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Key requirements, status, possibilities, consumer perceptions, and barriers of organic poultry farming: A review

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ABSTRACT

The global population tend to increase rapidly, especially in developing and underdeveloped countries. The increasing population demands more food items, ultimately prompting abuse of our resources. Additionally, the unsystematic usage of antibiotics, anti-toxins, anthelmintic, and synthetic acids in livestock farming has represented an unbelievable degree of wellbeing peril to humans. With much admittance to education and learning, safe and healthy food is preferred by the soaring populaces. Food from animal sources like poultry meat, generally organic, is supposed to serve the worldwide interest. In light of this, organic poultry farming is likely to become a fast-growing industry in the coming days. Instead of intensive poultry, organic poultry meat is always demanding in the market due to higher consumer preferences. Likewise, the market price involved for such food is also higher due to the main issues taken for the production framework. The organic production system for poultry birds comprises strict sets of organic standards to be followed by organic poultry farmers. Different management issues such as health, hygiene, feeding, diseases, housing etc., are to be foreseen for utmost results during the production cycle. Better production practices improve poultry health and performance that benefits both the producers and the consumer without compromising poultry health and welfare. This review aims to delineate the pertinent data, including key necessities, current status, possibilities, and consumer discernment, and conclusively highlight the barriers to organic poultry production.

Keywords: Organic, poultry, antibiotics, housing, health, methionine, outdoor

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1 Introduction

Organic poultry production can be referred to as a rearing framework that entirely avoids the utilization of genetically modified organisms (GMOs), conventional feedstuffs, animal by-products, synthetic additives, amino acids, and prophylactic ramifications of anthelmintic and anti-microbials (except for immunization) (Abbas and Ahmed, 2015; Adisa et al., 2017; Golden et al., 2021; Nölting et al., 2016; Rezaei et al., 2017). Nevertheless, it permits the use of locally produced feedstuffs and naturally grown roughages (Adisa et al., 2017; Alagawany et al., 2018; Rezaei et al., 2017) and requires a long rearing period (>10 weeks) (Rezaei et al., 2017) and exercise outdoor for the birds (Abbas and Ahmed, 2015; Fanatico et al., 2016a). Organic poultry production is a way through which organic products, i.e. meat and eggs, are obtained following the well-established organic standard for poultry production (Chalova et al., 2016; Tufarelli et al., 2018). Moreover, the EU regulations also specify that the land for poultry production should be free from synthetic chemicals like pesticides, herbicides, and fertilizers for a specific time and, feed ingredients must be produced organically (Chander et al., 2011; Tufarelli et al., 2018). Organically produced foods offer a great market demand for the ultimate consumers globally due to various reasons like health, food, safety, welfare, and related environmental status (Chalova et al., 2016; Upadhyaya et al., 2022). A great appeal has also been overseen in organic poultry production (Ricke, 2021).

Organic poultry is easily differentiated from conventional poultry in terms of specific rules and standards like stock origin, housing, nutrition, and animal health (Chalova et al., 2016) (Table 1). Under organic poultry production, the birds are administered alternative natural products free from antibiotics and drugs with a more extended period of rearing (Khan, 2018; Tufarelli et al., 2018). Organic farmers must fulfill the organic standards to reach consumers' expectations in terms of animal welfare and health, environment, and food safety (Rocchi et al., 2021; Souillard et al., 2019) (Table 5). The commercially well furnished, vibrant, scientific poultry industries rely on utilizing anti-toxins, anthelmintic, and synthetic acids (Biradar et al., 2011). The utilization of antibiotics in poultry production has posed an incredible health hazard to people (Millman et al., 2013). For instance, according to Millman et al. (2013), antibiotics can impact the recurrence of antibiotic-resistant microorganisms in humans including, extra-intestinal pathogenic *E. coli*, *Enterococcus*, *Salmonella*, and *Campylobacter*. Nowadays, there is a positive response from consumers globally to organic poultry products since they are becoming more aware of the quality and safety of consumed food products (Biradar et al., 2011; Kim et al., 2018; Rumokoy et al., 2016). In addition, apart from healthy meat, organic poultry is known as more nutritious and has higher protein than conventional broiler ones (Halim et al., 2020). Accordingly, the populace of antibiotic-resistant extra-intestinal pathogenic Escherichia coli has been viewed as less raised without antibiotics (RWA) poultry (Millman et al., 2013).

Organic poultry farming is setting a new dimension for animal husbandry due to the growing need to make sustainable production of meat and eggs (Jin et al., 2021). This system guarantees the quality of the product as well as the overall production process with a set of well-determined organic standards (Chalova et al., 2016). Since producers are also facing difficulties in developing practical, effective, and environment-friendly approaches for improving the safety and quality of products. Regardless, there are a few significant limitations to organic poultry production, such as inaccessibility of quality feed ingredients that can guarantee organic standards (Rumokoy et al., 2016), organic broiler prone to microbiological and parasite manifestation (Halim et al., 2020), unavailability of neonatal poultry vaccination (Singh and Sonwani, 2021), and conflicting investigations and consequence of dietary profile of organic broiler because of different areas, mixtures, strains, conditions (Halim et al., 2020). The motive behind this paper is to exhibit the current state of organic poultry production around the globe. This article unfolds the concept of feeding parameters, standards, breed selection, certification bodies, housing, stock, and outdoor management. Further, identify the variables that restrain the increase in production.

2 Present status and possibilities

Poultry production is carried out throughout the world with no restraint. On the worldwide database, poultry meat accounted for 17% in 1975, which raised to 27% in 2000. This shows the abrupt transformation of the commercial sector (Adisa et al., 2017). In India alone, the poultry segment oversees almost 851.81 million poultry population in 2018-19, and the production shows a tremendous growth rate of 4.5% annually at the commercial level and 45.79% at the backyard level (Singh et al., 2021, 2020). However, with the growth of production, the use of synthetic antibiotics and amino acids also increased. About 84% of antibiotics are primarily used for the mass prescription of pigs and poultry. In 2011, an aggregate of 8.5 tons of antibiotics was sold (governing 25 European countries) (Vaarst et al., 2015). Also, any product that relies on medication use risks developing resistant bacteria over the long haul. Because of the genuine mischief on health, two specific types of growth promotors were even restricted from 1999 (Vaarst et al., 2015). This addressed the consumers to be health aware, and organic poultry production was boosted (Abbas and Ahmed, 2015; Diaz-Sanchez et al., 2015; Loo et al., 2010). In 2005, poultry reliably adsorbed about 75% of the organic meat market in the USA (Biradar et al., 2011). Organic birds have better hock condition, leg health, and overall welfare compared with the conventional production system (Souillard et al., 2019) (Table 1). The organic poultry system has become a fast-growing sector in us due to the demanding organic product by consumers (Apaeva et al., 2021; Sapkota et al., 2014). The demand for organic production over the period 2007-2017 in the European region was increased by 5.6% per year, as stated by the Eurostat 2019 report, but the animal product only represented 3% of the total due to the high cost of feeding animals' medication restriction (Nölting et al., 2016; Adeboye, 2014; Rocchi et al., 2021). This small percentage of organic production of animals and poultry is due to higher production costs in organic poultry, the high cost of organic meat and eggs is mainly attributed to the organic cereals and soybeans which are about 50-100% more expensive than conventional feed (Karcher and Mench, 2018). In Russia, a standards level has been implemented for the premise of certification and production of organic products. The established laws are followed and implemented by commercial and local farmers to get the imprint 'organic' checked by certified bodies

