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Symptomatic Exclusive Overview on the Sustainability of Antibiotic-Free Poultry Production

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ABSTRACT

Broiler chickens in the commercial setting are raised with antibiotics regularly, not only for disease prevention and treatment but also for body growth. The prevention and treatment of bacterial infections is critical to intensive poultry production. Antibiotics are natural, manufactured, or semi-synthetic compounds that inhibit or kill microorganisms. Primarily bacteria, they treat and prevent infections in humans and animals. Antibiotic use in poultry production has a cost; it contributes to an increase in drug-resistant infections in broiler chickens, which can be passed to humans and have a severe influence on human health. The usage of antibiotics in animal feed production has led to the current global discourse, making broiler feeds a reservoir of antibiotic-resistant bacteria. Antibiotic overuse and misuse in poultry production are contributing to the rise of antibiotic resistance. WHO (2018) stated that correct doses of antibiotics in poultry production can help minimise antibiotic resistance. As a result, antibiotic-free broiler meat production is growing in popularity worldwide to meet consumer demand. Antibiotic-free poultry production is suitable for long-term sustainability because no antibiotics are used during the life cycle of the birds raised on the farm for human consumption. However, various obstacles must be overcome in producing antibiotic-free broiler meat by implementing appropriate food safety and poultry welfare techniques. This review finds that antibiotic reduction also aligns with the concept of sustainable broiler production. Consequently, non-antibiotic additive alternatives such as

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probiotics, prebiotics, acidifiers, essential oils, phytobiotics, enzymes, and whole grains in the feed are strategies that can be used to achieve antibiotic-free poultry production. Fundamental best practices are helpful to bird health and welfare and flock productivity at all stages of poultry production.

Keywords: Broiler, Antibiotics, Antibiotic-Free, Chickens, Sustainable Poultry Production.

1. INTRODUCTION

Antibiotic-free poultry production is ideally sustainable poultry production that does not use any antibiotics during the life cycle of the bird species on the farm and for human consumption. However, antibiotics are drugs used for various functions throughout the animal's life cycle to prevent and treat diseases and promote growth rates. They are an antimicrobial agent that aims to kill the growth of bacteria that cause disease (Marshall & Levy, 2011). Antibiotics are then routinely used prophylactically to reduce mortality in young chicks and to prevent infection when chicks are particularly susceptible to diseases like E. coli and Salmonella in the post-vaccination period (Agunos *et al*., 2012). Brugaletta *et al*. (2020) stated that poultry is produced strategically with the supplements of antibiotic-free additives such as probiotics, prebiotics, and essential oils in their food and water. Antibiotic-free poultry is becoming more common for consumers in the poultry meat market. Consumers' views of food choice are defined in terms of the label's quality expectations when new food labels, such as no antibiotics ever, become more widely available (Grunert *et al.,* 2014). Due to customer perceptions that antibiotic-free poultry production is preferable to conventional poultry production, it is becoming increasingly popular in the market.

Small-scale poultry farmers produce poultry products in small quantities compared to large-scale farmers due to the lack of farming resources. They are broiler and egg farmers who use locally accessible low-cost materials and family labour (Islam, 2010). Smallholder farmers have limited working capital, access to formal loans, and little knowledge of market potential or new technologies (Begum, 2005). Small-scale poultry farmers, for example, cannot afford to buy day-old chicks and poultry feed directly from hatcheries or feed manufacturers in large quantities, so they rely on dealers or brokers who offer credit (Shah, Sharmin & Haider, 2006). Regarding food safety and chicken welfare, numerous problems must be overcome by implementing appropriate strategies for producing antibiotic-free poultry. According to Bhogoju *et al*. (2018), the use of antibiotics in chicken food production has been identified as the principal source of antibiotic-resistant pathogenic and commensal bacteria shedding, which may be subsequently transmitted to people through different routes, such as food chains, which pose a global public health danger (Landers *et al.,* 2012; EMA, 2017).

