

Review

Organic Foods and Public Health Importance: A Review

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ABSTRACT

Organic livestock farming is a useful strategy to overcome the challenges of the agricultural sector like sustainability, food security, and food safety while matching with a high status of animal welfare, care for the environment, restricted use of medical drugs, growth promoters, synthetic fertilizer and the production of healthy food products without drug residues. Furthermore, organic livestock farming could also be an interesting strategy for the eternal rural development issue and solution for the farms' decreasing profitability. The regulation of organic animal production is comprehensive and affected by different aspects such as feeding, housing, breeding, health care, and medical treatment. In contrast to conventional production systems, animals under organic livestock production are allowed a larger housing area, have obligatory straw bedding, fed organic feed, and roughage. The animal feed is a strong determinant of the fatty acid composition of the milk, egg or meat. In relation to animal health and welfare, the application of breed selection, good management, nutrition, and husbandry plays a greater role in disease prevention and good animal welfare. Now-a-days, antimicrobial resistance is a global public health issue and a threat to the modern health care system which is recognized by many international health organizations. Accordingly, over the last few years, the demand for organic products and availability in the market has been increased and made significant development in the economy. Several people have started to consider organic food instead of conventional food because it is healthier and less prone to the impact of chemical residues. Consequently, awareness creation and encouraging the importance of organic products for customers is important for the development of organic production.

Keywords

Conventional production; Organic market; Organic production; Public health.

INTRODUCTION

Organic agriculture is a farming system which had been followed by farmers from ancient times, and free from the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives. According to Food and Agriculture Organization (FAO)/World Health Organization (WHO) Codex Alimentarius Commission (CAC), it is an integrated production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity.^{1,2}

Organic farming can be distinguished from conventional agriculture by exercising particular respect for human values, the environment, nature, and animal welfare, etc. The basic principles of organic farming, as formulated by the International Federation of Organic Agriculture Movements (IFOAM) need to be incorpo-

rated. The processing of organic food aims to maintain nutritional value and limit the number and quantity of additives and processing aids in food products.^{3,5}

A risk to human health from antibiotic resistance developing in micro-organisms is one of the major public health threats that will be faced in the 21st century. In spite of these concerns, antibiotics are still used widely by non-organic livestock farmers as growth promoters or for disease suppression by routinely adding them to feed and water. The routine uses of antibiotics to curb disease outbreaks or promote growth are prohibited in organic standards. Instead, disease outbreaks are minimized by the avoidance of dense stocking levels or intensive housing and the promotion of positive animal health through good husbandry and free-range conditions. The veterinary use of antibiotics has been minimized and strictly controlled, and withdrawal periods after administration

of a veterinary drug are stricter than those recommended in order to prevent detectable residues in meat or milk.^{6,7}

Pesticide residues have been, known to exert carcinogenic, genotoxic, neuro-destructive, endocrine and allergenic effects and found usually in higher contents in conventionally produced foods. There is scientific evidence that dietary exposure of children to organophosphorus pesticides, measured on the basis of the level of pesticide metabolites in urine samples, is much lower on organic than on conventional diet.^{8,9}

Now-a-days, antimicrobial resistance (AMR) is a great concern to the world. The consequences of antimicrobial resistance include the failure to successfully treat infections, leading to increased mortality; more severe or prolonged illness; production losses; and reduced livelihoods and food security. The indirect impacts of AMR include higher costs for treatment and health care. The health consequences and economic costs of AMR are estimated at 10 million human fatalities annually and a 2 to 3.5% decrease in global gross domestic product (GDP) or United States Dollar (USD) 100 trillion, by 2050. But the true cost of AMR is hard to predict.^{10,11}

Antimicrobial use in animals for growth promotion, prophylaxis, and metaphylaxis (i.e. medicating mixed groups of healthy and infected animals in order to control outbreaks of disease) has been substantially reduced in high-income countries in recent years, however, livestock antimicrobial use will continue to increase in low- and middle-income countries (LMIC) during the next decades due to the growing demand in LMICs for animal protein that it is contributing to increasing antibiotic resistance in pathogenic bacteria.^{12,13}

