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ANTIBIOTIC ALTERNATIVES TO PRODUCE ORGANIC POULTRY MEAT AS A SAFE FOOD SOURCE AND THE IMPACT OF ITS CONSUMPTION ON HUMAN HEALTH – A REVIEW

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Abstract

The scientific evidence on the effects of consuming organic chicken meat on human health is examined in this review article. Few studies particularly look at the effects of eating organic chicken meat on people's health. Although the evidence is conflicting, they speculate that consuming organic chicken meat may reduce the incidence of obesity and allergy-related illnesses. Customers who purchase organic chicken meat generally have healthier eating habits. The significance of these discoveries for human health is unclear. Still, animal and poultry studies suggest that whether agriculture produces food from conventional or organic sources has different effects on early development and physiology. Omega-3 fatty acids and meat are more abundant in organic than in common meat. However, this is not nutritionally relevant compared to other dietary sources. The widespread use of pharmaceuticals is one of the primary drivers of antimicrobial resistance in traditional animal agriculture. It is possible to reduce this risk and potentially have significant positive effects on public health by preventing animal sickness and using antibiotics more sparingly, as is done in organic farming. The review highlights the importance of organic feeds as an effective and vital alternative to antibiotics in the poultry industry and their impact on human health.

Key words: organic farming, antibiotics, chicken meat, human health

The poultry industry is facing a significant setback in the form of infectious diseases (Fayyaz et al., 2022). The control of such diseases, especially those of bacterial origin, is usually treated by antibiotics. However, the irrational and excessive use of commercially available antibiotics has led to the development of antibiotic resistance (Malik et al., 2022; Sagor et al., 2022). This development of resistance is rapid and widespread, leaving no option for sustainable control of poultry pathogens. The issue of antibiotic residue in poultry products is also of serious concern. In this scenario, there is a dire need to explore alternatives to commercially available antibiotics that are effective and safe for use in poultry. Such alternatives may be probiotics (Gul and Alsayeqh, 2022; Rashid et al., 2023) and a nanotechnological approach (Saad et al., 2023). The probiotics derived from *Bacillus* (Rashid et al., 2023) and *Limosilactobacillus* (Mehmood et al., 2023) are found to be effective against salmonellosis in poultry. Their growth-promoting effect in poultry flocks is also well documented.

Organic poultry farming is growing in popularity within the borders of the US, with an approximate 17% rise in healthy poultry and slaughtered meat production, which made a $991 million contribution in 2016 (OTA, 2017). Additionally, the growing of standard chicken results in significantly lower net profitability than sales of naturally produced chicken meat, making it lucrative for the producers despite manufacturing organic meat being more expensive than normal poultry (Cobanoglu et al., 2014). Organic farming minimizes synthetic compounds in agriculture to minimize human, animal, and environmental impacts, focusing on sustainable practices (Fanatico et al., 2009; Gamage et al., 2023).

Organic feed additives are crucial in the poultry industry, a major animal protein source. Feeding accounts for approximately 60% to 70% of the costs associated with chicken production. An essential factor is the optimal utilization of feed (Llanes and Ramirez, 2022; Mohamed et al., 2024). Various researchers (Abd El-Hack et al., 2023 a; Kamal et al., 2023 a, b; El-Ratel et al., 2024) have found that natural feed additives improve bird and farm animal growth performance and carcass traits, enhancing immunity and efficiency.

Abd El-Hack et al. (2022) found that organic feed additives, which are simple to mix, boost feed intake, immune systems, digestion, nutrient availability, antibiotic use, antioxidants, and anti-inflammatory agents. One of the most urgent requirements for producing organic livestock and poultry is compliance with organic standards, according to the Organic Farming Research Foundation (OFRF, 2007). Additionally, selenium nanoparticles (SeNPs) and zinc nanoparticles (ZnNPs) have been found to increase broiler productivity and improve carcass traits, health, and meat quality at varying levels (Abd El-Hack et al., 2024 a, b).

Growth-promoting antibiotics improve chicken performance and solve this low output issue. However, when these antibiotics are used in excess, microbes become resistant, and issues with their residues in the human food chain arise (Deepak et al., 2020; Uddin et al., 2021). Many plant and herb extracts and metabolites have demonstrated outstanding potential to increase the manufacture of chicken and safeguard bird health, and as a result, they are becoming more popular as antibiotic alternatives (Tiwari et al., 2018; Abdelli et al., 2021; Hartady et al., 2021; Seidavi et al., 2022).

Due to its taste, quality, and affordability, people highly value poultry. It is a top protein source and a strong competitor in the edibles industry. The demand for chicken has led to modern poultry farms, raising layers for egg production and broilers for meat (Wang et al., 2017). Furthermore, broilers typically weigh greater than or equal to 1.5 kg at the end of three months (Khan and Ahmed, 2014). This period must be cut down significantly to satisfy the widespread demand for chicken (Ahmad et al., 2017). To improve chicken growth in less time, specialized poultry feed has been brought to the market (Iqbal et al., 2016).

Two types of poultry feeds are grill diets, primarily proteins and lipids for rapid weight growth, and calcium-enriched diets for layer hens, which are crucial for egg development (Borda-Molina et al., 2016). Organic broilers are fed natural grains and grit, while traditional broilers provide professional meals, resulting in varying nutritional profiles and meat composition (Boysinova et al., 2024). Organic animal production offers a solution to rural development and declining farm profitability by controlling breeding, housing, food, and medical care, promoting weight increase and growth in broilers, and consumption by the population (Bayer and Kühl, 2024).

Organic chicken meats

The health status of organic cattle is complicated, and each farm will require a different approach to disease prevention (Kijlstra and Eijck, 2006). The components used to produce organic chicken meat are shown in Figure 1. There was a consensus of 40 between the output and mass of the weighed-out samples/cuts from the items under examination, with the average carcass weight of the organic and conventional chickens being roughly the same ($P>0.05$). All portions/cuts of the organic chicken carcass that were analyzed, except for the breast, displayed higher weights and yields than those of the conventional chicken (Abdullah and Hulánková, 2021). Contrarily, every chest from a commercial chicken weighed considerably more than 100 g than each chest from an ecological chicken. The breast produced most of the carcass cuts/portions, making up around a third of each normal chicken carcass (32.8%). In general, each organic broiler's structure of the breast was smaller, thinner, and longer when compared to conventional chicken, and the weight of an organic chicken's thighs (muscles and bones of thighs) was noticeably larger than a typical chicken. The yield of thighs (32.86%) in the organic chicken carcass was the highest of all the cuts or portions. Organic chickens also possessed significantly higher tibia bones (12.24 cm), which contributed to their higher legs than conventional chickens (10.27 cm) and heavier ($P\leq0.01$) wings than broilers raised in a conventional system. The naked eye made it easy to see that the meat on organic chicken wings was larger (Abdullah and Hulánková, 2021).