Table 1. Comparison of industrial and organic methods of poultry production

Sl	Criteria	Industrial method	Organic method	References
1	Maintenance	In confined poultry buildings with cage and floor keeping, there is a lack of access to free-range, natural sunlight, and fresh air.	Birds must be allowed to roam freely in their native environment and must have access to a free range.	Erensoy et al. (2016); Roiter et al. (2020)
2	Feeding	Compound feeds and specific combinations, including those containing growth hormones and feed additives, make up the majority of the feed basis.	At least half of the fodder base is made up of fodder grown on the farm, or fodder grown organically by other farms in the same region.	Rezaei et al. (2017); Singh and Bhatt (2021)
3	Rearing density	Less than 25 chickens per square meter	Less than 19 chickens per square meter	Erensoy et al. (2016); Kim et al. (2018)
4	Breeding	Artificial insemination, genetic engineering, and intense breeding procedures are the most common.	Natural reproduction, particularly with slow-growing bird breeds is implied.	Chalova et al. (2016); Roiter et al. (2020)
5	Health status	Antibiotics and other powerful treatments are used to prevent and cure poultry diseases.	Immunobiological drugs are authorized for illness prevention, and phytotherapeutic, homeopathic preparations, and trace elements on an organic foundation are employed for poultry therapy.	Dhama et al. (2014); Souillard et al. (2019)
6	Priority of economic activity	Profit maximization via meeting market demand through productivity increase and reducing the time it takes to get marketable items.	Profit maximization for high-quality, environmentally friendly items using a pricing strategy.	Roiter et al. (2020)
7	Humane attitude	Not taken into consideration	Keeping any discomfort at bay	Rocchi et al. (2021)
8	Separate space for diseased chickens	Not present	Present	Kim et al. (2018)

and the state (Martynova et al., 2021). Likewise, In the US, the National Organic Program (NOP) caused the affectation of organic poultry products firmly and sanctioned (Abbas and Ahmed, 2015). As of now, almost 130 countries are delivering certified organic poultry products and some of them are even exporting those products including Brazil, Mexico, and Argentina (Biradar et al., 2011). This scenario has caused the augmentation in the organic poultry production by 76% from 2016 to 2017, allocating a market share of $750 million in 2016 (Micciche et al., 2018).

3 Key managements

3.1 Stock management

Stock management is of great importance for slow-growing strains raised in the free-range system for the organic production system (Castellini and Bosco, 2017; Martynova et al., 2021). Slow-growing strains' adaptability is better than the fast-growing strains under proper stock management (Castellini and Bosco, 2017). In the US, standards of the National Chicken Council (NCC) state stocking densities varying from 3 to 4 kg of live weight per 1 ft^2 of house floor area (31.7 to 43.9 kg/m^2) depending upon the bird's desired market weight (Diaz-Sanchez et al., 2015) (Table 5). Numerous studies on alternative poultry production systems suggested that lower stocking densities, greater freedom of movement, and eating green vegetation positively impact birds' health and product quality. So, proper selection of birds is of utmost importance on birds for the organic production of poultry (Sosnówka-Czajka et al., 2017).

3.2 Housing requirements

There is a chance of a high occurrence of diseases in environmentally controlled poultry houses. Housing parameters are of prime importance in organic poultry farms for the well-being and good husbandry practices in alternative production systems. Appropriate housing facilitates shelter against wind and rain, protection from predators, and a safe and clean area for poultry (Bosco et al., 2010; Ricke, 2021; Singh et al., 2021). Inorganic poultry production system, the

Table 2. Botanical alternatives for antibiotics and their biological effects on poultry production

Sl	Feed additive	Inclusion rate	Effect	References
1	Cinnamon powder	200ppm	Contains cinnamaldehyde that improves and boosts FCR in broiler	Arsi et al. (2017); El-Hack et al. (2022a,b); Tabatabaei et al. (2015)
2	Japanese Green tea	1%	Improve FCR	El-Hack et al. (2022a)
3	Lemongrass EOs	-	Inhibits pathogenic microorganisms, such as *Salmonella typhimurium*, *Salmonella enterica*, *Escherichia coli*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Klebsiella pneumoniae*, and *Candida albicans*	El-Hack et al. (2022b)
4	Moringa olefeira leaf	5%	Performance reduction at inclusion levels exceeding 5%	El-Hack et al. (2022b)
5	Green Tea extract	0.1g/kg	Decrease faecal coliform bacteria	Diaz-Sanchez et al. (2015); El-Hack et al. (2022b)
6	Rosemary leaf	5.7-11.5g/kg	Improve LWG and FE	Micciche et al. (2018)
7	Thymol	0.25%	Reduction of Campylobacter in ceca contents	Arsi et al. (2017)
8	*Ocimum basilicum* EOs	5,000 ppm	Shows antimicrobial action against a broad spectrum of Gram-negative and Gram-positive bacteria, yeast, and mold	Gong et al. (2014)
9	Garlic powder	1g/kg	Reduces population of *Clostridium* spp.	El-Hack et al. (2022b)
10	*Mentha piperita* leaves	-	Enhances histomorphology structure of mucosa of the small intestine of broilers	Al-Amri (2021)
11	EOs	200 ppm	Increases FCR by 6 and 12% compared to the antibiotic and the control groups	El-Hack et al. (2022a)
12	Cinnamon bark oil	300 mg/kg	Enhances antioxidant status in broilers as SOD activity is considerably raised in cinnamon bark oil	Micciche et al. (2018)
13	Eucalyptus and peppermint EOs	150g/Tn	Shows greater hemagglutinin-inhibition antibody titers against both avian influenza and Newcastle vaccinations as compared to control	Gong et al. (2014)
14	Carvacrol	100 mg/Kg	Decreases Campylobacter colonization, however, consistency in the antimicrobial efficacy throughout the tests was a concern	Arsi et al. (2017)
15	Enviva EO	100 g/Tn	Improve BW by 1,924 gr and improves FCR by 1.90	El-Hack et al. (2022a)