The use of antibiotics in poultry production consists of many challenges, such as an impact on chicken growth, digestive tract, immune systems, and the environment is also affected. In the South African region of Kwa-Zulu Natal, an antibiotic-resistant *campylobacter* strain was found on small-scale and commercial chicken farms (Bester & Essack, 2012). In addition, *Campylobacter* spp. is common in South African poultry products, posing a health risk, and it can harm the gastrointestinal tract, causing diarrheal diseases (Bartkowiak-Higgo & Veary, 2006). Local producers are driven to inappropriate and unlawful usage of antimicrobial drugs by a lack of easily accessible veterinary facilities and adequate knowledge. Farmers with no prescriptions have easy access to antibiotics from registered veterinarians, which contributes to indiscriminate antibiotic use, which can lead to antimicrobial resistance in food animals (Saifu *et al.,* 2016). There are a variety of strategies that can be used to achieve antibiotic-free poultry production, including the use of non-antibiotic additives such as probiotics, prebiotics, acidifiers, essential oils, phytobiotics, enzymes, and the inclusion of whole grains in feed (Bugaletta *et al.,* 2020). Using fundamental best practices at all stages of poultry production benefits bird health, welfare, and flock productivity. Essential practices include choosing compatible breeds, ensuring biosecurity measures, using antibiotic-free feed supplemented with probiotics, prebiotics, organic acids, and essential oils and using natural herbal remedies as treatments. Farmers and veterinarians are responsible for protecting the birds under their care from pain and suffering and maintaining the antibiotic-free status of every broiler sold to market.

Successful antibiotic-free poultry production has been achieved by buying breeding stock from poultry hatcheries that do not use antibiotics from the start. Producing antibiotic-free poultry starts with a production plan that limits disease pressure by design (Al-Mamun, Islam & Rahman, 2019). All-in-all-out is another strategy that is used to achieve an antibiotic-free flock. Strict biosecurity protocols, such as maintenance of flock environment, cleanliness, no visitors allowed, and personal hygiene, are crucial in achieving this sustainable production.

Smith (2019) has stated that broiler chickens should be provided with optimal nutrition free of antibiotics and monitored to grow as expected for their age. The antibiotic restrictions have focused on drugs critical to human health and those used as growth promoters (Hughes, Hermans & Morgan, 2008). Regulation (EC) No. 1831/2003 has prohibited the marketing and use of antibiotics as growth promoters in feed in the European Union (EU) since 2006 and in Sweden since 1986 to reduce the use of antibiotics in animal production (European Commission, 2003). According to Singer *et al*. (2019), the USDA FSIS, 70% of US customers buy meat and poultry that has been reared without antibiotics because they believe it is healthier for the animal and encourages good animal husbandry.

2. ANIMAL WELFARE

According to Sutherland *et al*. (2013), animal welfare is related to using antibiotics, which support good health and reduce or eliminate potential pain and suffering associated with disease or infection. In particular, controlling and preventing coccidiosis remains a critical concern for any poultry operation (Sutherland *et al.,* 2013). Antibiotics are not the only tool used to maintain animal health. Management practices, good nutrition, hygiene, and housing are important in supporting good animal welfare. Nevertheless, antibiotics in animal feed should be regulated (WHO, 2017a). Deprivation of food, water, bedding, overcrowding, and over-handling increase the incidence of disease in animals and affect animal welfare (Karavolias, Salois, Baker, & Watkins, 2018). The environment in which the birds have been raised affects the welfare of the animals. Research has shown that the broiler chickens and layer hens raised in an antibiotic-free production system had lower mortality levels, cannibalism or aggression and keel damage than broiler chickens and hens in alternative systems (Coalition for Sustainable Egg Supply, 2015).

Non-therapeutic use of antibiotics in animal production has been outlawed in several countries due to the global concern of antibiotic resistance and growing treatment failures (Castanon, 2007; Cogliani *et al.,* 2011; Choct, 2001). According to Cogliani *et al.* (2011), Sweden was the first country to prohibit the use of antimicrobial's for non-therapeutic uses between 1986 and 1988 (for growth promotion) and (for prophylaxis). Denmark, the Netherlands, the United Kingdom, and other European Union countries followed suit (Cogliani *et al.,* 2011). In 2011, these governments went even further and outlawed all

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necessary antibiotics as preventive medicines (Maron, Smith & Nachman, 2013). Several other nations have banned certain antibiotic classes or established institutions to govern specific antibiotics in farm animals (Choct, 2001). In 2018, the European Parliament passed rules limiting antibiotics for disease prevention (prophylactic use) to individual animals and only when a veterinarian has determined a high infection risk (European Union, 2006).

