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# Advances of organic products over conventional productions with respect to nutritional quality and food security

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ABSTRACT

Organic products are derived from the organic production system, following organic agricultural cultivation standards, and processing schedules must be identified by an independent certificate authority. The main characteristic of the organic agricultural production system is that all artificial synthetic materials such as pesticides, fertilizers, growth regulators, feed additives, and gene engineering products are not allowed to use. However, there is much debate on organic production quality and health safety issues in academic circles. Some people believe that there is a "Three Cannot" problem with organic production, that is, organic products "cannot be distinguished, cannot be tasted and cannot be measured" compared to common ones. To objectively reflect the differences in nutritional quality and food safety between organic and conventional products, we combined extensive literatures with our research data and have reported some advances in the sensory quality, nutritional value, and safety of the two types of products. The results showed that organic products tasted better; the percentage of leanness was higher, and the products tasted much tender. The dry matter content of most organic crops was about 7–20% higher than that of conventional foods, and enriched vitamin C, anthocyanins, isoflavones, carotenoids, and other phenolic compounds and more elements such as P, Fe, and Mg and trace elements such as Zn, Cu, and Cr were verified in organic crops. Organic animal products contain more beneficial polyunsaturated fatty acids; the nitrate content in organic fruits and vegetables was 20–50% of that in normal fruits. No pesticide residues and less heavy metals were found in the organic products. Our investigation showed that there were obvious differences in quality and safety between the products that originated from organic agriculture systems and conventional alternatives. This conclusion can provide an important theoretical basis for the healthy development of the organic industry.



Organic products are derived from the organic production system, which are produced and processed according to the international standards of organic agriculture, with the products being certified by an independent certificate authority [1]. The essential requirements of organic production are: (1) none applications of organisms and products that generated from genetic engineering; (2) none usage of chemical synthetic pesticides, fertilizers, growth regulators and feed additives, etc.; (3) applying a series of sustainable agricultural technologies and maintaining stable agricultural production system based on natural rules and ecological principles [2].

Organic foods have obvious advantages in promoting human health, ecological protection and biodiversity maintenance, and thus have been widely accepted by consumers especially consumers in developed countries [3]. The data from FiBL-IFOAM of 2016 showed that, global market capitalization of organic foods had reached 800 billion dollars. There are 172 countries that produced certified organic foods and the total producing area has reached 4.37 million hectares, with 2300 thousand farmers engaging in organic farming [4]. Because of natural sources, rich nutrition, high quality and safe environmental protection, consumers from all over the world tend to buy organic foods. In the United States, for instance, though organic products are 30–60% more expensive than conventional ones, organic food have still accounted for 4% of the nation's food sales [5]. In China, the price of organic products is 2.5–3 times of the conventional ones [6].

Developing organic farming in China is facing serious problems, mainly including organic certifications lacking management, and the organic market is disturbed by fake and poor quality products, which hits the consumers' confidence. More seriously, consumers are short of awareness of organic foods, and lack direct communications with organic producers, resulting in mistrusting organic producers and operators. All the obstacles have restricted the development of organic agriculture eventually [7]. Even for the quality and food safety of organic

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products, the academic circles have no agreed conclusions [8–9]. In April 2009, Quality Low Input Food Report of European Union summarized the research data of five years and found significant differences in grains and livestock under organic and conventional production systems. The main differences included (1) organic food contained more beneficial nutrition such as vitamins, polyunsaturated fatty acids, antioxidants, etc.; (2) organic food had lower levels of heavy metals, fungal toxins and pesticide residues [8]. On the contrary, Spangler from Stanford University analysed the differences in vitamins and nutrients of organic and conventional grains, vegetables, fruits, meats, poultry, eggs, milk, through reviewing 223 studies. Unfortunately, he found that "The published literature lacks strong evidence that organic foods are significantly more nutritious than conventional foods" [9]. Further research is needed for revealing the truth in terms of nutrition, ecological conservation and food safety.