Table 2. (continued) Botanical alternatives for antibiotics and their biological effects on poultry production

Sl	Feed additive	Inclusion rate	Effect	References
16	Sunflower oil nanoemulsion	-	Shows antibacterial efficacy against pathogenic pathogens such as Listeria monocytogenes, Salmonella typhi, and Staphylococcus aureus	El-Hack et al. (2022a)
17	Pomace extract	60g/kg	Increase *Lactobacillus* in the ileum	Salaheen et al. (2017)
18	Capsaicin	150 to 300 ppm	Reduction of E. coli and C. perfringens	El-Hack et al. (2022a)
19	Ginger	250 g/100kg	Shows antimicrobial effects	El-Hack et al. (2022a)
20	Ajwain oil and clove oil	400 and 600 mg/kg	Decreases the counts of *Escherichia coli* and *Clostridium* species in pre-cecal contents	Arsi et al. (2017)
21	Oregano and thyme EOs	1g/kg	Reduces the amount of a wide spectrum of harmful bacteria such as *Salmonella* strains in the chicken gastrointestinal system	Diaz-Sanchez et al. (2015); El-Hack et al. (2022a); Jin et al. (2021)
22	Thyme, oregano, rosemary, clove, and cinnamon	-	Preserves the intestinal wall from damage owing to the effects of coccidial proliferation and promotes growth	Dhama et al. (2014); Micciche et al. (2018)
23	Pepper	200 ppm	Improves FCR and BW	Poku et al. (2020)
24	Marjoram leaf	0.50%	Improves LBW, BWG, FCR, and FI	(Dhama & Khan, 2014)
25	Thyme oil	1 g/kg	Reduction of coliform counts	Arsi et al. (2017); Diaz-Sanchez et al. (2015)
26	Cranberry extract	1mg/ml	Increases phagocytosis and intracellular killing activity of chicken heterophils	Diarra and Hammermeister (2014)
27	*Ginko biloba* leaves	-	Enhances the growth performance	Dhama et al. (2014)

intensive system is restricted, and the arrangement of mobile housing and outdoor access, i.e. a deep litter system, is emphasized (Bestman and Bikker-Ouwejan, 2020; Martynova et al., 2021). The easy outdoor access increases the bird's activity which relatively fabricates stronger immunity and makes them less susceptible to diseases. The significant benefit of Mobile poultry processing units (MPPUs) is that they provide an opportunity for birds to exhibit all their normal behavior patterns (Biradar et al., 2011; Martynova et al., 2021; Micciche et al., 2018). And the housing can be easily moved from a soil-borne parasites area to fresh grassy areas (Singh and Sonwani, 2021). Moreover, the birds get a chance to forge insects, and seeds and directly attain natural protein, minerals, vitamins, and amino acids. In like manner, the outdoor access imparts progressive retention of ultraviolet rays that instigates vitamin D production and provides good absorptivity of calcium ions therefore poultry attains higher bone density, feather quality, strong eggshells, and extravagant egg yolks (Karcher and Mench, 2018; Martynova et al., 2021). Conversely, observing the standards a farmer is allowed to provide artificial lighting for about 16 hours a day, in case of unacceptable geographical location (Martynova et al., 2021). The housing ought to be fabricated in such a way that the birds can accomplish good sanitation, referable space, and protection from predators during rearing periods (Biradar et al., 2011). Auger feed lines and automated drinkers may be used on farms to supplement feed and water. Phase fed diets are delivered which helps to meet the growing feed demands of growing birds in different production phases. lighting programs are typically 23:1, light: dark for the first week, and provided with 20:4 throughout the remaining production period (Karcher and Mench, 2018). The birds must have access to fresh air, a balanced ration, and clean water to accentuate animal welfare and exhibit natural behaviors. Debeaking usually doesn't fall under the organic poultry production's standards and is prohibited, however, some certifying agencies still lean towards it. So, the debeaking if carried out, the upper beak should be removed more than 5 mm (Erensoy et al., 2016). Following Erensoy et al. (2016), in the starter period (0-21 days) a maximum of 20 birds/m^2 (21 kg/m^2) ought to be applied. In 3 weeks of span, the average weight might reach 1 kg. And lastly in the fattening period (22-81 days) upmost of 10 birds/m^2 (21 kg/m^2) is ought to be permitted. Further, it is prescribed to have a limit of 500 flock size, and for more than that authorization is expected from the concerned bodies (Table 5).

3.3 Health management

As the organic poultry market continued to grow many new challenges are overseen by varied environmental conditions and the entry of food-borne pathogens. Thus, to limit the growth and establishment of disease pathogens prebiotic compounds can be used selectively (Chander et al., 2011; El-Hack et al., 2022a; Emami et al., 2013; Ricke, 2021). In organic farming, producers are suggested to establish preventive health care practices in line with standards of organic production (Chander et al., 2011). The vaccination ought to be inferred when the diseases are expected to cause problems in a particulate region and can't be constrained by other management strategies (Biradar et al., 2011; Singh and Sonwani, 2021). In compliance with NOP, naturally derived enzymes, antioxidants and botanicals are allowed to be used in organic poultry farming against infections and to overcome health and quality products (El-Hack et al., 2022b). However, in organic production, the management practices are designed in such a way that bird health can be promoted and disease is prevented through preventive medication. The free-range or pastured system for organic production is improvised with organic feed pieces of stuff with restrictions on the use of the particular compound for preventing diseases (Karcher and Mench, 2018; Sosnówka-Czajka et al., 2010). The birds in organic systems are well adapted to the less controlled environment and have high foraging aptitude, active immune response, and thermotolerance as well (Fiorilla et al., 2022).