Compared to the poultry's control group, neither existed appreciable alterations in the meat's formulation of fatty acids, claim Kucheruk et al. (2019). There is a modest rise in palmitoleic, linoleic, and caprylic acids. Additionally, when comparing the meat of organic and intensively raised grilled chickens, it was found that the latter had a substantially reduced fat content, which is good news for the meat's nutritional qualities. It has been determined that organic grill chickens have a higher concentration of omega-3 to omega-6 fatty acids ratio in the proper range of omega-3 fatty acids. Compared to healthy chicken meat from the commercial channel, it has a 3–5% reduced amount of conventional chicken meat. Additionally, according to Kucheruk et al. (2019), in the meat of hens, omega-3 fatty acids increased by 0.8%, whereas omega-6 fatty acids were reduced by 7.57% in chickens raised using organic technology compared to chickens raised using conventional technology. Thus, the importance of organic chicken meat resides not only in its biological value and dietary attributes but also in the fact that there are no antibiotic drugs, pesticides, or herbicide residues.

Castellini et al. (2002) and Combes et al. (2003) examined the poultry farms' natural and traditional quality criteria. The first investigation compared different types of chicken meat. In contrast to the conventional farming technique, where broilers were grown in cages, organic farming allowed them access to the outside. The raw components used to make the organic chicken feed were also organic. Compared to chickens raised organically, less post-slaughter bulk was discovered in the breast and thigh flesh. However, their meat was distinguished by having less belly fat and more iron. According to the researchers, the organic chickens' lower total body mass and slower growth rates were brought about by their higher activity levels (which were supported by behavioral observations) and higher energy costs associated with thermoregulation. Studies on the substance makeup of poultry produced by both methods revealed that organic meat had a greater concentration of fatty acids than those that are unsaturated and heavy and a lower concentration of monounsaturated. Significant variations were discovered, particularly in the quantity of n-3 acids, such as docosahexaenoic acid (DHA), whose concentration was twice as high in organic chicken meat as in typical chicken flesh. This is probably brought on by the vegetation that livestock consumes. The potential of organic poultry to bind water was shown to be less effective at lower pH levels, which led to higher cooking loss rates. The research of Combes et al. (2003) did not support the relationship between a method of production and meat pH. However, organic was shown to have a lower total fat content in both assays, attesting to its superior dietary benefit (Castellini et al., 2002; Combes et al., 2003).

According to a research investigation where a sensory board was used, the meat from organic chicken breasts was more succulent and had a superior overall flavor than the flesh from conventional chickens of the same part. Eggs have played a significant role in the human diet for countless years. Eggs, which have a variety of useful qualities like retaining water, emulsifying, and foaming, have evolved into a staple element in many cuisines. According to McNamara and Thesmar (2005), the human organism needs fatty acids, essential amino acids, proteins, cholesterol, vitamins, and minerals, all abundant in eggs. The fundamental goal of the laying hen is to create new life, not to generate high-quality food for people. As a result, bird eggs include essential components as a way of existence, and much of the molecules within them exhibit the biological process. Therefore, an excellent source of unprocessed products is hen eggs for traditional food and pharmaceutical businesses and for nutritious diets that promote health (Huopalahti et al., 2007).

Egg production involves various systems, including battery cages, barn structures, outdoor spaces, and pastured settings. Organic egg farmers only use antibiotics during infectious epidemics. Research shows that various housing arrangements impact egg quality, with hen diet and farming practices affecting egg health. Organically raised chickens have fewer yellow breasts, thighs, and skin parts than conventionally raised chickens (Güçcük and Alkan, 2024).

When pasture was commonly available, organic eggs had greater omega-3 fatty acid content and reduced omega-6/omega-3 ratio. Following prevailing natural laying hen requirements, hens were either housed inside a standard housing system (the “control”), with access to 4 m^2 of pasture per hen (the “organic”), or with access to 10 m^2 of pasture. Organic eggs are more brittle than conventional eggs but are lighter, less colored, and have a lower yolk-to-albumen ratio. However, few studies have been conducted on eggs (Mugnai et al., 2014; FAO, 2019). Organic eggs have a decreased eggshell breaking point and a smaller yolk-to-albumen percentage than conventional eggs, making them much lighter. Additionally, it was shown that organic eggs had lower eggshell-breaking strength and a lesser coloration on the organic yolk (Breithaupt et al., 2003).

