Antibiotic-Free Broiler Meat

Subjects: Others
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Chickens are raised with the assistance of the regular use of antibiotics, not only for the prevention and treatment of diseases but, also, for body growth. Overuse and misuse of antibiotics in animals are contributing to the rising threat of antibiotic resistance. This practice contributes to the development of drug-resistant bacteria in livestock, including poultry, and humans through the food chain, posing a global public health threat. Therefore, antibiotic-free broiler meat production is becoming increasingly popular worldwide to meet consumer demand. However, numerous challenges need to be overcome in producing antibiotic-free broiler meat by adopting suitable strategies regarding food safety and chicken welfare issues.

Antibiotic-Free Broiler Meat | Chickens | food chain | antibiotic resistance | antibiotics

1. Introduction

There is a worldwide movement to support a sustainable agricultural system that involves sustaining farmers, resources, and societies. It is expected that this can be achieved by upgrading farming practices that are profitable, environmentally sound, good for communities, and antibiotic-free. However, raising animals without antibiotics is a challenge, and especially, antibiotic-free broiler meat production is a growing challenge in many developing countries, including Bangladesh, where antibiotics are used injudiciously [1]. Broiler chickens are reared particularly for meat production because of their typical soft, tender meat, low-fat content, and short production period. Broilers take the place of valuable food animals globally by notably contributing to food security, protein supply, and people's employment [2]. Sustainable broiler production not only requires maximum productivity but, also, includes bird and human welfare and environmental protection. In addition, consumers are concerned about antibiotic residue and antimicrobial resistance, as well as pesticide residues, additives, nutritional content, flavor, traceability, regional production, genetically modified organisms, social justice, etc., with regards to broiler meat production. Therefore, broiler meat production without using antibiotics is crucial in the battle of antimicrobial resistance to save poultry, animals, and public health.

Broiler meat production has undergone exponential growth for global consumption and business profit. Low production costs and rapid economic progress are pivotal in its expansion [3]. Though commercial poultry farming is a profitable business, it faces a number of challenges. Among them, the occurrence of infectious and noninfectious diseases is a major challenge due to poor biosecurity and husbandry practices. Over several decades, some antibiotics have been used in broiler feed to control, prevent, and treat diseases and boost performance and feed efficacy [4][5]. This inappropriate antibacterial use favors antimicrobial resistance. The most common pathway for

bacteria to gain resistance is through mobile genetic components, including bacteriophages, plasmids, naked DNA, or transposons. Plasmid-mediated gene transfer facilitates the flow of resistant genes between bacteria, accelerating antibiotic resistance [6]. Bacteria can also develop antibiotic resistance through sequential mutations in the chromosome, as happens in fluoroquinolone resistance. Using normal genetic variations, bacterial populations mutate to render antibiotics ineffective against them [7]. Indeed, antibiotic resistance begins with the interaction between bacteria and antibiotic, leading to the removal of sensitive bacteria and selection of resistant populations. However, the distribution and assortment of resistance are complicated matters that pose a severe public health problem [8]. The indiscriminant use of antibiotics in nonbacterial infections like influenza and other viral infections facilitates antibiotic resistance [9].

In Bangladesh, commercial poultry farmers extensively utilize antibiotics without any veterinary advice and often do not follow withdrawal period guidelines [10]. A lack of both easily accessible veterinary facilities and adequate knowledge combined with a high-profit motive are some of the factors that drive local producers to inappropriate and, at times, illegal use of antimicrobial agents [11]. The cost-effective production of broilers may act as a driver for the practice of using growth-promoting medicines, including antibiotics, for the overall growth performance [12][13]. These agents get stored in various body parts and tissues, resulting in antibiotic residues for unintended exposure to consumers. Sattar et al. [14] reported antibiotic residues mostly in the liver, kidney, thigh meat, and breast meat of broilers. Easy access to antibiotics from registered veterinarians by farmers without prescriptions contributes to the indiscriminant use of antibiotics, which can result in antimicrobial resistance from food animals [11]. Although antibiotic resistance has always been present in nature, antibiotic pressure due to inappropriate use facilitated the rapid and widespread emergence of drug-resistant pathogenic bacteria [15]. As several antibiotics frequently consumed by livestock are identical to those used in humans, there is worldwide fear that antibiotic-resistant bacteria may be transferred from animals to humans, leading to severe public health concerns [16]. Resistant bacteria with resistant genes can quickly spread among humans, animals, and the ecological community. Therefore, new approaches should be considered for antibiotic-free broiler production so they can be sustainably raised and marketed.