There is strong evidence that poultry and livestock that consume animal feeds and pastures grown using organic methods produce meat, milk, and eggs that has modestly higher levels of protein, more of some vitamins and minerals, and elevated levels of heart-healthy n-3 fatty acids and conjugated linoleic acid (CLA).^{3,14}

ORGANIC FARMING

Organic farming and sustainable agriculture are synonymous because they both depend on the sustainability of agro-ecological systems. Sustainability can be defined as meeting the need of the present without compromising the ability of future generations.^{15,16}

Organic farming consumes less energy and at the present, when the world is focused on the energy crisis, organic agriculture achieves lower energy consumption rates because, it does not apply fertilizers and pesticides, whose production requires high energy inputs. In addition, high energy lead to large emissions of greenhouse gases and conventional farming is a very large emission source of them. Therefore, organic plant production significantly contributes to reducing greenhouse gas emissions. Furthermore, conventional agriculture leads to eutrophication and pollution of water resources by the use of pesticides.^{7,17} Body fluids i.e. urine

and blood of children on conventional diet contained six times more pesticide residues than children on an organic diet.^{18,19}

Animal Management

The standards for organic livestock farming offer a good framework for animal health and welfare management. In these fields, it is still necessary to solve certain grey areas among the organic farming objectives. Animals feed grown organically showed better for growth and reproduction than animal feed grown conventionally.^{4,20} The main advantage of organic food production is the restricted use of synthetic pesticides which leads to low residue levels in foods and thus lower pesticide exposure for consumers. It also reduces the occupational exposure of farmworkers to pesticides.^{3,21}

Feeding: Organic livestock husbandry requires that a large fraction of the feed should be locally produced. While soy, palm kernel cake, cereals, and maize silage are substantial feed fractions in many conventional livestock systems, they are less used ingredients in organic systems. On the other hand, grass-clover hay and other roughage make up a larger portion of the feed-in organic than in conventional systems. There is a well-established link between the fatty acid composition of the feed, and the fatty acid composition in the product (meat, milk, eggs). Outstandingly, soy, palm kernel cereals, and maize have a low content of omega-3 fatty acids, while grass and red clover are rich sources of omega-3 fatty acids.^{8,22}

Nutrition affects the immune status of animals and humans. Accordingly, nutrients play a great role in optimum immune response. However, deficient and excessive intakes can have negative consequences for the immune status and the susceptibility to a variety of pathogens.^{15,23,24}

Housing: The housing conditions and the access to straw bedding used in organic animal farming might lead to the conclusion that the animals would be less stressed than conventionally kept animals; therefore, stress affects the immune response of both humans and animals.²⁵⁻²⁷

Breeding: In organic livestock production, the principle for disease prevention is preferably based on the selection of the appropriate breeds or strains of animals. There are a number of breeding strategies for improved disease resistance in organic livestock production. These include (1) the recording of disease incidence in the progeny and the selection of parents that produce progeny with the lowest incidences, (2) the use of breeds possessing certain major histocompatibility-complex antigens known to be associated with resistance to certain infections, and (3) the identification of a set or combination of immune parameters crucial for resistance to infections and using parameters with high heritability in breeding programs.²⁸⁻³⁰

Health care: Organic livestock production requires producers to establish preventive health care practices. These practices include: selecting the appropriate type and species of livestock, providing adequate feed, creating an appropriate environment that minimizes

stress, disease, and parasites, administering vaccines and veterinary biologics. Besides, the animal husbandry practices should promote animal well-being in a manner that minimizes pain and stress. Producers cannot provide preventive antibiotics rather they are encouraged to treat animals with appropriate protocols, including antibiotics and other conventional medicines when needed, but these treated animals cannot be sold or labeled as organic. Producers cannot administer hormones or other drugs for growth promotion.^{29,31-33}