China has successfully fed 20% people of the world with <7% of the world's cultivated lands, however consumed 35% of the world's chemical nitrogen fertilizer and 70% of the world's agricultural water resources [10]. The continuous food supplying capacity of China is severely restricted by the result of widely applying chemical fertilizers rather than nourishing the land, leading to farmland's hardening and acidification [11–13]. In recent years, a series of food safety incidents have come to light, and people tend to pay increasing attentions to the relationships between food nutrition and health [14]. To scientifically solve the problems of food quantity and food safety, we must separate the food for human from those for animals. For human food supply, we should adopt organic agricultural measures, improve agricultural products, and reduce the production and consumption of chemical fertilizers, pesticides and agricultural films [15]. While to correctly guide the development of organic industry, we must illustrate with facts by using a scientific attitude and avoiding subjective judgment. We therefore focus on studying the sensory quality, nutritional value, and safety aspects of agricultural products. We have combined extensive literature with our research data to prepare this report, hoping to provide a scientific basis for the development of organic agriculture, especially in China.

## 1. Differences of sensory quality between organic products and conventional products

Sensory qualities such as shape, color, taste, smell and homogeneity are the most intuitionistic descriptions and judge indexes for food quality. Studies have found that, in comparison with the past, the tomato's sweetness has dropped from 3.24 to 2.77 and sugar content decreased from 5.29% to 4.85%, while the firmness has increased from 6.86 to 12.1 [16]. The main reason is that people pursue high yield and increase chemical fertilizers' dosage and shorten the mature period of fruits and vegetables through artificial ripening, violating the plants' natural growth laws. Compared with conventional fruits and vegetables, in despite of inconsistence in appearance and even insect bites, organic fruits and vegetables grow following natural principles, absorb macroelements and microelements from organic fertilizers, and produce natural food with "good taste". The "good taste" is derived from nature, and what the customers eat is the most natural parts [17–19]. Some reported that the contents of soluble sugar, organic acid, aromatic compound in organic apples are higher than that in the conventional ones, and as a consequence, organic apples smell and taste better [20–21]. Some also found organic potatoes have lower browning degree and taste much more brittle after frying compared with conventional ones [22]. Instead, some still argued that there were no differences in sensory quality between organic and conventional grains [23]. For instance, Tobin et al. employed volunteers to judge the sensory quality of 9 fresh organic and conventional vegetables and fruits, and found no obvious differences existed between organic and conventional products [24]. Even through, organic poultry farming is allowing the poultry grow in the natural environment, breathe fresh air and feed on natural-source food such as insects, earthworms, seeds and tender leaves. The organic poultry have delicate and compact flesh, and the eggs taste better [25].

## 2. Differences in nutrition between organic and conventional products

### 2.1. Dry matter content

Dry matter is accumulated through the plant photosynthesis, which is the rest of the organism after being fully dried under constant temperature of 60–90 °C. Dry matter is an important indicator for measuring organic matter's accumulation and nutrition composition, including starch, cellulose, protein, fat, inorganic minerals, etc. It was noted that organic fruits and vegetables contained higher content of dry matter than the conventional ones [26–28], which may due to the fact that conventional plants which grow consuming excessive chemical fertilizers need absorbing more water [28]. Nevertheless, there are also studies found that dry matter in organic products was less than that in the conventional ones. For instance, Huber et al. compared dry matter content of 19 organic and conventional fruits and vegetables, in which only 10 showed that organic products had 20% higher dry matter content [29]. By contrast, Gastol et al. noted that in comparison with the conventional products, dry matter content was higher in organic pears, black currants, beetroots and celeries, but lower in organic carrots and apples [30]. Brazinskiene et al. revealed that conventional potatoes contained much more dry matter than the organic ones (Table 1) [31]. The above mentioned debates may be due to the fact that different results may be associated with different crop types.

### 2.2. Proteins and amino acids

Protein is the material basis for life which is the most important material for forming cells. Protein consist of 20 kinds of amino acids in different composition, among which there are 8 essential amino acids that must be supplied by food. In organic farming system, due to the insufficient supply of nitrogen fertilizer, the protein content in organic products is somewhat lower than that in conventional ones. However, some studies found that organic products had high protein content, which maybe because the metabolism of plants was driven towards the process of increasing some essential amino acids when the nitrogen source was limited [32]. Protein content is not the only indicator reflecting the crop quality. High quality protein should be digested easily and contain human body essential amino acids. Vrcek et al. compared the protein content and its digestibility between organic and conventional wheat flour and found, the organic wheat flour had 14% and 17% lower average protein content than the conventional separately, but had 2.9% and 5.1% higher protein digestibility than the conventional one [33]. Carillo et al. discovered that the organic potatoes powder ($7.0\ g \cdot 100\ g^{-1}$) not only contained 1.49 times higher protein content than the conventional ones ($4.7\ g \cdot 100\ g^{-1}$), but also had 25.7% richer total amino acids over the conventional. The former contained more alanine, arginine, asparagine, aspartic acid, glutamic acid and other amino acids [34].