2. Economic and Clinical Importance of Antibiotic-Free Broiler Meat Production

The fast growth of the poultry industry has been attained through the effective implementation of high-yielding strains of meat-type chickens and the availability of nutritionally balanced feed. Broiler farming plays a central role in enhancing income, improving food safety, and mitigating scarcity in the countryside and in semi-urban communities in developing countries. For a couple of decades, the poultry industry has played a critical role in the economic development of Bangladesh by providing job opportunities, food security, and good-quality protein. The poultry industry has assisted in changing living and food habits by moderating animal protein sources such as beef and mutton. For instance, about 44% of the protein for everyday human consumption comes from poultry and animal products [17]. As a primary portion of production, this industry's ability to furnish the country with affordable and nourishing protein in the form of meat and eggs is encouraging [18]. There are over a million small and large

poultry farms, 80 grandparent (GP) stock farms, 130 parent stock farms and hatcheries, and over 50 feed mills across the country, making up a USD 2.36 billion industry. About five million people are employed in the industry directly and indirectly. A study estimated that around 150,000 poultry farms in Bangladesh are producing 570 million tons of meat and 7.334 billion eggs annually, and about 68.17% of animal protein consumed comes from poultry meat [19]. A significant number of pastoral individuals depend on this business for their income. The poultry industry has made up one-third of the entire agronomic contribution to the Gross Domestic Product (GDP) (18.60%) in recent years [20].

In food animal production, antibiotics are also exploited, albeit unwisely, to advance animal growth and feed efficiency [21][22]. Generally, farmers in developing countries use antibiotics deliberately to promote growth without any veterinary consultation. Additionally, shockingly, 88% of producers did not adhere to the required antibiotic withdrawal time before marketing [22]. On the other hand, only 10% of farmers stopped using antibiotics before marketing, and only 2% of farmers withdrew antibiotics at least seven days before marketing. Still, they did not always follow this withdrawal protocol [23]. Generally, excessive and unnecessary use of medicines affects the total cost of production. A study on the antibiotic usage patterns in Bangladesh concluded that the use of antibiotics has an economic effect on broiler production [11]. Another study revealed that the cost of antibiotic usage could be 3.53% of the overall production rate based on responses from 84% of farmers [23]. The cost of antibiotics varies from farm to farm due to the presence and severity of diseases and their use as growth promoters. Removing antibiotics from broilers can lower the production cost and, thereby, decrease the market price of broiler meat.

The nontherapeutic use of antibiotics increases the residual accumulation more than medically necessary to use and, thereby, increases the incidence of antimicrobial resistance. The consumption of residual medicines through animal food products (e.g., meat, milk) is assumed to initiate resistance development in humans. Besides, commensal bacteria of livestock are often present in fresh meat, which can serve as reservoirs of resistant genes to be relocated to pathogenic bacteria in humans [7]. Studies have shown that antibiotic residues were present in more than 50% of samples of broiler and layer meat collected in different regions of Bangladesh [14][22]. Another study by Faiz and Bashe (2011) reported that some pathogenic bacteria, such as Pseudomonas aeruginosa and Salmonella typhi, are resistant to commonly used antibiotics [24]. The high degree of antibiotics resistance in Bangladesh poses a regional and global threat [25]. In Bangladesh, diarrhea accounts for around 230,000 child deaths annually, and a significant portion is due to antibiotic-resistant bacterial infection [19].

3. Prospects

In veterinary practice, antibiotics are used for prophylactic, therapeutic, and growth-promoting purposes. The purchase of medicines without a prescription is common in developing countries like Bangladesh. This can lead to an inadequate course of treatment, incorrect antibiotic selection, indiscriminant and excessive use, and enhanced residual deposition in animal bodies. A recent study with 160 poultry samples from different regions in Bangladesh identified antibiotics in more than 50% of the samples [22]. Producing a sufficient amount of food for a growing population is a great challenge for any country. Of the 17 Sustainable Development Goals (SDGs), 14 are connected to the poultry sector in some way or other. According to data from the Bangladesh Poultry Industries

Central Council (BPICC), the annual commercial production of eggs and poultry meat is about to 1022 crore pieces and 14.6 lakh tons, respectively.

Thus, the poultry industry appears to be a big sector, worth about USD 353.88 crore [26]. Nowadays, consumers are refusing to consume antibiotic-treated chicken and demanding safe, antibiotic-free beef. Therefore, there is a large market for antibiotic-free chicken in Bangladesh. The challenge is to find a way to produce them. One option would be to use medicinal plants instead of antibiotics as growth promoters. Bangladesh is rich in medicinal plants, and many such plants have been shown to have antibacterial activities, such as Abutilon indicum L., Caesalpinia bonduc L., Ixora nigricans L., etc. Many natural foods also have antibacterial actions, such as broccoli (Brassica oleracea), guava (Psidium guajava), garlic (Allium sativum), and okra (Abelmoschus esculentus) [27][28][29][30]. Based on antibacterial medicinal plants and natural foods, a safe antibacterial preparation could be developed to use in food animals as an alternative to antibiotics for growth promotion and feeding efficiency.