Quality of Organic Animal Food

Under organic farms, consumers expect quality organic products including milk, meat, eggs, leather products to come from farms. Besides, farms that are verified and meet rigorous standards have the mandate to use organic feed, prohibit the use of prophylactic antibiotics (except in medical emergencies) and give animals access to the outdoors, fresh air and sunlight. Production methods are based on criteria that meet all health regulations, work in harmony with the environment, build biological diversity and foster healthy soil and growing conditions. Animals are marketed as having been raised without the use of persistent toxic pesticides and antibiotics.^{3,29,34}

Comparison between Organic and Conventional Animal Food Products

Food products that are produced under organic farming are more nutritious and safer than conventional foods. Even though some studies indicated that organic foods have lower pesticide residues compared to conventional foods, they cannot be defined as pesticide-free.^{3,24,35}

Organic farming uses more ‘natural’ methods and differs from conventional farming in a number of ways although the difference in the actual practices of both cultivation systems can vary substantially between different countries/regions. In conventional plant production, inorganic fertilizers (NPK) are used to increase the yield, and pesticides, insecticides, herbicides, and fungicides are used for pest and weed control. Organic farming use growing intercrops or cover crops, use organic wastes and compost, crop rotation and biofertilizers to keep and build good soil structure and fertility to supply nutrients the plant.^{36,37}

Organic foods of animal origin are derived from animals fed on 100% organic food for at least 12-months. The use of antibiotics, synthetic growth promoters, genetically engineered vaccines is prohibited.^{13,38}

Currently, most research focus on compositional differences of organic and conventional animal-based foods is on the fatty acid composition, with a major interest in omega-3 fatty acids due to their importance for human health.³⁹ Some studies also address the content of minerals and vitamins in organic and conventional livestock products. The fatty acid composition of the milk, egg or meat is mainly determined by the fatty acid composition of

the feed. Roughage feeds especially grass and red clover, contain between 30% and 50% omega-3 fatty acid of total fatty acid, while the concentrate feeds such as cereals, soy, corn, and palm kernel cake have less than 10% omega-3 fatty acid of total fatty acid.^{5,40}

Milk: Milk is one of the most important nutritional sources, especially in the nutrition of children. It is reported that the composition of organic milk compared to conventional milk from high input systems can be very different, especially while comparing the antioxidant and the fatty acid profile. Organic milk has a higher content of CLA, n-3 fatty acids and a better n-6/n-3 fatty acids ratio.⁴¹ Factors for beneficial milk fatty acids composition are outdoor grazing, high biodiversity in pastures, low-levels of concentrates and no silage feeding (except red clover).^{1,42,43}

Meat: Meat (beef, pork, and lamb) from the organically raised animals are generally characterized by a lower content of total fat. At the same time, organic pork and lamb were found to present higher intramuscular fat content⁴⁴⁻⁴⁶ and it contains usually more unsaturated and less saturated fatty acids. Moreover, the n-6/n-3 fatty acid ratio in organic beef was reported to be much lower comparing to the conventional beef, higher weight of breast and thigh muscles in poultry carcasses.^{18,28}

In most cases, organic meat has also better nutritional quality than conventional meat. Organic lamb was found to present better eating quality than conventional lamb in terms of juiciness (attributed to the higher intramuscular fat content) and flavor (attributed to the higher level of linolenic acid and total n-3 fatty acids). Meat derived from organic farming perform desirable nutritional properties, such as favorable ratios of fatty acids. Since it has the lower content of saturated and monounsaturated fatty acids, higher content of polyunsaturated fatty acids and a lower ratio of n-6 fatty acids to n-3 fatty acids (Table 1).⁴⁷

Table 1. Differences between Organic and Conventionally Produced Meat Food Products, Country and Nutritional, Sensory, and Technological Aspects