3. IDEAL STOCKING DENSITY AND REGULATION IMPLICATIONS

Minimising the stocking density of chickens can have positive implications on food security and prices in a way that the animal welfare of chickens will be improved, disease risks will be reduced through lower stocking densities and environmental benefits of reduced ammonia emissions and waste.

Stocking density is a critical consideration for successful broiler farming. The stress level of birds rises as the stocking density rises. Increased stress is linked to weakened immunity and, as a result, increased disease vulnerability. As a result, reducing stress by decreasing stock density can help reduce infection risk and antibiotic use (Simitzis & Kalogeraki *et al*., 2012). Compared to the typical program, a lower stocking density is also a great alternative for keeping litter moisture at a minimum (McKeith *et al*., 2020). Farmers could minimise stocking density, reducing coccioocyst and harmful bacteria shedding (Haque *et al.,* 2020). This method also assists in healthy ventilation and aeration, lowering stress levels.

On the other hand, the appropriate stock density is currently being debated. Son & Kim *et al.* (2022) found that a lower stock density considerably improved overall growth performance, carcass quality, and mortality. Haque *et al.* (2020) mentioned that each bird in Bangladesh is normally given 1 to 1.5 square feet of floor area. Conversely, providing more space than is required is critical in producing antibiotic-free broilers.

In the United States, certified antibiotic-free poultry products are regulated by the National Organic Program/USDA (NOP, 2014). This regulation states that broiler birds must be reared without being exposed to antibiotics or chemicals. The birds must be free to access the outdoors for fresh ventilation, and the broiler feed should be certified organic (NOP, 2014). According to the US Department of Agriculture (2014), the extension officers of the United States provide a written organic system plan and inspect small-scale farmers' farms. Glatz and Bolla (2004) have stated that raising antibiotic-free broilers is a quick, simple management procedure. In this case, the broiler house must be prepared a week before the arrival of the day-old chicks. Cobb-Vantress (2008) stated that the house must be thoroughly cleaned with water and disinfected with a disinfectant such as a micro-set to kill the bacteria and diseases that might survive inside the house. Then, the house must be left to dry for seven days. The day before the arrival of the day-old chicks, the sawdust must be used and prepared for bedding in the broiler house, and the feeders must be filled with feed (Dejong & Swalander, 2012).

4. LITTER MANAGEMENT

According to Dunlop *et al*. (2016), keeping the litter dry is vital in the overall management of any poultry farm since it affects the performance of the birds by lowering the ammonia level. The cornerstones to successful chicken production are dry waste and low ammonia levels. Ammonia has been shown to have a deleterious impact on bird performance (Payne, 2012). Kristensen and Wathes (2000) has stated that dry litter lowers frustration due to contact dermatitis and inflamed bursa by controlling ammonia levels and providing a better flock atmosphere. When moisture is trapped in unused bedding materials, it bunches together to generate litter coating, increasing ammonia production (Miles, Branton & Lott, 2004). As a producer, monitoring the ammonia levels regularly is a good idea; handheld sensors can help you do so. The most practical approaches to limit ammonia and enhance litter quality are to amend the litter and provide appropriate ventilation (Payne, 2012).

Proper ventilation in chicken housing facilities can help producers limit bacterial development and antibiotic use. According to a study by Brook *et al.* (2010), antibiotic-resistant bacteria were found in the air of broiler chicken facilities, where mould is a possible source of infection, while dust is a great carrier of bacteria. An environmentally controlled structure should be built longitudinally in the east-west direction for proper airing, heat, relative moisture, and light, with large exhaust fans on the west side and evaporative chilling plugs on the east side, as well as programmed feeding and drinking methods inside (Verma *et al.,* 2014). In addition, NOP (2014) stated that different housing systems can be used to provide birds with access to the outdoors, and a permanent structure similar to conventional housing can be used. Still, it must have a door for outdoor access.