Though, in hot and humid climatic regions, the predominance of parasitic problems including Coccidiosis, and Helminth are the risk factors that can be neutralized by the use of natural medicines and implications of Homeopathy and Ayurvedic methods (Biradar et al., 2011; Cisman et al., 2020; Jin et al., 2021; Singh and Sonwani, 2021; Souillard et al., 2019). Helminths occurrence in poultry is generally lower but they can affect the health and performance of poultry. the control of helminths in organic poultry production is based on strategies through grazing management by breaking the life cycle of parasites (Souillard et al., 2019). In the paper of Erensoy et al. (2016), overexposure to sunlight might cause feather pecking, and recommended to reduce light intensity to avoid such problems. Further, in organic poultry production, beak trimming is banned, so the management of injury, pain, and diseases is generally muddled and can be kept up with through ecological enhancement (Sossidou et al., 2015). The debilitated, harmed, and perished birds should be given prompt and necessary treatment. The sanitation, housing condition, feeding ingredients, and natural behaviors should be analyzed to find the cause of the illness and eliminate and prevent it in the future through variation in the management practices (Erensoy et al., 2016; Singh and Sonwani, 2021). Moreover, medicinal plants like Neem (*Azadirachta indica*), *Aloe vera*, Noni, etc. should be the alternative for the prevention of different diseases due to their role as antibiotics growth promoters. The natural plant compounds and extracts such as trans-cinnamaldehyde from cinnamon, thymol from thyme or oregano, and eugenol from clove have shown higher efficacy against pathogenic bacteria such as *Salmonella* spp., *Escherichia coli*, *Clostridium* spp., etc. which are major threats in organic poultry (Donoghue et al., 2015; Upadhyaya et al., 2022; Diaz-Sanchez et al., 2015) (Table 2).

3.4 Feeding management

In the poultry production system, the feed cost accumulates almost 60-65% of the total cost of poultry production hence a proper balanced ratio is necessary to obtain good production (Mallick et al., 2020; Mathavan et al., 2011). The digestive system of the poultry can metabolize seeds, grains, and insects in comparison to forage. Therefore, there is a necessity for a well-formulated concentrated balanced feed ratio at the organic level (Biradar et al., 2011; Ricke, 2021). Generally, almost all organic standards ideally require 100% of the feed ingredients to be organic, yet exceptionally some allow the incorporation of a few percentages of non-organic stuff (Biradar et al., 2011). Such as, the United Kingdom Register of Organic Food Standards (UKROFS) allows 50% of the diet to be organic, 30% of the diet from non-organic, and 20% from sources that are yet in the process to convert into an organic product (Erensoy et al., 2016) (Table 5). Accordingly, to fulfill the CP prerequisite local protein sources like peas, soybeans, rapeseed, and Faba beans can be employed (Chalova et al., 2016). Similarly, different forages like alfa, perennial ryegrasses, marigold, and red clover with high fiber levels are important sources of xanthophylls for natural pigmenting agents (Jeni et al., 2021; Tufarelli et al., 2018). Further, the sprouted grains, straw pellets, maize gluten, potato protein, and skim milk powder can be the supplement for the requirement of amino acids (Biradar et al., 2011; Quendt, 2021; Rezaei et al.,

Table 3. Plant and animal protein sources that can be used in organic poultry production

Sl	Protein Sources	Examples	Characteristics	References
1	Grain legumes	Soybean meal, Faba beans, Lupines, Grass peas	Rich in lysine; not appropriate as single protein providers; presence of anti-nutrients	Fajardo et al. (2012); Fanatico et al. (2018); Guz et al. (2022); Adeboye (2014)
2	Cereal grains	Corn, Corn hybrid	High crude protein and high-methionine content	Fajardo et al. (2012); Mathavan et al. (2011); Ricke (2021)
3	Oilseeds	Sunflower meal, Canola meal, Sesame meal, Soyabean oil	Relatively high protein content; a good source for most of the essential amino acids; relatively high amounts of sulfur-containing amino acids; higher amounts of residual fat; presence of anti-nutrients	Guz et al. (2022); Quendt (2021)
4	Fish	Fish meal	High methionine content; balanced amino acid composition	Fanatico et al. (2018, 2016a); Upadhyaya et al. (2022)
5	Milk	Dried skim milk, Casein	High methionine content; good source of essential amino acids	Chalova et al. (2016); Erensoy et al. (2016)
6	Grass & shrubs	Kentucky bluegrass, tall fescue, White clover, red clover, Chicory, alfalfa	Relatively high metabolizable methionine; rich in proteins, fats, vitamins, and minerals; highly variable nutritive composition	Adeboye (2014); Tufarelli et al. (2018)
7	Microorganisms	Bacteria, Yeasts	Enhanced methionine production	Chalova et al. (2016)
8	Tropical trees	*Artocarpus heterophyllus*, *Eucalyptus* spp., *Hibiscus rosa-sinensis*, *Leucaena leucocephala*, *Morus alba*	High dry matter; high neutral detergent fiber; high organic matter	Martínez-Pérez et al. (2017)
9	Insects	Tree ants, House crickets, Black soldier fly, Common housefly, yellow mealworm, grasshoppers, locusts, crickets, silkworms	Rich in proteins, fats, vitamins, and minerals; highly variable nutritive composition; possible carriers of heavy metals, toxins, pollutants, and/or pathogenic organisms	Chalova et al. (2016); Fanatico et al. (2018); Khan (2018); Adeboye (2014)
10	Soil invertebrates	Caterpillars, Earthworms	Relatively high metabolizable methionine; rich in proteins, fats, vitamins, and minerals	Chalova et al. (2016); Khan (2018)
11	Mollusks	Mussel meal	High-quality protein source; similar to fishmeal	Adeboye (2014)
12	Kernels	Mango seed kernel flour	Has a significant amount of valuable nutrients and bioactive compounds	Yadav and Paudel (2022)
13	Seeds	Hemp seed, Sainfoin seed, Anise seed	Rich sources of protein and amino acids; highly nutritious and bloat-free	El-Hack et al. (2022a); Adeboye (2014)

2017; Tufarelli et al., 2018). Likewise, the limestone, phosphate rock, and oyster shell can be offered to supply calcium and minerals to the poultry diet. The oily fish meal can be used in the organic ration to have a well-balanced ration and healthy and sound organic birds (Biradar et al., 2011; Chalova et al., 2016; Singh and Sonwani, 2021). Further, certain insects belonging to orders Diptera such as black soldier fly, house fly, Coleoptera such as mealworms, Lepidoptera such as silkworm, orthopterans such as grasshoppers, locusts, and crickets have huge potential to be used as a protein source and other active substances such as polyunsaturated fatty acids, antimicrobial peptides for poultry feeds (Allegretti et al., 2018; Khan, 2018) (Table 3).