Food Products	Country	Nutritional, Sensory and Technological Aspects
Pig	Korea	Organically reared pigs had higher myoglobin content compared with those for conventionally the reared pigs
Suckling lamb	United Kingdom	The appearance of the organic raw meat was more fibrous, darker, and with a lower aroma intensity than the conventional one. In grilled meat, the organic samples had less subcutaneous fat, less fibrous texture, less aroma intensity, but also less juiciness than the conventional one
Chickens	Midwest	Organically raised chickens had less yellow appearance for breast, thigh, and skin pieces when compared with conventional carcass components
Source: ⁴³		

Egg: Organic egg has higher omega-3 fatty acid content and a lower omega-6/omega-3, especially when pasture was widely available. Hens were kept indoors in a standard housing system (“control”), with access to 4 m² of pasture per hen (“organic”), in line with current requirements for organic laying hens, or with access to 10 m² of pasture.⁴⁸ Organic eggs are lighter, less pigmented, with a

lower yolk/albumen ratio but also more fragile than conventional eggs. However, the number of studies concerning eggs is limited (Table 2).^{24,38}

Table 2. Differences between Organic and Conventionally Produced Eggs Food Products Country Nutritional, Sensory and Technological Aspect

Food Products	Country	Nutritional, Sensory and Technological Aspects
Egg	Italy	Organic eggs are significantly lighter; it was found a lower yolk/albumen ratio, lower eggshell breaking strength in organic eggs than in conventional eggs. It was also observed a lower pigmentation on of organic yolk
Egg	Netherland	Lower eggshell breaking strength in organic eggs

Source: Breithaupt et al²⁶

PUBLIC HEALTH IMPORTANCE OF ORGANIC FOOD PRODUCT

Most human studies reported mother-and-child have positive associations between organic vegetable and dairy consumption due to reduce risks of pre-eclampsia in mothers, hypospadias in baby boys and eczema in infants.^{18,31,49}

The human studies that have directly investigated the effects of organic food on human health have so far yielded some observations, including indications of a lower risk of childhood allergies, adult overweight/obesity and reduce Hodgkin lymphoma (but not for total cancer) in consumers of organic food.^{5,50}

Organic food consumption results in higher dietary intakes of a range of nutritionally desirable compounds such as antioxidants, certain vitamins, and omega-3 fatty acids, but lower intakes of nutritionally undesirable pesticides, cadmium, and saturated fatty acids, so organic foods are safer for human consumption (Table 3).^{7,32,51}

Table 3. Definition of Food Safety, Including Aspects of Both Product Safety and Agri-food-system Safety

Food Products	
Product Safety	Agri-food-system safety
<ul style="list-style-type: none"> • Safety, non-toxicity of the food • Safety, nutritious food • Safety of the declaration (all components of the food are shown on a declaration) • Safety of the label (the organic food is truly organic) 	<ul style="list-style-type: none"> • Safety of supply • Safety of distribution • Safety of transparency and proximity • Safety of consumer influence on food production • Safety of information on the whole food production process (e.g. by using label) • Safety, no negative impacts of production practices on humans and other living organisms, the environment, climate, etc.

Source: ^{1,18}

Effect of Regulation of Animal Product

Principles of organic animal husbandry at all times require a thorough analysis of the problems and opportunities involved and existing local knowledge. Some key considerations in organic animal

husbandry that producers and other stakeholders need to take into account are the origins of livestock, livestock feed, living conditions, waste management, health care, record keeping.^{3,5,33}

The regulation of organic animal production is comprehensive and influences aspects of feeding, housing, demarcation, care, medical treatment, and slaughter. An European Union (EU) regulation on organic animal husbandry was released in 1999 (1804/99), different aspects of which are expected to directly affect the composition of organic animal products. This regulation provides for access to outdoor areas with a lower stocking density and restrictions on animal feeds: compulsory use of roughage feeds, ban on antibiotics, growth promoters and additive, ban on genetically modified organisms (GMOs) plus prohibit on meat and bone meal.^{21,38}