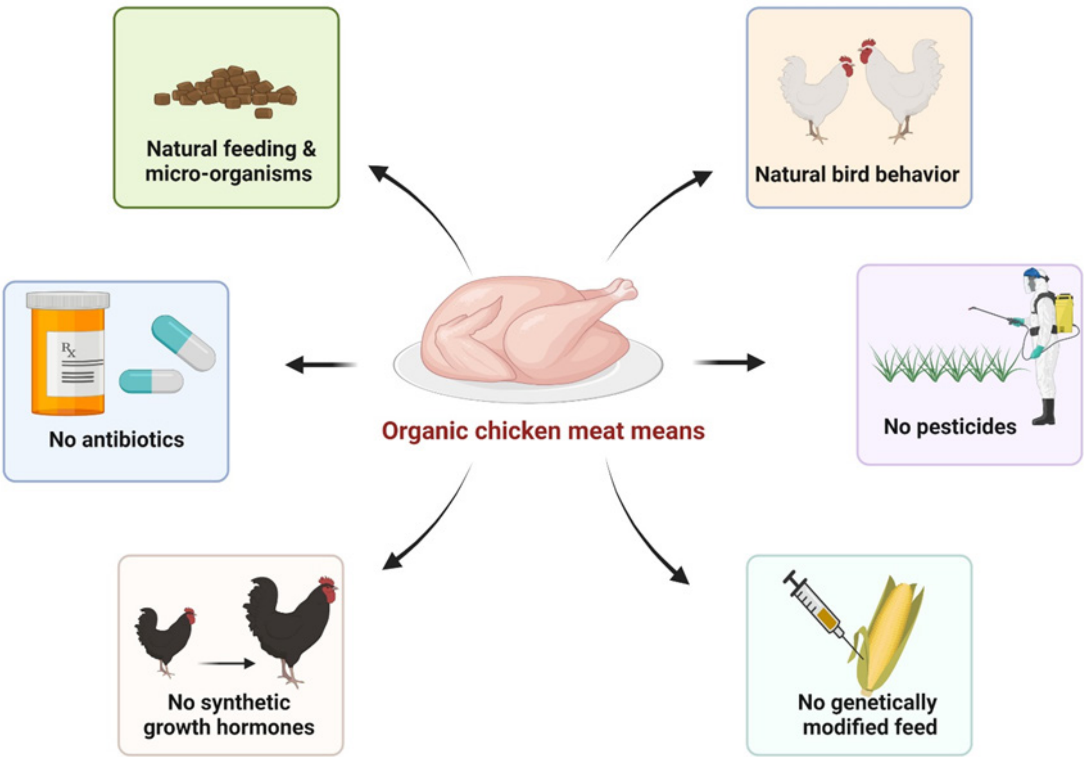

Figure 1. Elements of organic production of chicken meats

GMO substances, manufactured elements (premixes, amino acids), bone and meat meal, and items that are not verified organic and more are prohibited for organic poultry production (Kucheruk et al., 2019). Compared to retail chicken meat, traditional organic chicken meat contains 7.57% fewer omega-6 fatty acids and 0.8% more omega-3 fatty acids (Kucheruk et al., 2019). Additionally, confinement conditions impact a bird's body's physiological and biochemical processes. This unquestionably influences the meat's composition and quality, particularly the fatty acid ratio (Yepyk and Petrenko, 2018; Castellini et al., 2019). According to Dalziel et al. (2015), compared with traditional chickens, natural hens had less lipid content and higher cis-monounsaturated fatty acids. The quantity and proportion of triacylglycerols in the lipids contain several intriguing fatty acids, namely omega-3, omega-6, and omega-9. Since complete cell regeneration is impossible without them, these fatty acids have the highest biological value (Yepyk and Petrenko, 2018).

Based on differences in the biological consequences of linoleic and linolenic acids as well as features of their digestion, two families of significant fatty acids – the group of linoleic acid, or omega-6, and the grouping of linolenic acid, or omega-3 – were divided (Dalziel et al., 2015). The three primary omega-3 polyunsaturated fatty acids are linolenic acid (C18:3), eicosatetraenoic acid (C20:5), and docosahexaenoic acid (C22:6). In contrast, the two omega-6 families are represented by linoleic (C18:2) and gamma-linolenic (C18:3) acids. Since the human body can synthesize neither category of fatty acids, they must always come from outside sources together with other nutrients. Oleic acid (C18:1), arachidic acid (C20:1), erucic acid (C22:1), and nervonic acid (C24:1) are all members of the omega-9 family. Despite being relatively prevalent, the unsaturated omega-9 fatty acids category has not been extensively explored. The most significant is oleic acid (C18:1), which lowers undesirable cholesterol in bodily tissues. Although omega-6 and omega-3 fatty acids are considered more significant, omega-9 fatty acids are more uncomplicated to digest. Since their function in cholesterol metabolism, their effects on the skin, and their part in preventing atherosclerosis, attention to polyunsaturated fatty acids has grown (Hibbeln et al., 2006). The high omega-3 fatty acid level of the product aids in the prevention of numerous diseases, especially cancer. Increasing the nutritional value and security of chicken meat is essential for farmers, as customers choose natural and organic meals.

In fixed organic poultry housing, there can be no more than six hens/m^2, as opposed to a maximum of nine hens/m^2 in traditional laying hen housing. Unlike conventional broiler production, which can use up to 42 kg of live weight/m^2, organic broiler production has a maximum density of 10 broiler chicks/m^2 in stable habitation (with an acceptable live weight/m^2 of 21 kg). Furthermore, organic hens and broilers have access to a minimum of 4 m^2 of outdoor space per animal, which may include a porch or winter garden. According to Kijlstra and Eijck (2006), the objective of the organic rules is to provide birds with access to a large, enriched, and natural environment so they can engage in more organic behaviors and have more opportunities to stay in excellent health. In the end, this would result in fewer animals requiring preventive medication.

Use of some herbal extracts and spices in poultry and human nutrition

Numerous research and review papers have demonstrated the therapeutic effects of several plants, some of which are listed in Table 1. Natural growth promoters are increasingly being used in place of antibiotic growth promoters. Different natural growth boosters are employed globally for this purpose. Antibiotic alternatives include prebiotics, probiotics, organic acids, enzymes, antioxidants, and botanicals. Due to their variety of therapeutic properties, botanicals and their extracts are good alternatives (Wenk, 2003; Das et al., 2012; Rana et al., 2014). Spices and herbal extracts substantially impact bird species' production and health.

Table 1. Use of some herbs as well as spices and their main functions for the improvement of poultry production and human public health

Herbs (their forms)	Functions
Garlic	Antioxidant, immunostimulant, growth-promoting, and T-cell booster
Onion	Antioxidant, antihelmintic, effective in diarrhea, skin infections
Ginger	Growth-promoting, antioxidant, and helpful for eye and diarrheal disorders
Curcumin	Growth promoter, immunomodulator, antioxidant, anti-inflammatory, antiseptic, hypoglycemic, hypolipidemic
Echinacea	Good immunostimulant for diseases of the stomach and the upper respiratory tract.
Rosemary	Growth promoter, antioxidant
Thyme	Growth promoter, antioxidant, immunomodulator, antimicrobial, antilipidemic
Cinnamon	Growth promoter, antioxidant, immunomodulator, antimicrobial
Black pepper (*Piper guineense*)	A strong antibiotic and fungal agent can eradicate many Gram-positive and Gram-negative bacteria and a considerable number of fungus varieties causing serious human illnesses.
Hot red pepper	Immunomodulation, antioxidant, and anti-inflammatory activities.
Grapeseed oil	High proportions of unsaturated fatty acids, high levels of vitamin E, high levels of linoleic acid (important for prostaglandin production, which controls platelet activation and inflammatory reactions), and low cholesterol levels have many advantages for human consumption.
Chamomile oil	Hypoglycemic, hypotensive, hypolipidemic, antiallergic, antidepressant, and neuroprotective activity. Anticancer, anti-infective, anti-inflammatory, antioxidant, and neuroprotective properties.