**Table 1**
Dry matter content of organic and conventional vegetables and fruits.

| Material | Dry matter content (%) | | References |
|---|---|---|---|
| | Organic | Conventional | |
| Pear | 12 | 11.2 | Gąstoł et al. (2011) [30] |
| Blackcurrant | 15.2 | 12.6 | |
| Beetroot | 12.2 | 8.3 | |
| Celery | 10.4 | 8.9 | |
| Carrot | 9.7 | 10.4 | |
| Apple | 12.4 | 13.4 | |
| Potato | 22.1 | 23.4 | Brazinskiene et al. (2014) [31] |

**Table 2**
Comparison of the total phenolic content in organic and conventional fruits and vegetables.

| Materials | The total phenolic content | | References |
|---|---|---|---|
| | Organic | Conventional | |
| Tomato/(mg 100 $g^{-1}$ FW) | 51.74a | 45.35a | Hallmann et al. (2013) [47] |
| Tomato/(mg gallic acid equivalents 100 $g^{-1}$ FW) | 12.13 ± 0.31a | 9.87 ± 0.22b | Vallverdú-Queralt et al. (2012) [48] |
| Tomato/(mg gallic acid equivalents 100 $g^{-1}$) | 196.00 ± 1.00a | 149.00 ± 4.00b | Vinha et al. (2014) [49] |
| Potato/(mg 100 $g^{-1}$ DW) | 355.00 ± 28a | 292.00 ± 18b | Lombardo et al. (2012) [22] |
| Eggplant/(mg $g^{-1}$ FW) | 13.64 ± 0.83a | 11.61 ± 0.46b | Luthria et al. (2010) [50] |
| Strawberry/(mg gallic acid equivalents 100 $g^{-1}$ FW) | 260.00 ± 0.20a | 288.00 ± 0.20a | Crecente-Campo et al. (2012) [51] |
| Grape/(mg/kg) | 982.00 ± 58.97a | 973.10 ± 57.00a | Muleroa et al. (2010) [52] |
| Blueberry/(mg 100 $g^{-1}$FW) | 319.3 ± 36.44a | 190.3 ± 31.37b | Wang et al. (2008) [53] |
| Peppermint/(mg gallic acid equivalents $g^{-1}$ FW) | 190.90 ± 0.3a | 191.80 ± 10.2a | Lv et al. (2012) [54] |

Different lowercase in the same line indicate significant differences between the organic and conventional products ($P < 0.05$). Data are means ± standard error.

### 2.3. Lipids

Difference in lipid is mainly reflected in the quality of meat and dairy products. Polyunsaturated fatty acid has essential physiological functioning to human body, such as regulating the lipid metabolism, preventing and treating centrum cerebrovascular diseases. Some noted that organic beef and mutton contained richer polyunsaturated fatty acid in contrast with the conventional ones [35–36]. Organic pork had more lean meat and tasted tender [37]. A Meta-analysis on dairy products revealed that organic milk had much higher content of polyunsaturated fatty acid [38]. Organic milk also contained much more beneficial fatty acid for human health, including polyunsaturated fatty acids, conjugated linoleic acid, linolenic acid, trans-11-acid and trans-18-octadecenoic acid [39–41]. In addition, some further confirmed that organic dairy products had more phytane acid and pristanic acid which are essential for human body and vital for reducing the cardiovascular diseases [42].

