyrethrins, is regularly found in organically grown vegetables in Belgium (AFSCA-FAVV, 2001). In addition, it is noteworthy to mention that, even for organic products, there is a possibility of slight contamination by pesticides entering the food chain via the environment (e.g. organochlorine pesticides) or other routes of exposure to pesticides (e.g. spray drift from adjacent fields).

The presence in lower quantities of pesticides in organic productions is not a decisive advantage as far as food safety is concerned when one knows about the strict norms imposed on conventional productions enforced by the current regulations. If no exceeding the ADI value can be considered as a good guarantee of safety, then one can argue that conventional food will not present a real risk because the general exposure is mostly less than one percent of this value. In addition, it must be remembered that the residues are determined on the raw commodities before any culinary treatment (such as pealing, blanching, cooking,...) which are known to further reduce the residue levels in the food to be eaten by the consumer.

The reduction of the exposure to nitrates through consumption of organic vegetables might be more relevant because vegetables represent an important exposure route compared, for example, to drinking water and because the intake is rather high compared to the acceptable dose (ca 75% of ADI according to the Danish Food Authority (2000)).

Some organic productions and especially the home-made (or artisanal) products have been proved to have bigger contaminations from biotoxins (such as mycotoxins). An example is the presence of patulin in apple juice. Research, however, is not developed enough to accurately quantify this impact. Generally speaking, one can say that, for mycotoxins (and especially for Fusarium toxins), the most important elements for preventing contaminations are linked to agricultural factors (type of rotation, choice of varieties) and the respect of good practices in the farm (elimination of rotten goods, good preservation conditions). It is unfounded to assert that the absence of plant protection products systematically leads to a higher mycotoxin contamination (European Commission, 1999c).

Concerning other biotoxins, such as phytotoxins, which might be present in higher concentrations in varieties privileged in organic production due to their resistance properties against pests, it is not obvious at all to state that they are advantageous with regard to the consumers health because some of these substances can be toxic for man (e.g. glyco-alkaloïds in potatoes) and others have ambivalent effects (e.g. the glucosinolates and phyto-oestrogens which can altogether be health beneficial (protection against cancer) as well as have harmful effects (goitrogenic effects, hormonal disruption, cancer induction).

As to the contaminants transmitted by the environment, the two types of production globally seem equally sensitive. These chemicals (PCB, dioxins, heavy metals) seem to be very relevant as far as food safety is concerned considering that the exposure via the food chain is very close, or even exceeds the tolerable intake threshold derived from the toxicological studies. One must also point out that for certain animal productions requiring access to outdoor environment, risks can be higher in the organic system. The real situation, however, still needs to be further assessed. Indeed, while there is evidence that organic eggs might contain more dioxins than their conventional counterparts, it has been shown in Belgium that the egg contamination by dioxins is much more a problem for hobby breeders than for organic farms.

With respect to downstream processes, the two production methods hold risks due to the exposure to some contaminants that can be introduced during food processing, storage or packaging. Whilst aluminium is forbidden in organic production, other risks may stem from the use of recycled products. The estimation of the real risks linked to certain characteristic contaminants (e.g. phtalates, bisphenol A diglycidyl ether (BADGE),...) is still not very developed today (possible disruptions within the endocrine system, oestrogenic effects).

A summary of the risks linked to the presence of contaminants is proposed in Table 5 considering all main types of contaminants together. From this table it can be concluded that organic products present some additional advantages in the case of some well-known contaminants (nitrates, pesticides) but for which the safety margins are already very important in conventional agriculture. For other contaminants such as natural toxins and chemicals released downstream in the food production process, there are still uncertainties about the hazards while exposure could be higher for some organic productions (larger amounts of some less studied plant chemicals and of some compounds released by recycled packaging materials).

4. Recommendations

Owing to the scarcity of available objective information today (scientific studies, official monitoring programs) regarding the presence of certain residues according to the mode of production, it would be useful to gather more accurate information in order to establish a better picture on the presence of residues. It will be necessary to not only take into account production inputs which were shown to be present in fewer amounts in organic foodstuffs (pesticides, veterinary medicines, antibiotics, fertilizers), but also to consider other very relevant contaminants like those either produced by living organisms (mycotoxins and other biotoxins) or those transmitted by the environment (organochlorinated pesticides, PCBs, dioxins, heavy metals) as well as during food processing/packaging (PAH, acrylamide, endocrine disruptors). This can be done by implementing either global or targeted monitoring programmes. Hence, following recommendations can be made to the authorities responsible for food control:

(1) Adapt the sampling plans in order to be able to take into account the various modes of production and integrate more items in the databases dealing with

the analysis of contaminants. This is needed to improve the traceability of the samples (more information on the mode and on the place of production of the analyzed samples).

(2) For the various productions with certification and (or) market claims, there is a need to widen and adapt the controls in order to be able to better assess the global quality of the foodstuffs. It is important, for the consumers, to be well informed on the actual content in residues for these various production methods. This holds not only for nitrates and pesticides (being synthetic or natural) but also for other relevant toxicants such as biotoxins and environmental contaminants.

(3) It is also recommended to collect more information on the occurrence and toxicity of mycotoxins, phytotoxins and other natural toxicants that could be relevant for the consumer's health, and to adapt the monitoring programs accordingly.

(4) More information is needed on the hazard identification and characterization as well as on the intake of food-processing and food-packaging chemicals with a special attention to recycled materials (paper, cardboard) that are preferentially used in the organic production system.

(5) The authorities should show a particular interest in the communication of information towards the consumers. The complexity in the field of food safety is such that appropriate means must be used in order to inform the public in the most neutral and complete way.

(6) Finally, it would be advisable to continue, at the European and international levels, the efforts of harmonization as well as the efforts for methodological improvements about the detection of residues (pesticides, mycotoxins, environmental contaminants). It is indeed very important that common criteria are set concerning the detection limits, the list of molecules to analyze and the sampling methods.

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