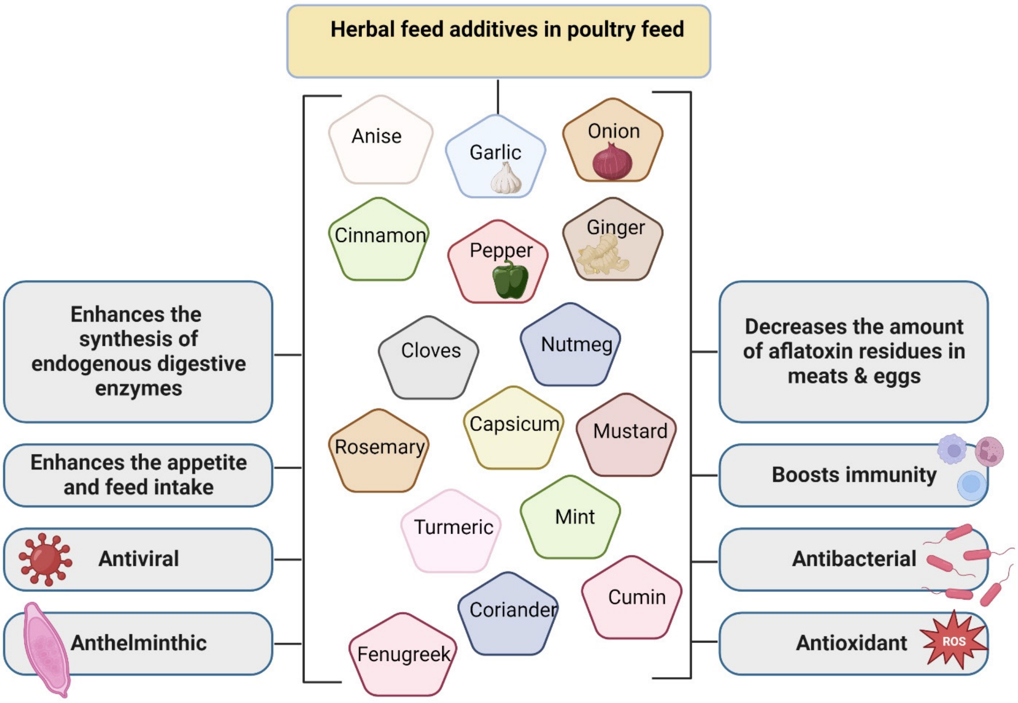

Figure 2. Herbal extracts and spices in poultry and human nutrition

Herbal extracts or other active ingredients in bird food may have advantages such as enhancing the synthesis of endogenous digestive enzymes, enhancing appetite and feed intake, and possessing antioxidant, antiviral, antibacterial, anthelminthic, and immunity-boosting properties. Isoprene derivatives, flavonoids, glycosylates, and other plant compounds may affect the biological and biochemical function of the bird's gut (Wang et al., 2024). According to Abd El-Hack et al. (2023 b), the food and feeding business could use probiotics and prebiotics to reduce aflatoxin concentrations in milk, eggs, and meats. As a result, probiotics and prebiotics may be practical strategies for reducing the harm that aflatoxin does to the chicken industry's profitability and the general population. The production of poultry and other animals is at risk from various infections, which could cause significant financial losses (Muanda et al., 2011).

Chicken operations increasingly use natural feed additives due to limitations on applying certain antibiotics, potential side effects, and cost efficiency. Herbs, spices, and extracts can be utilized in various ways (Suganya et al., 2016). They encourage feed intake, increase the immune system, and function as antioxidants in addition to having antibacterial, coccidiostatic, and anthelmintic effects. Nutmeg, cinnamon, cloves, cardamom, coriander, cumin, anise, celery, parsley, fenugreek, capsicum, pepper, horseradish, mustard, ginger, garlic, onion, rosemary, thyme, mint, and turmeric are among the most commonly utilized botanical feed additions in feed for poultry (Figure 2) (Suganya et al., 2016).

Chicken meat is essential for human nutrition

The breasts, drumsticks, and thighs are the best-quality sections of the broiler carcass. 75.27–86.01% water, 21–23% protein, 1.90–1.97 fat, and 0.74–0.77% collagen comprise breast muscle composition. The thigh muscles include 19.03–19.93% protein, 4.70–6.05% fat, and 0.91–1.13% collagen. Compared to dark meat, more potassium and magnesium are found in white meat, and less zinc and iron are found. There are 12.5–13.5 g of protein, 10.7–11.6 g of fat, and 1.0–1.1 g of minerals in 100 g of edible egg portion. Eggs provide 167 kcal of calories per egg. Leucine, isoleucine, lysine, arginine, valine, and phenylalanine are essential amino acids particularly abundant in eggs. Also, eggs have many vitamins and macro- and micro-elements besides the A, D, E, K, and B-complex. Eggs and meat supplemented in nutrients (polyunsaturated fatty acids n-3), eicosatetraenoic acid, docosahexaenoic acid, selenium, and lutein) meet the requirements for functional food status due to their increased value and benefits to human wellness (Figure 3) (Kralik and Kralik, 2017).

Several variables, including age, feeding, housing, hybridization, carcass components, and meat type, influence the nutritional content of poultry meat. It is necessary to design preventative measures against the subject's dangerous elements. Spices and medicinal plants with growth-promoting characteristics must replace antibiotics, antibacterial characteristics, and more healthy advantages to address antibiotic resistance pathogen development (Marangoni et al., 2015). In addition to fat-soluble vitamins, poultry flesh contains sizable levels of B vitamins, including pantothenic acid, pyridoxine, and niacin. Different forms of meat contain varying amounts of biologically significant minor components for people's physique, including iron, zinc, and copper. The vital trace element selenium, which has antioxidant and anticarcinogenic characteristics, is also abundant in poultry meat (Marangoni et al., 2015; Kralik and Kralik, 2017).