Access to outdoor area: Usually, zoonotic diseases can be transmitted from animals to human beings through the consumption of food, but in conventional agriculture, attempts have been made to control zoonosis through the use of hygiene barriers. Knowledge about the influence of different production systems on the occurrence and distribution of microbes in foods still very limited. However, in comparison with conventional farming practice, in outdoor organic animal production systems, the density of livestock per hectare is relatively low. This may decrease the pressure of infection and help to neutralize the risk of zoonosis.^{32,52,53}

Conventional production is typically aiming for high production levels with restricted input resources such as space, feed, etc., and these conditions may cause stress in the individual animal as it is unable to cope with the situation, e.g. in pig production. This means that higher stocking density, restricted space, and barren environment are factors increasing the risk of the development of diseases, and therefore it is more likely that animals under these conditions need antibiotic treatments.⁴³ Organic production aims for less intensive animal production, which generally means that the animals have access to a more spacious and enriched environment, access to an outdoor range and restricted group sizes, and other preconditions.^{3,25}

Compensatory use of roughage: In organic production systems, feed composition has a great role in reducing the incidence of zoonosis as compared to the conventional production system. Accordingly, in organic farms due to the higher content of grass in animal diets, a significantly higher content of conjugated linolic acid has been observed as compared to conventional milk. A higher content of conjugated linolic acid in organic milk could have positive consequences for health, because it may help to control the onset of cancer and arteriosclerosis. Feed composition can reduce the incidence of zoonosis in organic as compared to conventional production systems (Table 4), the compulsory use of roughages in organic systems reducing the occurrence of harmful intestinal bacteria.^{15,19,24}

Restrict the use of medicine: National Organic Standards (NOS) prohibit the use of any antibiotics in livestock production. Numerous studies have demonstrated that the benefits of organic produc-

Table 4. Effect of Regulation on Product Safety in Organic Animal Production Compared to Conventional Farming

Product Safety in Organic Products				
Compound or Organism	Potential Effects on Human Health	Driving Force State	Concentration of Compound Organism	Impact on Human Health
Conjugated linolic acid (CLA) in milk	Preventive against cancer and arteriosclerosis	More grass fodder	Higher than in conventional product	Positive
Salmonella, Campylobacter	Infections	Extended use of out-doors areas. Compulsory use of roughages	Lower/higher than in conventional product	Both positive and negative
Medicine residues	Transfer of resistance genes from animals to human pathogens	Restricted use of medicine, double retention time	Possibly lower than in conventional product	Positive

Source:⁵²

tion in protecting human health, directly reducing consumer exposure to antibiotic-resistant bacteria *via* contact and consumption of animal products. According to different investigations on retail meat products, organic chicken, turkey, pork, beef, and even eggs are much less likely to be contaminated with antibiotic-resistant bacteria than conventional meat products.^{13,31,54}

Pesticides that may contaminate feeds are potentially toxic to farm livestock, and this is even more worrying if the animal products are intended for human consumption.^{37,55} The restricted use of antibiotics could have a positive effect on health by reducing the risk for transfer of resistance genes from animals to human pathogens.⁵⁶ The growth-promoting, prophylactic and routine use of antibiotics in agriculture is of mounting concern to governments and the medical profession, and there is growing evidence that it is contributing to increasing antibiotic resistance in pathogenic bacteria. Antibiotics in animal feed are currently under review in the EU and several of those used as growth promoters are already banned.^{37,57,58}

Antimicrobial Resistance

Antimicrobial resistance is increasingly recognized by many international health organizations as a global public health issue and a threat to the modern health care system that could hamper the control of many infectious diseases and dramatically set back the modern medicine.¹² The growing worldwide phenomenon of AMR is generally associated with the “selective pressure” caused by the improper use, overuse, or misuse of antimicrobials in humans and animals. Infections by antibiotic-resistant strains are associated with a reduced quality of life, with metastatic bacterial infections, an increase in recurrence rates, chronicity, and future opportunistic infections with resistant organisms.⁵⁹