5. BROILER FEED AND WATER QUALITY

Broiler feed is the most important aspect since it contains nutrients that help the birds grow. Feed that is tasty and easy to digest should be supplied to birds. According to Arango (2009), the starter diets have a high protein content of 24%, the grower is 20%, and finisher rations have decreased protein content by 18%. Starter feed is the most important in developing healthy gut microbial populations in broilers. According to Brugaletta *et al.* (2020), it is beneficial to add probiotics, prebiotics, organic acids, short and medium-chain fatty acids, and phytogenic feed to achieve a balance in gut microbiota for nutritional enhancement of the gastrointestinal (GI) tract, increase immunological development, and facilitate nutrient absorption. Barekatain and Swick (2016) stated that broiler feeding is centred on reaching market weight as rapidly as feasible. Because this constitutes more than 20% of the broiler growth period, there is growing interest in a specially developed pre-starter feed for 10–14 days of broiler growth. Healthy poultry farming requires a good water sanitation program. Birds need water to survive, and a yearly water quality analysis should be performed to determine bacteria, pH, hardness, minerals, and total dissolved solids (Batal *et al.,* 2005).

6. ALTERNATIVE TO ANTIBIOTICS

The international scientific community is aware of the importance of finding effective and adequate alternatives to antibiotics in food animals as a critical strategy for overcoming the antibiotic resistance problem in poultry production (Woolhouse *et al.,* 2015). There is a variety of strategies that can be used to achieve antibiotic-free poultry production, including the use of non-antibiotic additives such as probiotics, prebiotics, acidifiers, essential oils, phytobiotics (plants extract), enzymes, and the inclusion of whole grains in feed (Brugaletta *et al.,* 2020). In addition, these antibiotic alternatives are used to exploit the broiler chicken industry, and removing antibiotics or adopting alternatives to antibiotic growth promoters can change the microbial ecology of the body (Pedroso *et al.,* 2013). Biosecurity measures, enhanced vaccination, and excellent hygiene practices are other alternative techniques used to limit antibiotic resistance (Magnusson *et al.,* 2019).

7. EFFECT OF ANTIBIOTICS ON HUMAN HEALTH

Angulo *et al.* (2004) have stated that the farm-to-fork route is the most evaluated pathway linking antibiotic usage in chickens to human health impacts. Antibiotic-resistant pathogens can be transmitted through the food chain. Therefore, consuming antibiotic residues in animal products might cause the public to develop antibiotic resistance, allergic reactions, or liver damage (WHO, 2011). *Campylobacter* spp. is common in South African poultry products, posing a health risk. It can harm the gastrointestinal tract and cause diarrheal diseases (Bartkowiak-Higgo & Veary, 2006). Consuming or handling pathogen-contaminated meat can transmit resistant bacteria from poultry products to people. Once these pathogens have colonised the human system, the resistant genes may be shared or transferred to the endogenous gut flora, compromising future treatments for infections caused by these organisms (Sahin *et al.,* 2012). Antibiotic residues in poultry products may result from the ongoing use of antibiotics as normal feed additives. Even as residues, certain antibiotics might induce allergic or hypersensitive reactions in people. As a result, treatment failures, increases in morbidity or death, and quality-of-life measures, such as quality-adjusted life years, are utilised as human health outcomes (Angulo *et al.,* 2004; Molbak, 2004). These are some of the various ways that antibiotic usage in poultry can harm human health.

Antimicrobials are commonly used in commercial feed and water when small-scale farmers produce broiler chickens (FAO, 2014; Mottet & Tempio, 2017). According to much research, due to a lack of antibiotic use awareness and access to competent veterinary services, small-scale farmers operating production systems continue to misuse antimicrobial agents (Forman *et al.,* 2012; Glasgow *et al.,* 2019). Small-scale farming enterprises may lack the financial resources to support the same biosecurity measures as commercial operations. Lack of personal protective equipment, poor sanitation, and unsafe manure disposal are just some biosecurity flaws (Conan *et al.,* 2012; Braykov, 2016). No worldwide standard currently incorporates small-scale poultry raising biosecurity measures (Conan *et al.,* 2012). As a result, numerous studies have identified intense small-scale animal husbandry as a high-risk activity that could result in regional outbreaks and worldwide disease pandemics (Graham *et al*., 2017). According to Shallcross and Davies (2014), antimicrobial resistance kills about 50,000 people annually in the United States and Europe. Bester and Essack (2014) found that antibiotic-resistant Campylobacter strains were isolated in small-scale and commercial broiler farms in Kwa-Zulu Natal, South Africa. Food security, animal welfare, a prolonged treatment cycle, and public health are all threatened by antimicrobial resistance.