### 2.4. Phenolic compounds and antioxidants

Phenolic compounds are plant secondary metabolism compounds that combined by one or more of the aromatic with one or more hydroxyl, including flavonoids (anthocyanins, flavonol, flavonoids, etc.), terpenoids (carotenoids, lutein) and nitrogen compounds (glycoside, amines, alkaloids, etc.) [43]. Numerous studies showed that organic fruits and vegetables contained a wide variety of phenolic compounds and antioxidants [31,44–46], which could help enhance human immunity, eliminate free radicals and have positive functions in anti-cancer and immunomodulation. Table 2 shows that total phenols content in organic products are higher than those in the conventional ones. By the way, there are still some researchers argued that the total phenols content of organic strawberry and peppermint were lower than those of the conventional ones [22,47–54]. In terms of researches on tomato's phenolic compounds, organic tomatoes had higher content of quercetin, naringenin as well as resurrection lily phenol than the conventional products (Table 3). These substances are powerful antioxidant, and play vital roles in anti-cancer and anti-bacteria [47–48,55].

Soybean isoflavones have obvious anti-tumor effects, especially for resisting the tumor associated with hormone, which could increase the activity of antioxidant enzymes in blood and organizations. Some demonstrated that isoflavones content in transgenic soybean (1.87 mg $g^{-1}$) was significantly lower than that in the native soybean (4.78 mg $g^{-1}$) [56].

Anthocyanin is a natural anti-aging nutrient, which is the most effective antioxidant ever found, and could slow the body's aging, alleviate eye fatigue as well as improve eyesight [57]. Some investigators found that organic grapes' anthocyanin content (700.0 mg/kg FW) was 2 times of the conventional ones (329.6 mg/kg FW) [52]. The studies on blueberry showed the same tendency [53].

Carotenoid is a class of natural pigment, which consists of the carotenoid and lutein. The human body can't synthesize carotenoid otherwise uptakes it through food, in which the fruits and vegetables are main source. Carotenoids play important roles in anti-cancer, anti-oxidation, eyesight and skin protection as well as osteoporosis prevention [58]. Fig. 1 shows that organic *Capsicum annuum* has larger content of β-carotene and lutein than the conventional one, with the tendency being the same in different years [59].

Wang et al. compared oxidation resistance of 8 organic and conventional vegetables by DPPH method, and found that the free radical clearance rate of organic eggplant, peppers and spinach was obviously higher than that of the conventional ones [60]. Some further discovered that the free radical clearance rate of organic tomatoes was 1.47 times of the conventional one [48]. Some found the oxidation resistance of organic blueberry was 50% higher than that of the conventional through ORAC method [53]. However, some still persisted the contrary conclusion with the same method. They argued that the conventional blueberry showed higher oxidation resistance in peel, flesh and seed than the organic blueberry [61].

### 2.5. Vitamins

Vitamins are the essential nutrients for maintaining human body's normal physiological function, and mainly include water-soluble vitamins and fat-soluble vitamins. Water-soluble vitamins mainly refer to vitamin C, a kind of antioxidant essential for human body, which is only taken from fresh fruits and vegetables. Woese et al. reviewed >150 research articles and found 50% articles reported that the organic products contained more vitamin C, especially in the leafy vegetables [62]. Organic celery had 31% higher vitamin C content than the conventional ones, and broccoli as well as edamame showed the same

**Table 3**
Comparison of flavonoid content in organic and conventionally produced tomato.

| References | Quercetin | | Naringenin | | Kaempferol | |
|---|---|---|---|---|---|---|
| | Organic | Conventional | Organic | Conventional | Organic | Conventional |
| Mitchiell et al. (2007) [55]/(mg $g^{-1}$ DW) | 115.8 ± 8.0a | 64.6 ± 2.49b | 39.6 ± 1.58a | 30.2 ± 1.57b | 63.6 ± 5.21a | 32.06 ± 1.94b |
| Vallverdú-Queralt et al. (2012) [48]/(μg $g^{-1}$ FW) | 3.83 ± 0.51a | 1.63 ± 0.22b | 61.25 ± 2.33a | 42.93 ± 2.93b | 29.60 ± 1.60a | 19.18 ± 1.32b |
| Hallmann et al. (2013) [47]/(mg 100 $g^{-1}$ FW) | 1.02 ± 0.02a | 0.90 ± 0.08b | – | – | 0.42 ± 0.20a | 0.44 ± 0.17a |

Different lowercase in the same line indicate significant differences between the organic and conventional products ($P < 0.05$). Data are means ± standard error.