Vitamin B2 (riboflavin) is given through the diets, with other dietary parts which are produced through special non-GMO fermentations using GMO- free yeast in organic poultry productions. In keeping with Quander-Stoll and Leiber (2021), the alternative of riboflavin i.e., EcoVit R has been produced through GMO- a free fermentation process that is equally useful as the conventional Cuxavit B2. The addition of lactic acid or maize silage can be employed to induce gastrointestinal bacteria and improve edibility (Steenfeldt and Engberg, 2021). Certainly, many herbs, plant extracts, and spices can be also used as antimicrobial, antioxidant, anti-inflammatory, and growth inducers to improve poultry performance since these are multipotent in nature (Dhama et al., 2014; Tabatabaei et al., 2015) (Table 2). Furthermore, there are some positive effects of utilization of pasture in the organic and free-range system to attain better meat quality, forage intake, animal behavior, and animal welfare (Martínez-Pérez et al., 2017). According to Tabatabaei et al. (2015), it has been accounted that the cinnamon extracts can be utilized instead of antibiotics, since it can forestall lots of bacterial and fungal diseases including *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Aspergillus flavus* because of antibacterial and anti-fungal properties (Table no. 2). Accordingly, incorporating different combinations and concentrations of carvacrol and thymol can minimize the *Campylobacter* colonization and foster a consistent treatment regimen (Donoghue et al., 2015). According to Rumokoy et al. (2016), the natural feed additives can be derived from the systematic combination of Curcuma and black soldier fly (BSF) larvae flour. This natural additive can be utilized to increase carcass flourishment and incite productivity. Generally, synthetic Antibiotic growth promoters (AGPs) are used to induce weight gain in poultry production. But to maintain the organic standards, antibiotics should be prohibited (Salaheen et al., 2017; Tabatabaei et al., 2015). Moreover, Animal feed additives have also been created on the nanoscale. For poultry and animal feed, there are nano-sized liquid vitamin blends (Yadav et al., 2022). Following the ban on antibiotic growth promoters other alternative natural antibiotics such as probiotics, prebiotics, symbiotics, organic acids, essential oil, enzymes, immunostimulants, and photogenic including herbs, essential oils, botanical and oleoresins are popularly used feed additives in poultry industry for their antibacterial, antifungal, antiparasitic and antiviral properties (Diarra and Hammermeister, 2014; El-Hack et al., 2022a) (Table 2).

Table 4. Amino acid requirements of broilers

Amino acid	Requirement (%)		
	Starter	Grower	Finisher
Methionine	0.5	0.38	0.32
Methionine + Cystine	0.9	0.72	0.60

Source: Fanatico (2010); Fanatico et al. (2016a,b); Bieliński et al. (2018)

The broilers feed is categorized into three phases, i.e., starter, grower, and finisher phase, since as the birds develop, they require less amino acids and higher energy. They require CP levels of about 21-22%, 19-20%, and 18-19% respectively in the three phases (Akinbobola, 2018). On the report of the National Research Council (NRC), the Met+Cys requirements in the starter, grower, and finisher phase is 0.90%, 0.72%, and 0.60% respectively (Chalova et al., 2016; Fanatico, 2010) (Table 4). Since the synthetic Met can't be fed in organic poultry production, there is an interest in developing natural Met supplements through bacterial fermentation (Burley et al., 2016; Fanatico, 2010). According to Fanatico (2010), genetically modified organisms (GMO) aren't permitted in organic production. So, the Met producing bacteria should be selected on a natural selection basis, which is partially limited and requires a high cost. Thus, the Met supplementation can't be provided to the poultry so there should be a drastic increase in CP employment to meet the Met requirement efficiently (Burley et al., 2016; Chalova et al., 2016; Golden et al., 2021). Methionine (Met) and Cysteine (Cys), are fundamental supplements for the legitimate growth, development, and production of poultry (Burley et al., 2016; Fanatico et al., 2018). Since these compounds are the major organic sulfur source that is converted to sulfate after catabolism and support the functioning of connective tissues (Burley et al., 2016). Due to the sparing activity of the Methionine and liable methyl donor, it deliberately aids in the formation of essential compounds including choline, Cysteine, Epinephrine, Glutathione, and many more (Fig. 1) (Burley et al., 2016). Hence, by minimizing inputs of synthetic or isolated substances in poultry feeds, the naturalness of organic poultry production can be achieved (Leiber et al., 2022).