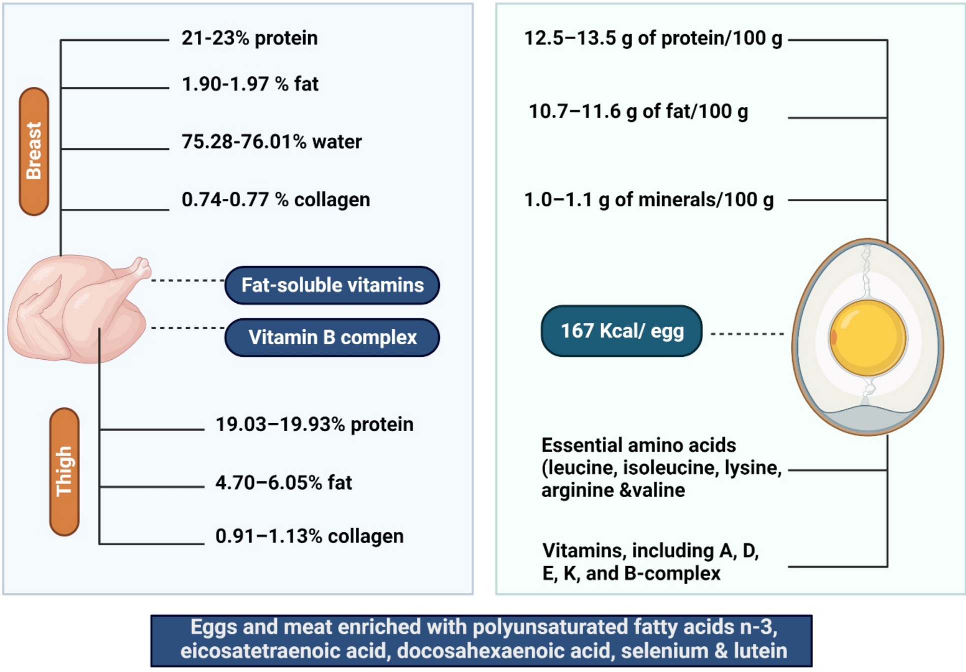

Figure 3. Nutritional composition of chicken meat and egg

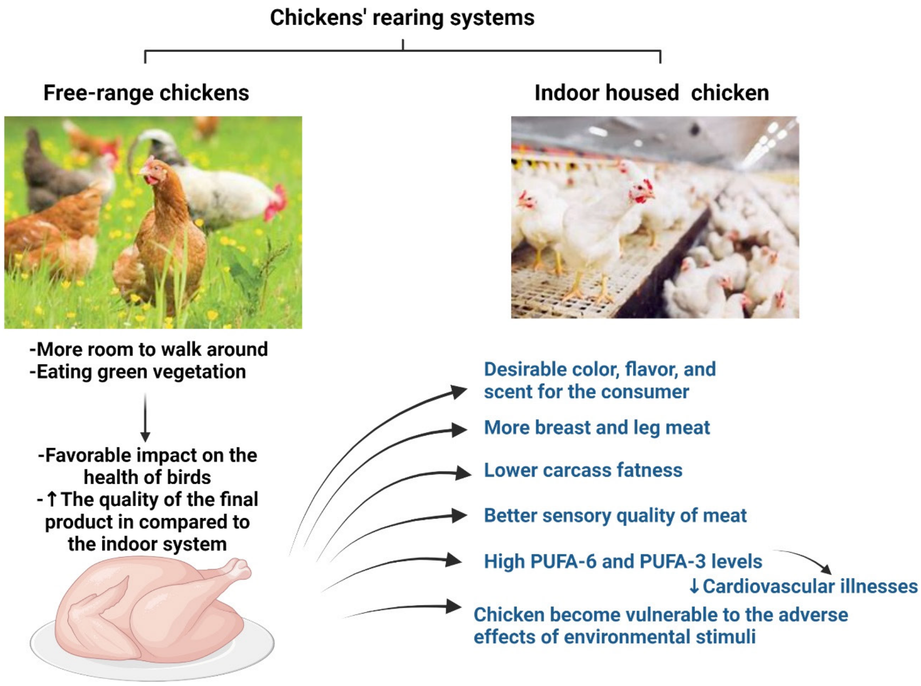

Figure 4. Effect of the organic production system on bird's performance and meat quality

Biochemical processes that contribute to the low level of exudative, tender, and light poultry flesh are centered on protein oxidation. Because of the reduced pH and decreased activity of superoxide dismutase, catalase, and peroxidase from glutathione are examples of enzymes that act as antioxidants, the proteins in breast flesh are more sensitive to oxidative stress (Carvalho et al., 2017). Cooking techniques and preparation times significantly impact the generation of oxidation items, specifically the oxidation of thiols, tryptophan, alkaline amino acids, and protein cross-linking in poultry meat. The sous-vide technique is the best for obtaining excellent meat prepared using cooking, baking, frying, and sous-vide techniques without forming disulfide or protein carbonylation bonds. The heating time affects the development of Schiff bases, free thiol groups, and hardness (Silva et al., 2016).

Most hydrophilic vitamins are abundant in meat, which is also the best food item for vitamin B_{12}. In poultry, the amounts of B-group vitamins, such as niacin, vitamin B_6, and pantothenic acid, are equivalent to those in other animals and do not significantly diminish while cooking. While red meat has the highest vitamin B_{12} content, chicken has a significant amount of niacin. The number of lipophilic vitamins, like vitamins E and K, found in muscles is lower in meat than in plant-based diets. Although there is a wide range in the amount of iron present in other meats, poultry provides a source of this mineral (100 g of chicken thighs include 1.4 mg of iron against 1.3 mg in an adult cow's rump steak) (Lombardi-Boccia et al., 2006). Fresh meat and poultry also have very little sodium, contributing little to nutritional intake.

On the other hand, prepared meat items could include excessive or very high sodium levels that have been included to increase flavor or as a preventive. Another great source of selenium is chicken flesh. Lean meat also has components that help increase the bioavailability of a few nutrients, which are frequently higher than those obtained from plant diets. Aside from heme iron, other nutrients that are highly accessible when eaten with meat include zinc, copper, and B vitamins. Additionally, when ingested concurrently, meat increases the bioavailability of nutrients in other diets. For instance, eating non-heme iron-containing foods alongside meat increases their absorption ability (Rahman and Ali, 2023).

The efficiency and nutritional impacts of the organic chicken system

Research on alternative poultry production systems shows that low stocking density, more room to walk around, and consuming green food favor bird well-being and the final product standard (Dal Bosco et al., 2012; Chen et al., 2013). Dou et al. (2009) discovered that compared to chickens kept indoors, chickens raised outdoors generated higher chest and leg flesh, improved perceptual flavor in their meat, and reduced carcass obesity. PUFA-6 and PUFA-3 levels were higher in the skeletal system of birds having access to the outdoors, according to Funaro et al. (2014), which is extremely desirable due to the reduction of cardiovascular illnesses (Figure 4). According to Sokołowicz et al. (2016) and Hailemariam et al. (2022), reducing fat and natural poultry meat is also healthier. It has a desirable color, flavor, and scent for the customer. Furthermore, birds raised in a free-range habitat are vulnerable to adverse ecological factors' impact (Rizzi et al., 2007), while high plant fiber content may compromise nutrient uptake, slowing growth and increasing the conversion of feed (Sales, 2014).