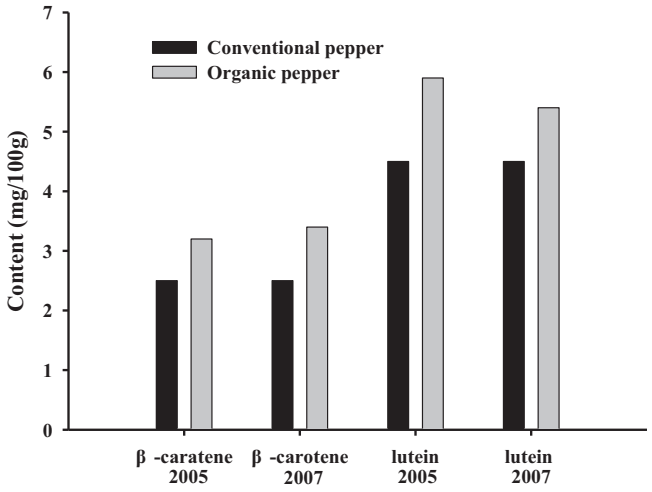


**Fig. 1.** The carotenoid content of conventional and organic pepper [59]. Different lowercase indicate significant differences between the organic and conventional products ($P < 0.05$). Data are means ± standard error.

differences [63]. The vitamin C content in organic tomatoes, turnips, kale and broccoli, bell peppers was markedly larger than that in the conventional ones, and the biggest gap is 3 times (Table 4) [64]. However, there are also some investigations that found no differences between organic and conventional strawberry [51] and tomatoes [47]. With respect to the fat-soluble vitamins and carotenoids, some studies found that organic carrots had higher level of β-carotene [65], and organic milk had richer vitamin E and β-carotene [41].

### 2.6. Mineral elements

Mineral elements are the essential structural materials for human body tissues, sustaining life as well as normal metabolism. The human body could hardly use the inorganic minerals from the natural environment and must obtain them from food. Previous studies have found that organic products had higher contents of P, Fe, Mg, Zn, Cu, Cr [45,62]. We assessed the mineral element contents in summer corn grain, and found that in comparison with the conventional corn, the organic one contained remarkably higher content of P, Mg, K, being 30%, 20% and 30% higher respectively ($P < 0.05$). The organic corn had higher content of Zn, Fe, although the differences were not significant ($P > 0.05$). The conventional corn grain contained notably richer S and Mn than the organic one by 15% and 17% higher, respectively (Fig. 2). Some also found that compared with the conventional products, organic wheat flour had more K, Mg, Zn, Ni, Mo [33]. Organic broccoli, kale, green peppers, lettuce contained higher content of K, Ca, Mg, P, Mn and Cr [64–66]. Organic tomatoes had richer K, Ca, Zn by 4.5%, 129.8%, 65.4% individually [67]. Organic black sesame had 58%–132% richer content of K, Mg, Ca, Na, P, and 21%–554% richer contents of Cu, Fe, Cr, Zn, Si, Sr as well as richer Al, Ba, Ti by 40%, 48%, 566%, respectively than the conventional one [68].

**Table 4**
The vitamin C content in the organic and conventional vegetables.

| Material | Vitamin C (mg 100 $g^{-1}$ FW) | | References |
|---|---|---|---|
| | Conventional | Organic | |
| Wheat radish | 27.1 | 21 | Song et al. (2009) [64] |
| *Brassica oleracea* | 120.8 | 51 | |
| *Brassica alboglabra* | 94 | 76 | |
| Sweet pepper | 131.7 | 72 | |
| Tomato | 21 | 19 | |

Studies on the mineral elements in egg products demonstrated that, in contrast with the conventional ones, the organic eggs had higher content of Zn, Co, Cr in yolk as well as higher content of Se, Zn, Mn, Cu and Cr in egg white [69]. On the contrary, the contents of P and Zn in organic eggs were lower than those in the conventional ones, however there were no significant differences in terms of Ca, Fe and Cu [70]. Besides, organic milk had higher content of Cr and Fe than the conventional one by 65% and 13%, respectively [71].