Antimicrobial resistance can lead to increased costs and the destabilization of health systems. Patients suffering from antimicrobial resistance nosocomial infections (mainly bloodstream infections) or who become sick due to the consumption of food contaminated by resistant pathogens experience longer recovery and a higher frequency of septicemic infections and mortality. In this situation, health care costs are higher, due to extended hospital stays and the use of more expensive drugs. Moreover, there are higher risks of toxicity associated with new drugs, as well as a greater frequency of adverse drug reactions (ADRs) and collateral

events.^{60,61}

Organic Food Consumers

Consumers’ perceptions of naturalness are important for the acceptance of foods and food technologies. Thus, several studies have examined the significance of naturalness among consumers. Nonetheless, the aspects that are considered essential in perceiving a food item as natural may vary across consumers and different stakeholder groups.⁶² Assessed consumer perceptions towards organic food and found that food safety, human health and environmental concern along with sensory attributes such as nutritive value, taste, freshness and appearance influence organic food consumer preferences.⁶³

Consumers’ perceptions regarding the quality of organic food consumption are influenced by different factors, such as freshness, food safety, price, environment-friendly, nutrition, and sensory attributes. Thus, food consumption patterns are ever-changing as a result of health and environmental issues.¹⁹ They prefer to buy organic food products because of their perception that organic food products are healthy and safe, nutritious and environment-friendly. Currently, organic food consumers seem to pay more attention to “hedonistic” motives for purchasing of organic food, such as health, taste and wellness, rather than to “altruistic” purchasing motives, such as environmental protection and animal welfare; this confirms the role played by sensory attributes in orienting food choices.^{7,44}

Consumers are very aware that organic food is good for health, these products are free from chemical which resulting in no side effects and do not cause harm to the consumers. The consumers living in urban areas are more aware of organic food products. Consumer believes that consumption of organic food helps to reduce stress level and maintain an energetic lifestyle. Another factor this study found that respondents are willing to pay even higher prices because it is beneficial for health.^{17,32,53}

Global Organic Market

In the last few years, the organic product production and availability in the market has been increased and made a significant development in the economy. Several people have started to consider organic food instead of conventional food because it is healthier

and less/no chemicals. This kind of purchasing behavior plays an important role in the consumer attitude and perception aspect of buying organic food products.⁵⁷ The approach for buying organic food is mainly influenced by gender, age, income, level of education and the presence of children in the household identified the main reasons for organic food consumption among consumers. The main reasons are concerns about health and nutrition, more delicious taste, care for the environment, food safety, lack of trust in conventional food, care for animal welfare, support the local economy, freshness, curiosity or because they are considered trendy.^{15,32,53}

Challenges in Organic Animal Food Production

Most serious problems are still restricting growth in organic farming. Some of these potential obstacles, especially when exporting livestock products, are as follows: small-sized land holdings, low-level of literacy, lack of information about organic production practices, high stocking density, inadequate production of feeds and fodders, high cost of certification.^{45,63} It is difficult to provide a large locomotion area, cost of production of organic meat is very high (in case of pork, 85.2% high), organic milk and meat production may further decrease the availability of milk and meat, processing or preservation of meat and meat products is difficult without use of certain chemicals like tri-sodium phosphate, sodium nitrate, etc.²⁹

CONCLUSION

Organic agriculture is one of the farming system which had been practiced by farmers from prehistoric times, and free from the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives rather used animal originated products. The application of organic farming has a great role in public health since it reduces the risk of childhood allergies, adult overweight/obesity, and the development of some cancers in consumers. In general, many people turn their face to purchase organic food products rather than conventional food because it has health important and less chemical residue. Even though organic farming has a great role in human health and biodiversity safety, but still so many constraints which obstacle its development stage like lack of awareness, inadequate production of feedstuff, lack of enough land, lack of information about its practice, high cost of production, etc. In conclusion, private and governmental organic farm owners need to be trained, encouraged and supported on how to practice and manage the organic farming system. The government and associated institutions should be creating awareness and encourage the importance of organic products for customers through scientifically explored research.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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