To produce organic poultry, proper bird choice is crucial. It is suggested that indigenous breeds of chickens ought to be used in natural agriculture because they are suited for outdoor ranges and less vulnerable to adverse weather due to the numerous nutritional and technological limits (Rizzi et al., 2007; Rizzi and Chiericato, 2010; Dal Bosco et al., 2012). The European Union has taken several steps to promote the cultivation of local breeds. It has provided various financial aid programs, particularly those for organic farms, to save many rare farm animal breeds from being endangered (Krawczyk et al., 2013). According to Rizzi et al. (2007), based on the kind of rearing system used, birds with diverse genetic origins exhibit variations in their rates of development and advancement, the results of the dissecting evaluation, and the fineness and taste of their flesh. Therefore, choosing native breeds to slow-growing hens might represent an attractive source of meat from poultry if they are raised organically to produce high-quality or local cuisine.

According to Sosnówka-Czajka et al. (2017), the organic production system improved the muscle tissue of the two native breeds of hens. It was examined for BW, feed conversion, and fatty acid composition. Rhode Island Red (R-11) hens grown in organic conditions were more productive than Yellowleg Partridge (Ż-33) birds, although their muscle fatty acid profiles were somewhat worse. Also, Castellini et al. (2002) indicated that the natural farming system is a good alternative because it provides improved welfare conditions and high-quality meat and carcasses. The more TBA-RS in the connective tissue, perhaps brought on by more physical activity, was a drawback.

Human health

The World Health Organization describes health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (Preamble of the WHO Constitution, 1948). In more recent years, according to age, society, and individual responsibility, health has been considered a dynamic condition of happiness that encompasses the physical, mental, and social capacity to meet the demands of daily life, much like in Antonovsky's salutogenic model developed in the 1970s (Antonovsky, 1979, 1987). Therefore, disease would be the absence of this potential. This aligns with the organic movement's goal of maximizing healthy traits in plants and animals.

Since genetic predisposition, environment, society, and lifestyle interact in complicated ways to affect human health, it is no longer viewed as a static state. Clinically speaking, health is defined as an organism's capacity to retort to threats and reestablish health effectively. A flexible reaction to pressures and shifts has replaced the static depiction of health in the notion and understanding of health (Virolainen et al., 2023). In superior natural studies, there has been a similar paradigm shift in the concept of product quality, a systems-level evaluation that shifts from an inert quantitative to an evolving process-oriented evaluation (Bloksma et al., 2007). As a result, the study of quality now takes into account processes that are reactive and dynamic. According to a reductionist perspective, both the possible rise in health-promoting substances and the potential decrease in synthetic residues could be responsible for the potential benefits of the nutritional value of natural food. More dynamic viewpoint, it is possible to hypothesize that the consumer's self-regulating abilities are strengthened due to the food product's homeostatic state. It is understood that nutrition affects the organism's capacity to handle potential illness hazards and maintain well-being.

Currently, nutritional research is increasingly incorporating tests of behavior and cognitive function. The quality of the eaten items can have a moderating favorable impact on nutrition, but diet composition has the biggest impact. Thus far, this idea has been linked to a decrease in synthetic residues and a potential rise in molecules that promote health. However, the results of the feeding studies mentioned that compared test meals with the same nutritional value but different production methods call for expanding the defined performance strategy and applying novel quality evaluation methods. One also needs to seek a method that includes incorporating contemporary systems biology approaches, like metabolomics (with incredible power for the composition analyses), which mainly utilizes techniques such as nuclear magnetic resonance (NMR) (Chandra et al., 2021 a; Emwas et al., 2021, 2020) and mass spectrometry (MS) such as gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS) (Al-Nemi et al., 2022; Zhang et al., 2020). Nuclear magnetic resonance, as a non-destructive technique, offers a great advantage in metabolomics studies by providing accurate fingerprints requiring little sample (bacteria, vertebrates or plant tissues, etc.) preparation and having high reproducibility. However, NMR methods suffer from low sensitivity, which is one of the reasons mass spectrometry, a destructive method that detects only ionizing molecules, is generally preferred in metabolomics due to its higher sensitivity. Despite this, certain methods have been recently developed to overcome the low-sensitivity issues posed by NMR and enhance the signals (Singh et al., 2023; Chandra et al., 2021 b). These techniques can reveal information at regulation stages when coupled with sophisticated statistical methods and in-depth biological information. This may simplify the systems-level analysis of what happens in the consumer organism (Van der Greef et al., 2007).

To determine whether the believed equilibrium characteristics of organic food can be associated with equilibrium or discord in the consuming organism, it will be necessary to pair these techniques with the previously discussed ones, which are currently being researched to assess comprehensive characteristics in food products (Rahman et al., 2024). Not every factor studied in feed experiments utilizing the recommended designs functions as a relevant biomarker that can be applied to human wellness. While benefits concerning nutrition or litter quantity preferences can shed light on variations brought about by production techniques, they are less useful as indicators of human health (Pesti and Choct, 2023). Pioneering investigations looking at health metrics more closely related to problems with human wellness can be seen in more recent feeding experiments looking into immune system effects and nutrigenetic influences. Thus, indicators being established as a base for treatment research in people and determining health indicators are the goals of future animal feeding trials (Abdollahi-Mousavi et al., 2024).

Herbal substitutes to antibiotics, including spices and plants having antibacterial qualities and other health benefits, must be used instead of conventional antibiotics to alleviate the emergence of antibiotic-resistant organisms (Diaz-Sanchez et al., 2015). Adding herbs and spices that contain phytochemicals that positively impact human health to poultry meat gives it additional antioxidant, anti-inflammatory, antibacterial, and antihelmintic properties. According to Dhama et al. (2015), some may also serve as growth promoters, immunomodulators, immunostimulants, hypoglycemic, and hypolipidemic drugs.

Health effects of an organic versus conventional diet

Meat from poultry is a crucial animal product for human nutrition. Chicken flesh is considered a beneficial diet due to the varied and moderate amount of energy it contains, easily absorbed proteins with good health benefits, unsaturated fats, B-complex vitamins, fat-soluble vitamins, and minerals (Marangoni et al., 2015; Kralik and Kralik, 2017).