## 3. Harmful substance

### 3.1. Nitrate

The conventional farming system consumes larger amount of synthetic chemical fertilizers, part of which couldn't be absorbed by plants. Otherwise, the chemicals will remain in the environment, enter into the soil and groundwater, and or release into the air as greenhouse gas, which cause adverse effects on human health. Nitrate can be converted into nitrite. After entering human body, nitrite could oxidize low hemoglobin into hemoglobin and cause acute intoxication as well as cancer. In the daily diet, human uptake 80% nitrate from vegetables. Studies showed that the content of nitrate in organic vegetables and fruits was 50% lower than that in the conventional ones, especially in leafy vegetables [72–74]. As is shown in Fig. 3, the nitrate content in 4 kinds conventional vegetables was 3–5 times of that in organic ones [59]. Some found that the nitrate content in organic carrot and celery was obviously lower than that in the conventional ones [63]. The same result was noted in potatoes, lettuce and tomatoes [22,66]. In the research on lettuce, potato, carrot, leek, beet and spinach, the results showed that in comparison with chemical fertilizers, organic compost could decrease the nitrate content in vegetables [74]. Nevertheless, there are also some reports found no obvious differences existed between the organic and conventional products [75–76].

### 3.2. Heavy metals

Heavy metals refer to the metal elements whose density are over 6.0 $g/cm^3$. Arsenic has the properties of metals, so it is treated as one of the heavy metals. Heavy metals could accumulate after entering the human body through food chain, and cause chronic impairment without being detected. In the conventional farming system, most of the chemical fertilizers, pesticides and fodders contain heavy metals. Exceeding heavy metals could result in memory loss, damaging the nervous system, increasing the cancer risk and infertility. Because organic farming strictly forbids applying the harmful materials to the agricultural ecosystem, so the content of heavy metals in the organic products is relatively lower. Studies showed that Cd and Pb content in organic wheat flour were significantly lower than that in the conventional one, by 50% and 95% separately, while the differences in Al and As were not notable [33]. It was also noted that the Pb content in organic lettuce, pepper and tomato was lower than that in the conventional ones [66].

### 3.3. Mycotoxin

Mycotoxin is the secondary metabolites produced by the fungus. It has a strong toxicity and carcinogenic, teratogenic and mutagenic effects, mainly including aspergillus toxin (AF), corn gibberellic ketene (ZEN), deoxynivalenol solution (DON), HT-2 toxin and T-2 toxin. The organic farming system applied organic compost, and forbade pesticides, antibiotics, thus may increase the probability that plants being damaged by microorganisms and pathogens. However, according to FAO2000 report, it seemed that no obvious differences existed between organic and conventional farming systems [77]. Even through, some found that the average contents of ZEN and ochratoxin A (OTA) in the conventional wheat flour were higher than that in the organic products

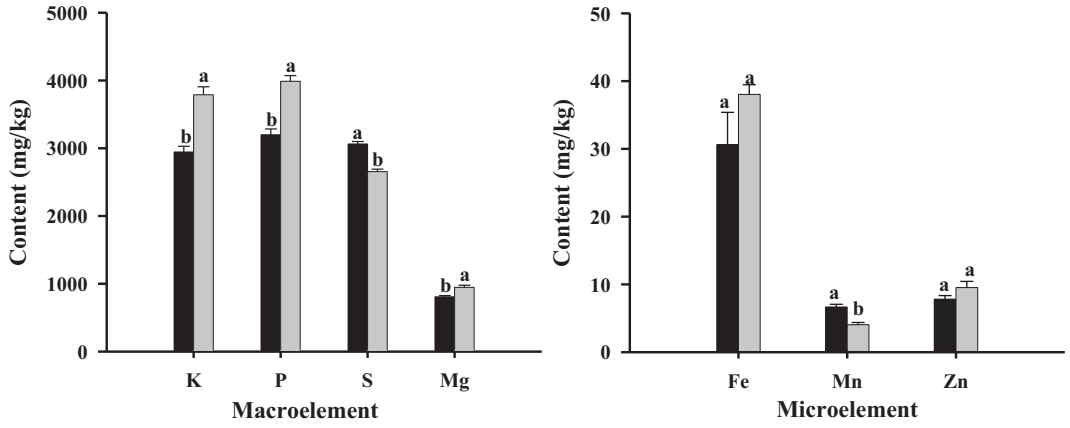


**Fig. 2.** Mineral elements of conventional and organic corn grain. Different lowercase indicate significant differences between the organic and conventional products ($P < 0.05$). Data are means ± standard error.