4. Significant Challenges

Bangladesh is a developing country, and its seasonal variations are very distinct, categorized by extreme temperatures, excessive humidity, and heavy rainfall. The environment is beneficial for the survival and growth of various microorganisms and makes them ubiquitous and fastidious. Most poultry farmers are not well-educated or well-trained for modern scientific farming. It is estimated that about 80% of farmers lack adequate knowledge about rearing current high-yielding strains [23]. Moreover, farmers in Bangladesh can quickly get antibiotics from local vendors without a veterinarian's prescription. Biosecurity measures are also terrible; thus, the entry of microorganisms on most farms is common, affecting the production performance of flocks. The commercial livestock sector is multiplying and conveying a lot of diseases with it. Thus, biosecurity must be implemented without fail [26]. Newcastle disease, Gumboro or infectious bursal disease, Marek's disease, duck plague, fowl pox, fowl cholera, leucosis, and infectious bronchitis are among the most common infectious diseases in the poultry sector [26]. It is therefore essential to control primary and secondary infections for successful poultry farming in Bangladesh. One of the most critical factors in antibiotic-free broiler production is the economic challenge, i.e., cost management. The most critical challenges in producing antibiotic-free broilers in Bangladesh and abroad (Figure 1) are addressed below.

Figure 1. Schematic presentation of the challenges in sustainable antibiotic-free broiler production.

5. Possibilities

Superior output and biosecurity management practices are essential components in raising chicken without antibiotics.

5.1. Strict Downtime between Placements

It is a quick, simple management procedure to raise antibiotic-free broilers. In this case, new flock entry should be restricted to a minimum of 14 days (downtime) with good cleanout (clearing out birds and removing the litter cake). The downtime should start when birds are out of the house production site.

5.2. Optimum Stocking Density

The stocking density is a crucial concern for profitable broiler farming. As the stocking density increases, so does the stress level of birds. Increased stress is associated with compromised immunity and, consequently, an increased susceptibility to disease. Thus, decreasing stress by increasing the stock density can help reduce the risk of disease and the need for antibiotics. A reduced stocking density is also an excellent option to help keep litter moisture at a minimum compared to the current conventional program. Farmers should decrease the stocking density, which, in turn, reduces the shedding of cocci oocyst and pathogenic bacteria. This practice also helps in proper ventilation and aeration and, thus, reduces stress. However, the ideal stock density is still being debated. Bilgili and Hess [31] reported a significant improvement of the overall growth performance, carcass quality, and mortality with a decreased stock density. In Bangladesh, usually 1- to 1.5-square-feet of floor space is assigned to each bird. However, in antibiotic-free broiler production, providing more space than required is an important factor.

5.3. Good Litter Management

Keeping the litter dry is critical in the overall management of any poultry farm, as it influences the bird performance by decreasing the ammonia level and, thereby, the growers' profits. Dry waste and low ammonia levels are the keys to success in raising poultry. The negative impact of ammonia on bird performance is well-documented [32][33]. Dry litter controls the ammonia levels and provides a better flock atmosphere and reduces disapproval due to contact dermatitis and inflamed bursa. When unused bedding materials start to hold moisture, it will clump together to form caking, leading to increased ammonia formation. Caking is mainly due to moisture in the litter and can be prevented by having adequate ventilation. Broilers drink approximately two pounds of water for every pound of feed they consume. About 20% of the water is used for growth, while most of it eventually reaches the litter as waste. Therefore, there must be adequate ventilation to remove moisture within the waste to prevent caking. Generally overventilation is needed to fix the problem once caking has started. Growers should attend to litter sanitation and treatment at regular intervals. It is a great idea to monitor the ammonia levels regularly, and handheld sensors can accurately manage them. Amending the litter and providing adequate ventilation are the most practical ways to control ammonia and improve litter quality [34]. Preventive fan maintenance can aid in keeping the ventilation program effective. A total litter cleanout at least once a year is highly recommended.

5.4. Control Environment Housing

Producers can reduce bacterial growth and antibiotic use by maintaining the adequate ventilation of poultry housing facilities. A study reported the presence of antibiotic-resistant bacteria in the air of broiler chicken facilities [35]. Dust is an excellent carrier of bacteria, while mold is a potential source of infection. For appropriate airing, heat, relative moisture, and light, an environmentally controlled structure should be built oriented in the east-to-west direction longitudinally, with large exhaust fans on the west side and evaporative chilling plugs on the east side, accompanied by programmed feeding and drinking methods inside [36]. Chick suppliers can provide useful information on the ideal temperature, humidity, and air quality for raising broilers. Airborne dispersion of antibiotic-resistant bacteria should not be underestimated, considering the respiratory health of chickens and poultry workers. Farmers should follow the standard guidelines for maintaining adequate ventilation [36].