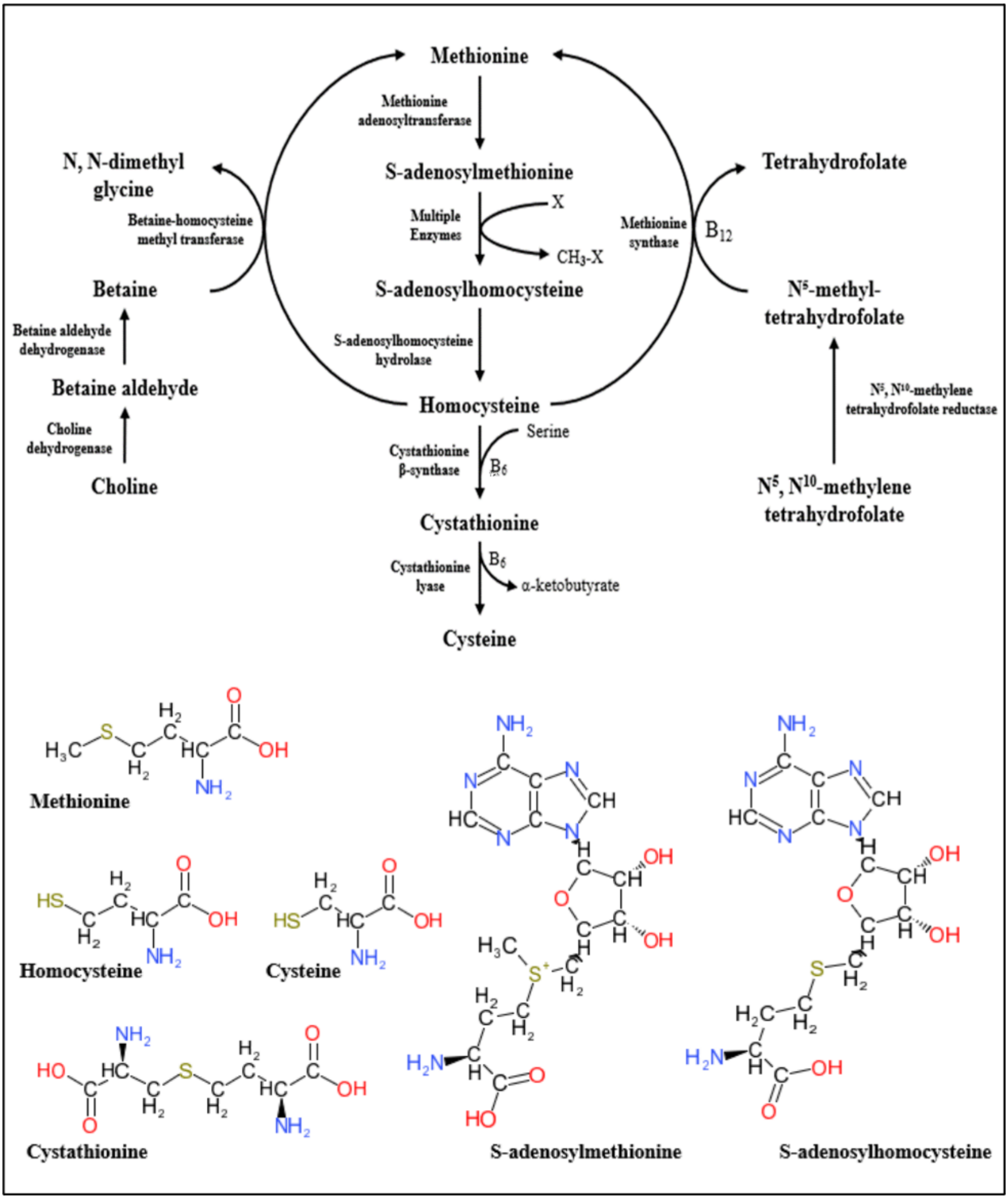

Figure 1. Interrelationship between Methionine and Cysteine. There is a complex relationship between these two compounds. The Methionine is converted to S-adenosylmethionine (SAMe) (which is the active form of Met), with an input of Methionine adenosyltransferase. The SAMe is then converted irreversibly to S-adenosylhomocysteine after giving off its methyl group and then further converted to homocysteine. The Homocysteine can be systematically remethylated by N5-methyltetrahydrofolate or Betaine to form Met. Likewise, the Homocysteine with the input of Serine is converted to Cysteine, through an intermediator called Cystathionine

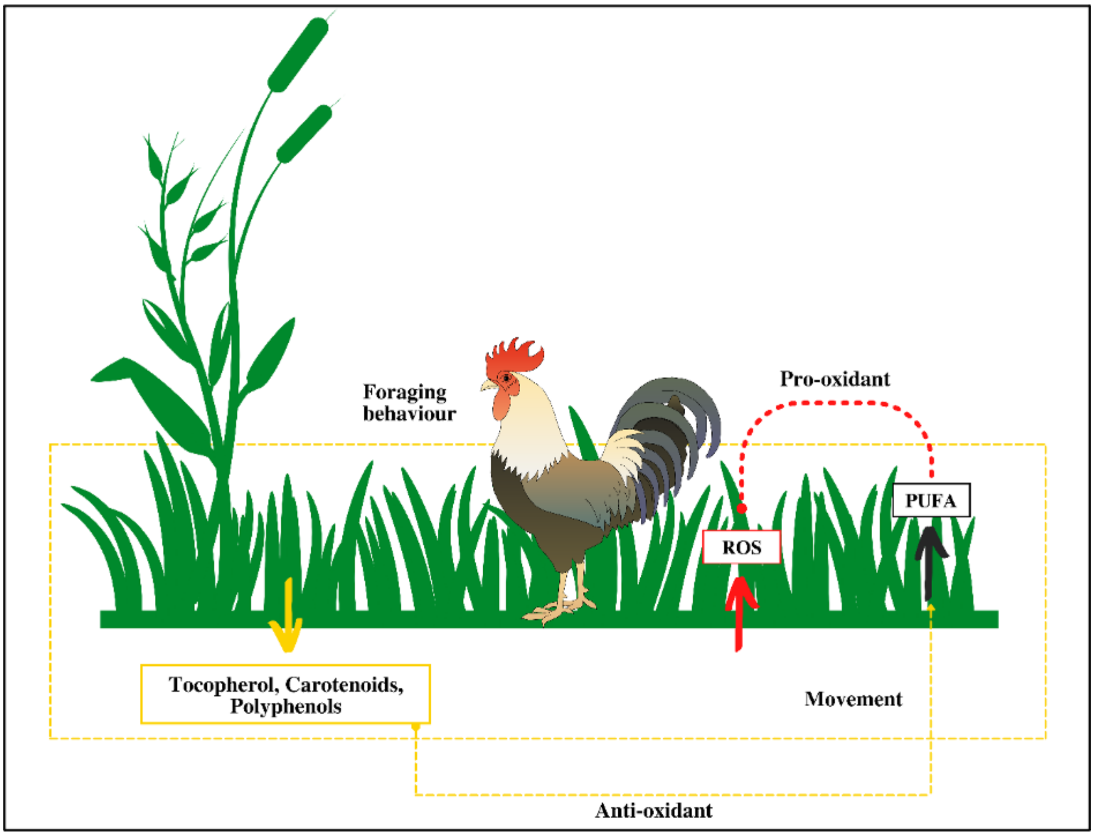

Figure 2. Oxidative balance in correlation to nutritive behavior and movement in poultry