[78]. Researchers in Poland detected 117 rye and rye products and found that infection rates of DON, ZEN, HT-2 toxin and T-2 toxin in organic rye were 113%, 54%, 50% and 40%, lower than that in the conventional one, respectively. And the rye products also had the same trend [79].

Patulin is a kind of mycotoxins which is teratogenic, carcinogenic and mutagenic. It mainly exists in the mildew apple and apple juice, which is one of the main factors influencing the quality of fruit and fruit juice drinks [80]. There is no agreed conclusions about the effects of different management system on the patulin in apple juice, which still needs further research [81–84] (Fig. 4). Some investigators detected 117 organic goat and sheep milk samples, and found aflatoxin M1 in 4 samples exceeded the maximum 50 ng/kg of EU rules. This result might be caused by the pollution happened in the processing and transportation, as chemically synthetic compounds are forbidden in the controlling fungi and bacteria during the organic production process [85].

### 3.4. Pesticides residues

According to the China Rural Statistical Yearbook, the total pesticides application amount was 733 thousand tons in 1990, and 355 manufacturing factories produced 3.19 million tons original pesticides in total. Some 1000 kinds were pesticides, fungicides and herbicides. Pesticides mainly include organochlorine, organophosphorus, pyrethroid and organic nitrogen, etc. [86–87]. Excessive pesticide residues have posed a huge threat to the food safety. In china, pesticides' usage is relatively higher and more frequent. Although the government has stated that the high toxic and poisonous pesticides should be banned in the food production, the pesticides are still in actual uses. Excessive pesticide residues may accumulate in the food chain and will cause carcinogenic, teratogenic and mutagenic harms. Because any chemical synthetic pesticides are forbidden in the organic production, so the organic food should not contain pesticides residues. A report by the United States Department of Agriculture showed that, the highest detection rate of pesticides in the conventional vegetables and fruits were as follows: celery (96%), pear (95%), apple (94%), peach (93%), strawberry (91%), orange (85%), spinage (84%), potato (81%), cucumber (74%). 82% of the conventional fruits and 65% of the conventional vegetables were detected possessing pesticides residues, while the detection rates of organic fruits and vegetables were only 23% [46]. A clinical test found that organophosphorus pesticide residue in the urine of children who ate organic food was 5 times lower than that in the control group. However, when the children in the control group changed the diet into organic food, no organophosphorus and organochlorine residues were detected in their urine [88]. It was reported that residues of acephate, methamidophos, methomyl, deltamethrin and dithiocarbamate ester had not been detected in the organic green peppers, but