5.5. Pre-Starter Feed

Pre-starter feed is crucial in establishing good gut microbe populations. To achieve a balance in gut microbiota for nutritional enhancement of the gastrointestinal (GI) tract, boost the immune development, and facilitate nutrient absorption, it is useful to include probiotics, prebiotics, organic acids, short- and medium-chain fatty acids, and phytogenic feed. The broiler industry has achieved noteworthy advances in productivity by prioritizing the hereditary selection, diet, and controlling procedures. The nutrition for broilers is focused on the need to get to the market weight as quickly as possible. There is a growing interest in a specifically designed pre-starter feed for 10–14 days of broiler growth, since this represents more than 20% of the growth time [37]. A specialized formulation should ensure that the feed is easily digestible and meets the broiler's nutritional needs. The efficacy of pre-starter diets relies on the potential carryover effect to increase the bird performance until market age. The nutrient requirements, particularly digestible amino acids, are crucial in the broiler's first 10 days. Rice and its lower non-starch polysaccharide substance may be a better option than corn or wheat for pre-starter diets. Additionally, the

addition of fibrous components in low-fiber feeds at earlier stages may enhance the gut development and improve nutrient absorption, eventually enhancing the overall growth performance. Finally, the manufacturer should concentrate on feed formulations to remove antibiotic growth promoters from all broiler diets. This will ensure sustainable growth and gain consumer acceptance. Broiler feed should receive particular attention by providing the particle size, protein and fat qualities, and specific additives.

5.6. Water Quality and Sanitation

A good water sanitation program is key to healthy poultry production. Water is essential for birds. A routine water quality analysis for bacteria, pH, hardness, minerals, and total dissolved solids should be conducted annually. Flushing and disinfecting between flocks with suitable quality disinfectants should be done to remove biofilm from the pipeline. Biofilm is a sticky film that can exist inside water lines, regulators, and nipple drinkers and can be composed of bacteria and other organisms [38]. Chlorine is the most popular sanitizer; other well-documented sanitizers include hydrogen peroxide, chlorine dioxide, and ozone. In addition, acidifiers can improve the sanitizer's effectiveness and reduce bacterial growth in water lines [39].

5.7. Antibiotic Alternatives

Over the past two decades, producers have extensively used antibiotics for broiler weight gain. Including antibiotics in broiler production enhances the food conversion ratio by 4% [40]. Thus, measures need to be in place to offset this loss and any undesirable growth performance in immunocompromised broilers [40]. Additionally, withdrawing antibiotic feed additives could raise necrotic enteritis in the flocks. Although removing antibiotic feed additives from the diet would enhance the production cost, this increased cost can be recovered from the expected increase in broiler meat prices [41]. It should be noted that the effect on broiler growth and weight from the withdrawal of growth-promoting medicines may occur only after the first year [42]. Thus, the campaign for an alternative to antibiotics should focus on antimicrobial stewardship [43]. These alternatives should provide a low mortality rate and an adequate level of yield while preserving the environment and consumer health. Much research has been conducted to explore natural agents with beneficial effects similar to growth-promoting antibiotics. In addition, several nontherapeutic alternatives can be substituted for antibiotics. The most popular options are probiotics, prebiotics, enzymes, organic acids, immunostimulants, bacteriocins, bacteriophages, phytogenic feed additives, nanoparticles, and essential oils.

6. Conclusions

Antibiotic-free poultry meat production is an old issue in developed countries; however, it is at the beginning stage in Bangladesh. Although consumers are becoming more interested in antibiotic-free poultry, it is not easy to produce quality antibiotic-free meat while maintaining animal welfare and making farming profitable. There is still a long way to go for sustainable antibiotic-free broiler meat production, particularly in developing countries like Bangladesh. The aspects related to broiler meat production and marketing should be ensured through improved management systems, proper legislation, and implementation. It is difficult to achieve sustainable production if

there is any interruption of the supply chain, such as the supply of day-old chicks from hatcheries or feed from feed mills, or other support. As such, producing sustainable broiler meat without antibiotics is an ongoing challenge for the food industry in Bangladesh. To overcome this challenge, good management practices, including strict biosecurity measures, should be ascertained. Moreover, access to antibiotics without a prescription by veterinarians should be strictly enforced. In addition, for fighting against antimicrobial resistance, awareness-building programs as recommended by the World Organisation for Animal Health (OIE) (https://oie-antimicrobial.com/) should be implemented for raising awareness among poultry farm workers, marginal poultry farmers, and poultry consumers to highlight the dangers of antibiotic resistance and the benefits of consuming antibiotic-free poultry meat. As policymakers and local poultry industries are aiming to produce safe meat without using antibiotics by 2024, alternative approaches to antibiotics and active participation by farmers and consumers will be required to achieve this.

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