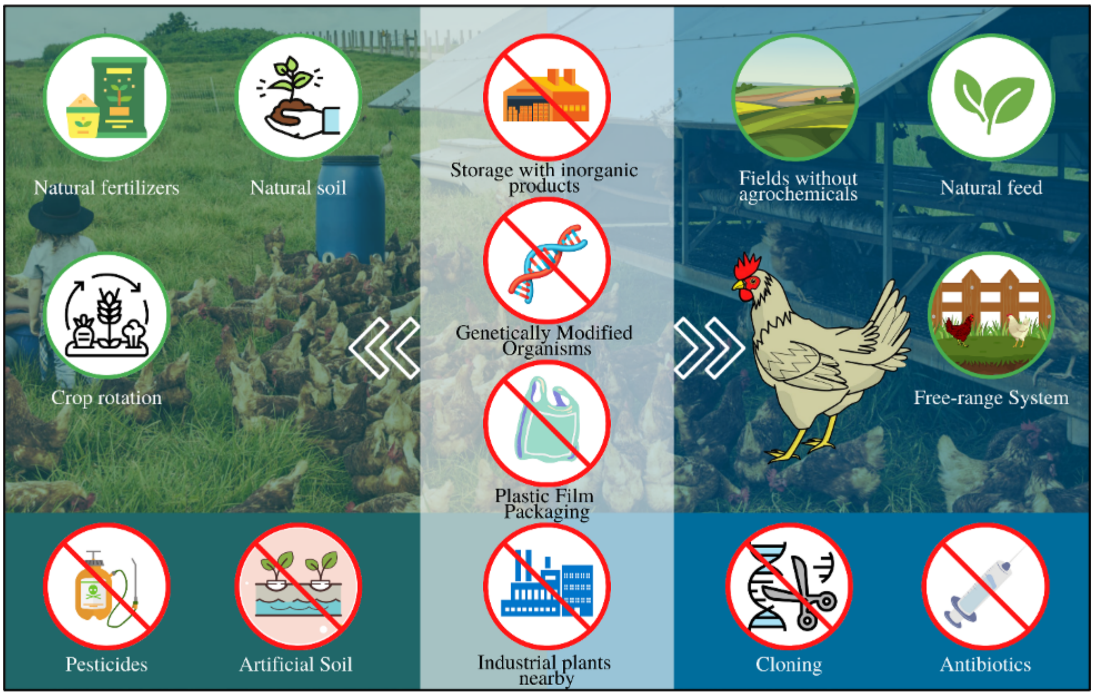

Figure 3. How organic products are produced

3.5 Outdoor management

Outdoor access is the primary feature of organic poultry production and one has to imply it to achieve the organic standards (Jung et al., 2020; Sossidou et al., 2015). In accordance with Acharya et al. (2021), the soil microbial diversity in the organic pasture is eventually higher, leading to a healthier association of soil-plant-animal nexus and supporting agricultural parameters. The birds should be given outdoor access when the feature changes and is proficient to regulate temperature. The pasture should be pivoted once a month to reduce pest pervasion risks and recuperate grazing (Sossidou et al., 2015). The access of organic chicken to the outdoor area is recommended to partly compensate for the nutritional needs for the transition to organic feed for birds (Adeboye, 2014). Their forage in the fields should be maintained in a vegetative state since they are profoundly digestible and preferred by the birds (Sossidou et al., 2015). Since grass is high in antioxidant chemicals, the bird's foraging activity has an impact on its oxidative state. Birds' kinetic activity elevates the oxygen demand, which raises the number of reactive oxygen species (ROS) in blood plasma and tissues. ROS has a pro-oxidant effect on polyunsaturated fatty acids in particular (PUFAs). The presence of tocopherols, carotenoids, and other bioactive chemicals are absorbed by the grass in a living system (Mancinelli, 2017) (Fig. 2). Likewise, the outdoor stocking density should be maintained at 4 m^2/bird, which implies environment enrichment and animal welfare. Largely, outdoor access allure the external predators so anti-predatory strategies should be implemented (Sossidou et al., 2015).

3.6 Breeding management

The breeding objective shouldn't oppose the animal's natural behavior and should select the breeds which are approximately 81 days old (Biradar et al., 2011; Singh and Sonwani, 2021). Likely, those breeds that are more lenient and adaptable to local scenarios ought to be selected such as the indigenous breeds, they can cope better with harsh conditions (Biradar et al., 2011; Erensoy et al., 2016). A timely and substantial diagnostic approach should be carried out to achieve parasitological screening (Tamara et al., 2019). Accordingly, the pure, hybrids (slow-growing breeds), and autochthone breeds are appropriate for organic poultry production (Erensoy et al., 2016; Mitrović et al., 2018). In accordance to Erensoy et al. (2016), though the slow-growing breeds are less efficient in producing the slow and moderate growing genotypes are suitable strains regarding health, behavior, and production. By selecting the native breeds such as yellow leg partridge and Rhode Island red, we can produce organic slow-growing chickens which could be a valuable source of organic poultry products (Sosnówka-Czajka et al., 2017). The natural reproduction technique is promoted whereas artificial insemination is allowed under veterinary necessity. The utilization of hormones at the hatcheries level is prohibited and should not be used to address organic standards (Singh and Sonwani, 2021) (Table 5). Since the meat quality is greatly affected by the breed's genetic lines. So wise selection is necessary to influence every parameter of rearing systems (Sokołowicz et al., 2016). The indigenous chicken has better immunity and prominent adaptability to the local conditions (Rehman et al., 2016). In the opinion of Rehman et al. (2016), the Aseel indigenous breed found in India-Pakistan (Asian regiment) subcontinent has highly aggressive behavior, muscular legs, upright posture, strong shoulders, narrow sternum, and small wattles, therefore highly suitable for organic poultry farming in Asian subcontinents.

4 Consumer perceptions and opportunities

The consumer demand for organically produced foods is increasing worldwide for over a decade (Donoghue et al., 2015). The main factor behind this could be increasing demand from consumers who are looking for safer and quality food products from a healthy environment and animal welfare perspective. Consumers desired organic poultry meat is characterized by low-fat content and has distinct color, taste, and aroma (Mancinelli, 2017). In the U.S. organic poultry meat is the most commonly accessible and utilized organic product, followed by eggs which are preferred by above 70% of the consumers (Donoghue et al., 2015). Poultry meat is well accepted by consumers of all ages, religions, nations, and regions. Since poultry meat is affordable and provides higher nutritional benefits at low expenditure (Castromán et al., 2013; Pottiez et al., 2012). Organic poultry meat exhibit significantly higher protein content and lower fat and lipid content that improves performance and meat sensory, further inducing polyunsaturated fatty acids (PUFA) in the breast, thigh, and drum stick (Abbas and Ahmed, 2015; Castromán et al., 2013). The production of certified organic products significantly tripled in the U.S. in 2005-5009, to over 2.4 million certified organic layers, 32 million certified organic broilers, and 0.3 million certified organic turkeys (Donoghue et al., 2015; Rajan et al., 2016). Likewise, the organic poultry has a higher percentage of muscles in the breast and thigh due to the induced physical activity, and feed consumption but on the other hand, showed poor feed conversion ratio (FCR) (Abbas and Ahmed, 2015). In accordance with Adisa et al. (2017), organic eggs are rich in omega 3 fatty acids and omega 6 fatty acids. Apart from nutritional benefits organic poultry meat is tastier and exhibits a 9.0 rating based on its meat quality on appearance,

Table 5. Certain international standards on organic poultry production for organic certification