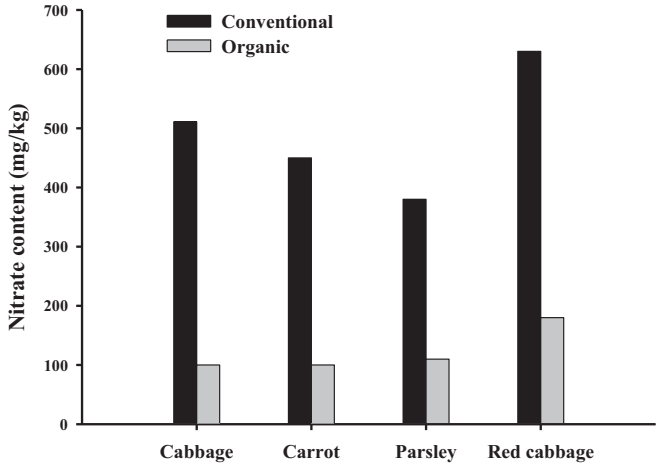


**Fig. 3.** Nitrate content of the conventional and organic vegetables [59].

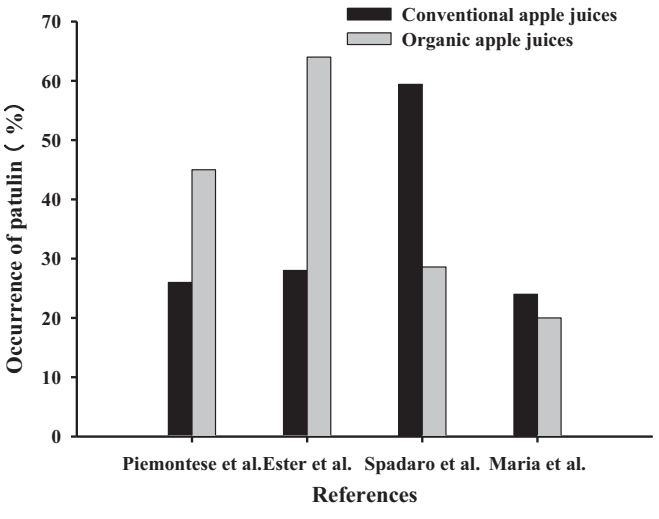


**Fig. 4.** Occurrence of patulin contamination in conventional and organic apple juices [81–84].

were detected in the conventional peppers [66]. Therefore, the organic and conventional products could be measured in terms of pesticides residues. It's easy to deduce that if pesticide residues are detected in some so-called "organic products", those must be fake organic products.

### 3.5. Pathogens

According to the definition of the World Health Organization, any diseases that caused by pathogenic factor that enter the human body through ingestion and triggered infectious or toxic symptoms are called foodborne diseases. Foodborne diseases are mainly caused by plant and animal sources of foodborne pathogen. The common pathogens are *Escherichia coli*, *Listeriosis*, *salmonella*, *Shigella* and *Brucella*. Because of the fact that no pesticide is allowed to apply in the organic farming system, the amount of pathogens may increase. For instance, if the organic compost is not totally mature, it will become the underlying infectious source of intestinal diseases. Some analysed the microbiota of organic farming broilers and found that, the average annual incidence of epidemic in organic broilers (54.2%) was significantly higher than that in the conventional ones (19.7%). The infection risk rate in the organic system was 1.7 times of that in the conventional one [89]. On the contrary, there're also some studies demonstrating that the organic chicken and pork are seldom infected by the pathogens, and the possibility of being polluted by >3 antibiotic-resistant bacteria was 33% lower than the conventional products [25]. Hence, organic agricultural producers must strictly manage the organic compost processing and control the pathogen's damage from the source.

## 4. Problems and prospects

In conclusion, "Three Cannot" problem, that is, organic products "cannot be distinguished, cannot be tasted and cannot be measured" is not really existed, while there were obvious differences in sensory quality, nutrients, heavy metals residues, pesticides residues between organic foods and conventional alternatives. On the whole, organic products taste better, containing much more dry matter and high quality proteins. Organic fruits and vegetables have richer content of phenolic compound that has anti-cancer and antioxidant functions such as anthocyanins, isoflavones and carotenoids. Organic livestock products contain more polyunsaturated fatty acids that are beneficial for human body health. Besides, organic fruits and vegetables contained less nitrate and heavy metals than the conventional ones, with none pesticide residues. People are becoming to realize the importance of food safety and quality, and organic agriculture has turned into the fastest developing industry with a huge market prospect.

But organic agriculture has not developed well in a lot of countries especially in China. The major reasons must exit in the following facts: 1) the consumers lack understandings about the organic products; 2) the crucial technologies in the process need to be improved; 3) the input in the conversion process is too high; 4) laws and regulations for the organic production are not sound, resulting in stressing on the certification instead of management in the process. The organic product certification is manipulated by the certification company, which is a commercial and static state activity that lacking dynamic monitoring for the products, so it is difficult to win the consumers' recognition [90–92].

To solve the above mentioned problems, we should take a series of measures. In the marketing, propaganda of organic products' concept and standards should be strengthened. For scientific research, the key technologies of organic production and the quality of organic foods need further study, in order to produce agricultural products with high quality. It is an urgent task to break through the technology, namely reasonable measures to ensure the yield and profits according to the certified standards [93]. Besides, the content of pesticide residues, nitrate and heavy metals in agricultural products need to be presented comprehensively to the consumers. The consumers don't trust the organic foods, mainly due to inadequate knowledge about the organic products. It needs researchers report the real differences in quality between conventional and organic foods through comparative analysis. As for the producers, although they produce according to the organic standards, their products will withstand tests. The agricultural products with high quality and safety are not generated from certification or the end of regulation, but generated from the source. In addition, the government needs to increase policy support for organic industry and improve the related management regulations.

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