The establishment of organic agriculture aimed to enhance supporting nature, the well-being of animals, sustainable development, and food integrity through ecological production management (Hovi et al., 2003; Calabro and Vieri, 2024). The organic poultry production system regulations are outlined in Commission Regulation No. 889/2008, revised in April 2016 in Commission Implementing Regulation 2016/673. These regulations cover living conditions, genetics, nutrition, welfare, health, and veterinary care. The natural structure supports slowly expanding hybrids or chickens raised until the minimum age (81 days) to avoid intensive poultry-rearing techniques. For broiler genotypes that grow slowly and are frequently employed in the EUs for an organic program to reach market weight, 12 weeks are required. Slow-growing chicken breeds produce less meat than fast-growing breeds, but they can have a variety of meat qualities and are more responsive to the conditions of an organic system (Fanatico et al., 2009). Due to the financial advantages, bird genotypes that grow quickly are typically used in traditional systems. Such hybrids have been genetically engineered for commercial purposes, including younger slaughter (40–55 days) and good production of breasts. In certain nations, rapidly developing birds grow naturally until they reach the required slaughter age (81 days). However, they are unsuitable for the organic system because of inadequate welfare (Frankham et al., 2004).

One of the most significant features of an organic system is the ability of poultry to access free-range areas. With access to the outdoors, chickens can consume greenery, herbs, stems, roots, insects, and worms and have a high activity (Sossidou et al., 2015; Oliveira et al., 2024).

According to Abdullah and Hulánková (2021), the organic systems adversely impacted the quantitative properties of the breast. Compared to organic broilers, conventional broilers' breast muscles were heavier. Compared to traditional broilers, slow-growing birds with high kinetic activity raised the weight and yield of thighs and wings under organic systems. The preferred part of the chicken carcass is the breast. Producers choose hybrid breeds of birds with the maximum breast output to meet market demand, and raising breeds with rapid growth is more profitable (Castilho Heiss et al., 2024). Although the organic system benefits the environment, the health of animals, the environment, and several aspects of food safety, customers cannot purchase more than twice as expensive chicken that contains less flesh (Figure 5).

Relationship between organic chickens and healthy humans

Whatever steps the industry has taken to decrease animal fat (Sun et al., 2006) should be applauded. However, what we discover is a stark contrast; more of our energy originates through fat than protein, and n-3 fatty acids are being reduced, both of which are likely to influence. A large energy intake because of the expense to the manufacturing sector and the significant environmental imprint, being transformed into fat that people do not desire or are advised against by healthcare specialists may also raise concerns. The intensive grill technique has been defended by businesses in the media because consumers demand inexpensive food. This stance disregards quality concerns. If DHA is considered the crucial ingredient for determining value, then eating six birds would need to consume somewhere in the range of 37 600 kJ (59000 kcal) to receive that same quantity of DHA from intensively bred chickens now like it might have been achieved in the 1970s. According to the National Audit Office (2001), fast food, social influences, watching television, schoolchildren's meals, sugary beverages, inactivity, genetics, and racial origins are some of the causes of the tripling of obesity since 1980.

To combat the "obesity epidemic," in 2006, the National Institute for Health and Clinical Excellence and the National Collaborating Centre for Primary Care released suggestions, and the Food Standards Agency took action, as did all three organizations. However, there is no mention of how food ingredients are evolving. Technically speaking, the high-fat chickens we observed may be obese. Regarding human nutrition and animal welfare, this circumstance raises the question of whether consuming obesity contributes to consumer obesity. Furthermore, the usefulness attributable to the depletion of nutrients by the high energy weight of chicken as a supplier of DHA and an array of nutrients has been reduced. Because of their confinement inside and lack of activity, these animals have less dark meat, indicating that their fast-acting muscle fibers have fewer mitochondria (Baéza et al., 2021).

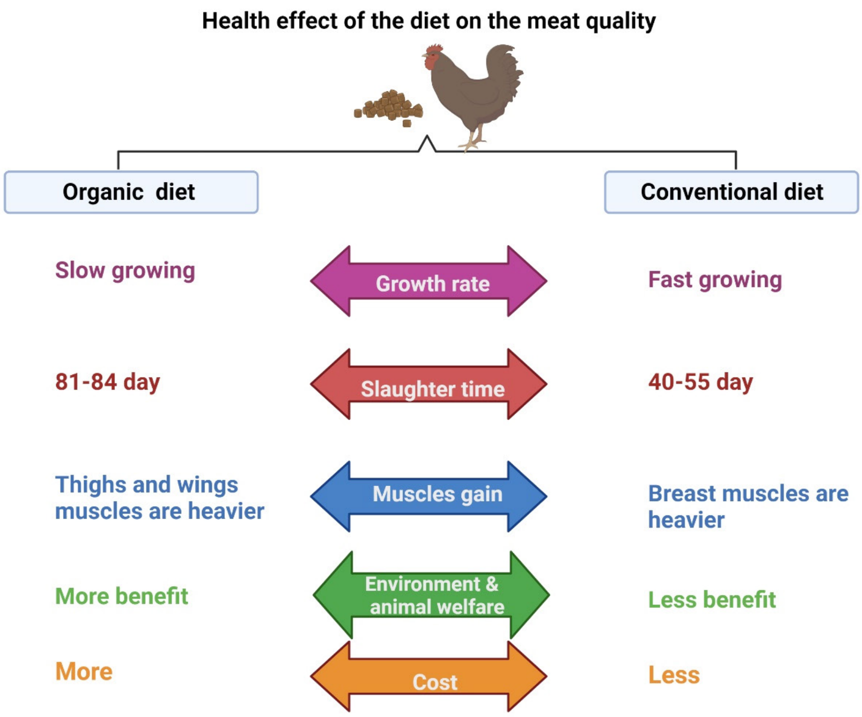

Figure 5. Health effects of an organic versus conventional diet

Regarding biochemistry, this suggests that a rise in the TAG: PL (triacylglycerol: phospholipid) ratio of the meat will be associated with decreased B vitamins, Fe, and other chemicals stored in mitochondria. Mental illness cost the UK economy £77 billion in 2008, the largest burden of illness due to the rise in brain diseases this century (Nurse, 2008). The increasing number of chickens is a part of the growing food industry that has neglected the requirements of people generally and the necessities of the brain, even though it cannot explain the rise in brain diseases on its own. It could be advantageous if alimentary manufacturing once more placed a higher priority on dietary requirements. Incorporating poultry meat into your diet is encouraged by the Mediterranean Diet and the Dietary Approaches to Stop Hypertension (Estruch and Salas-Salvadó, 2013; Sayer et al., 2015; Casas et al., 2014).