Sl	Criteria	Descriptions	Standards	References
	Stock management			
1	Source of chicken	Organic must be used if available, under organic management after 3 days	SOIL ASSOC. (UK)	Aksoy (2014); Rocchi et al. (2021)
		Under organic management after 2 days	USDA NOP	
		Organic must be used if available or under organic management after 3 days	EU	
2	Min. slaughter age	Min. age: 63 days	BIO SUISSE	Karcher and Mench (2018)
		Min. age: 81 days	EU	
3	Conversion duration	56 days	BIO SUISSE	Aksoy (2014); Erensoy et al. (2016)
		10 weeks	EU	
		63 days	EU	
	Feed and feeding			
1	General feeding	%100 organic	USDA NOP	Martínez-Pérez et al. (2017); Adeboye (2014); Sumitha et al. (2017)
		%100 organic	EU	
		Allowed non-organic feed %15	IFOAM 2002	
2	Essential amino acids	Prohibited (temporary exception for methionine)	USDA NOP	Burley et al. (2016); Erensoy et al. (2016); Golden et al. (2021)
3	Animal protein	Prohibited	EU	Chalova et al. (2016)
		No intensive additions	UKROFS	
		Dairy products, fishmeal	SOIL ASSOC. (UK)	
		Local certifier to specify	IFOAM 2002	
	Housing manag.			
1	Indoor area	At least 1/3 area of the floor with solid material	EU	Fanatico (2010)
		At least ½ area of floor with solid material	SOIL ASSOC. (UK)	
2	Outdoor area	At least 1/3 of chicken's lives	EU	Fanatico et al. (2018, 2016a); Jeni et al. (2021); Adeboye (2014)
		At least 2/3 of chicken's lives	SOIL ASSOC. (UK) USDA-AMS IFOAM	
3	Equipment	Min. feeder space: 2.5 cm/chicken Min. drinkers: 1 nipple/10 chickens	SOIL ASSOC. (UK)	Erensoy et al. (2016)
4	Max. flock size	4, 800 chickens per house	EU	Singh et al. (2021); Souillard et al. (2019)
		500 chicken per house	SOIL ASSOC. (UK)	
5	Max. outdoor density	4 m2 /chicken	EU	Mitrović et al. (2018)
		2,500 chicken /ha	SOIL ASSOC. (UK)	
6	Pasture rotation	Rest pasture for 2 months/year & 1 year in every 3 years	SOIL ASSOC. (UK)	Erensoy et al. (2016); Vaarst et al. (2015)
7	Waste management	To manage manure so that it does not contribute to the contamination of crops, soil, or water	NOSB	Chander et al. (2011)

Table 5. (continued) Certain international standards on organic poultry production for organic certification

Sl	Criteria	Descriptions	Standards	References
	Health context			
1	Antibiotics	As a final resort, it is permissible	FOAM 2002	Alagawany et al. (2018); Diaz-Sanchez et al. (2015); El-Hack et al. (2022a); Kim et al. (2018); Millman et al. (2013); Micciche et al. (2018); Souillard et al. (2019)
		Not permitted	EU	
		As a final resort, it is permissible	USDA NOP	
		Not permitted	FDA	
		Not permitted	USDA	
2	Plant compounds	Permitted	USDA-NIFA	Arsi et al. (2017)
	Transportation	Max. 8 hours	ASSOC. (UK)	Erensoy et al. (2016)
		Max. 10 hours	UKROFS SOIL	

flavor, juiciness, and tenderness to a 7.1 rating for conventional meat. Those compounds are responsible to diminish the risk of cardiovascular diseases in humans and potentially attribute to human health quality (Abbas and Ahmed, 2015; Castromán et al., 2013).

Moreover, the utilization of the combination of chemicals in conventional poultry production contributes to some of the major human health diseases like heart diseases, drug resistance, and even cancer (Adisa et al., 2017). Due to this, the rising consumer demands for high-quality meat products are reflected in the major changes seen in the management of sectors involved in chickens' meat production and enterprises involving standards of refrigeration, freezing processes, and marketing (Giampietro-Ganeco et al., 2018). Along with this, consumers perceive organic poultry as safer due to no use of antibiotics, no added preservatives, and chemicals in the feeding. Organic poultry production has persuaded the consumers to be a gateway food that is healthier and safer than conventional foods because of the preclusion of chemicals and pesticide usage (Sossidou et al., 2015). However few researchers reported that the degrees of omega 6 fatty acids in conventional poultry production systems result in more than inorganic or free-range poultry systems. Moreover, there is transparency in the report of the organic poultry system in terms of chemical, nutritional, and health status. So, more research and studies are needed in this field to address disease detection, biosecurity, awareness, and true nutritional and chemical results (Adisa et al., 2017; Vaarst et al., 2015).

5 Major constraints

Organic poultry has a higher risk of being infected by foodborne pathogens including *Clostridium*, *Campylobacter*, and *Salmonella*, and spreading zoonotic diseases because of the increased contact with external vectors and multiple avenues but the prevalence of these diseases is greatly retained at an intensive level (Donoghue et al., 2015; Micciche et al., 2018; Sossidou et al., 2015). As per Elson (2015), the prevalence of food-borne diseases in organically reared ones was 98.1% whereas, it was just 32.8% in free-range birds. Moreover, almost of small and marginal poultry farmers have inadequate knowledge and awareness of organic poultry production. The strict measures to attain sanitary standards are the biggest obstacles for them (Biradar et al., 2011). The rigorous standards set by certifying agencies for the manufacture of organic products may be a barrier to the growth of this industry (Fig. 3) (Martynova et al., 2021). In accordance to Adisa et al. (2017), poultry farmers are somewhat aware of organic products but they are unaware of the management and practices that are the significant fundamentals for producing organic poultry. The mortality rate in organic poultry production is higher compared with conventional poultry production. The shortage of higher resistant and tolerant strains, academic research, and the high cost of chicks can be the primary cause (Singh et al., 2021). Additionally, the unsystematic marketing because of the seasonal variation in the demand and consumption rate of eggs and meat, improper marketing channel, fluctuation of prices, and inadequate production poses a great challenge that constraints organic poultry production (Elkhoraibi et al., 2017; Sivachandiran, 2020). Following, other constraints include lack of capital, high cost of chicks, lack of access to organic feed ingredients, intensive labor, unavailability of chicks round the year, lack of technical and management skills, shortage of vaccination and deworming, and higher predation in the housing (Adisa et al., 2017; Singh et al., 2020).

6 Conclusion

Alternative poultry systems continue to grow and their market demand for organic and naturally produced poultry meat increase. Similarly, it is also crucial that feed additives are developed to protect bird health and minimize mortality and pathogens in the evolving organic poultry industry. A wide range of potential sources of prebiotics such as cereals grains and some forages are to be accessed for versatile applications in raising organic poultry. Likewise, several interventions are to be applied to assure poultry health and hygiene, and free from diseases. Appropriate housing and nutrition for poultry play a significant role in the management of stock density, preventing overcrowding, stress, and nutritional deficiency. More importantly, organic poultry growers need to be more focused on key-requirement like feeding, housing, breeding, health, and stock management to boost poultry production. As a symbol of purity and quality, organic poultry thrives to sustain following the ill effects of conventional farming. Therefore, greater emphasis on organic poultry may overlay a wider perspective that can help poultry growers/farmers to produce safer poultry products without compromising the poultry welfare.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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