Substituting red meat with chicken, fish, nuts, and legumes enhances glycemic management, reduces cardiac hazards, and reduces the chance of developing type 2 and gestational glucose diabetes. Heart health benefits come from low-fat diets that include fruit, grains, nuts, fish, and chicken instead of red meat. Pro-inflammatory cytokines are decreased by a diet rich in anti-inflammatory and anti-oxidative foods (Ibsen et al., 2020). This promotes an anti-inflammatory environment, which in turn enhances endothelium wellness and sensitivity to insulin, and as a result acts as a barrier to the development of atherosclerosis, metabolic syndrome, obesity, and type 2 diabetes (Bales, 2011; Bao et al., 2013; Esposito et al., 2016). Figure 6 depicts the connection between healthy humans and organic hens.

By substituting this valuable protein source for high-calorie foods currently frequently consumed by the young population, poultry meat prepared under ideal conditions will support children's healthy growth and development (Donma and Donma, 2017). This will aid kids in preventing overweight and chronic illnesses linked to obesity as children and adults. In comparison to groups with moderate and good nutritional status, communities with malnutrition have been found to introduce some meat, especially chicken, to children at later ages (Köksal et al., 2015). Because it contains a lot of protein, eating enough poultry meat can help people maintain a healthy weight and prevent the emergence of cancer, diabetes mellitus, cardiovascular disease, and being overweight (Marangoni et al., 2015). Chicken constitutes one of the most well-liked dietary sources of L-arginine, an amino acid required to produce nitric oxide. According to Lorin et al. (2014), supplementing with L-arginine may be a potential treatment for metabolic disorders and overweight. Selenium supplementation or fortification can exacerbate obesity issues due to its anti-inflammatory and antioxidant properties, as suggested by Donma and Donma (2016).

It is important to thoroughly analyze the complex relationship between meat consumption and health, paying close attention to the important distinctions that, while receiving a little emphasis in the research, set apart the effects of different kinds of meat. Unsaturated fatty acids (mostly present in the skin and readily eliminated), B-group vitamins (primarily thiamin, vitamin B_6, and pantothenic acid), minerals, and easily absorbed amino acids of good nutritional value (with low collagen levels) make poultry meat important nourishment (like iron, zinc, and copper) (Geiker et al., 2021). Epidemiological research has shown a strong link between eating poultry as a healthy diet and lifestyle component in diverse populations with varying dietary choices and nutritional practices.

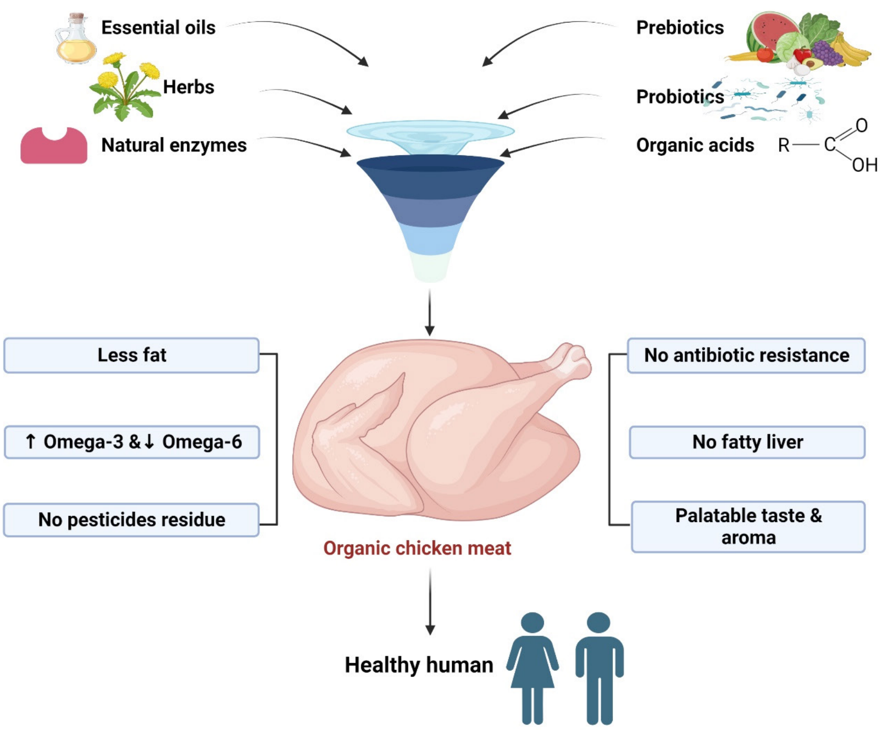

Figure 6. The relationship between consuming organic chickens and human health

Consuming poultry products in conjunction with a dietary regimen rich in vegetables is linked to a lower risk of developing cardiovascular disease, type 2 diabetes, and being overweight or obese. White meat, especially chicken, is considered neutral or mildly carcinogenic regarding cancer risk (Connolly et al., 2022). The UN Food and Agriculture Organization (FAO), which thinks that such a readily accessible, inexpensive meal is especially crucial in developing countries where it can help to address nutrient shortfalls, has also recognized the benefits of poultry meat for people (Henchion et al., 2021). Additionally, consuming poultry meat enhances the total nutritional value of a diet at every stage of life (including those during development, while pregnant up to the end of giving birth, throughout growth, and in the elderly) (Marshall et al., 2022). It is suitable for those who need more protein and calorie intake than the average person (Marangoni et al., 2015). Antibiotic resistance, which has emerged as one of the most significant health issues of the present, is among the most significant reasons to urge customers to purchase organic food, particularly organic chicken meat.

Conclusions

Consuming organic chicken can address the global health concern of antibiotic resistance by promoting sustainability, food security, and safety. Organic chicken production ensures the creation of nutritious food, maintains animal welfare, and restricts growth boosters and synthetic fertilizers. Since they do not rely on antimicrobial treatments, organic hens, raised without antibiotics, can be crucial in combating antibiotic-resistant bugs in conventional agriculture. Consequently, in recent years, there has been a significant increase in the market's supply and demand for organic products, which has had a big impact on the economy. Due to its superior health benefits and reduced likelihood of chemical contamination, organic food has gained popularity among many individuals, leading many to prefer it over conventional food. Therefore, it is imperative to advocate for the importance of organic chickens in maintaining human health.

Conflict of interest

All authors declare no conflicts of interest that could inappropriately influence this manuscript.

Author contributions

All authors contributed equally to this work. All authors read and approved the final version of this manuscript.

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