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8. THE IMPLICATIONS OF PRODUCING ANTIBIOTIC-FREE BROILER CHICKENS

Almost all small-scale chicken farms use antibiotics; this practice is likely to be widespread and contribute to the development of antibiotic resistance in humans, animals, and the environment. This has consequences for one's health. According to WHO (2011), no national antibiotic usage standards exist in South Africa's chicken production. The intervention of the National Veterinary Committee is needed to help close this gap as soon as possible. Raising awareness among small-scale farmers to limit antibiotic use is also necessary. Improved cleanliness and disease prevention through biosecurity are all viable alternatives to antibiotics for increasing production. These strategies should be publicised on a worldwide scale. To raise awareness of antibiotic usage and decrease inappropriate use, we need to implement a nationwide monitoring and surveillance system and an antibiotic monitoring registration for all chicken farms. Antibiotics with the highest priority and essential importance for human use (last-resort antibiotics) are utilised in chicken production (Koirala *et al.,* 2021).

The social media conversation surrounding antibiotics is growing and shifting from government sources to the food industry. Globally, the dialogue related to antibiotic use in farm animals increased by 7% in volume in 2016 from 2015 (EPI, 2017). Antibiotics can support good animal welfare through disease control, prevention, and treatment; consumers tend to believe that purchasing antibiotic-free poultry perpetuates good animal welfare outcomes. Recent consumer research examined why consumers purchase meats and poultry raised without antibiotics. Of those buying meat and poultry products raised without antibiotics, 70% do so because they believe it is healthier for the animals (ORC, 2017). In addition, consistent with the findings of Goddard *et al.* (2017), nearly two-thirds of those who purchase meat and poultry products raised without antibiotics (64%) believe purchasing beef, pork, and poultry labelled "produced without antibiotics" promotes good animal husbandry practices and leads to cleaner animal living conditions; far fewer believe that it harms (12%) or has no impact (9%) on animal welfare.

9. EFFECT OF ANTIBIOTICS ON THE ENVIRONMENT

Antibiotic residues, antibiotic-resistant bacteria, and resistance genes are considered environmental pollutants and are responsible for a tenacious public health crisis throughout the globe (Darwish *et al.,* 2013). Due to polluted and hazardous environments, poultry diseases and high mortality rates will likely increase. When the environment is polluted and the waste is not managed, it can negatively affect the health of humans and chickens, causing them to be affected and exposed to respiratory diseases. Bougnom *et al.* (2019) mentioned that the antibiotic-resistance boundary between humans and the environment is carried and transmitted by wastewater treatment plants, and antibiotic-resistant bacteria of animal and human origin are found in wastewater from hospitals, houses, and poultry farms. According to a study conducted in South Africa's Eastern Cape Province, wastewater treatment plants could be one of the origins of antibiotic-resistant *Escherichia coli* (Igwaran, Iweriebor & Okoh, 2018).

The poor disposal of the chicken carcass also increases the infection level of bacteria that can potentially infect people, meaning that they are zoonotic. Bougnom *et al*. (2019) mentioned that most rivers are considered sources of antibiotic pollution. Antibiotic-resistant genes and antibiotic substances may be found in farm and human waste, contaminating the environment. Aviagen (2013) stated that antibiotic-related crises are ascribed to the misuse of antibiotics that are ultimately discharged into the environment and the presence of antibiotic residues, which are parent antibiotics found in animal-derived products, livestock products, and wastes.

10. SUMMARY

The use of antibiotics in livestock has faced criticism over the years, with conversations around animal and human diseases and zoonosis, leading to a tightening of antibiotic use regulations. The antibiotic resistance effect is the effect of excessive, continuous use of antibiotics in livestock for human food products or human consumption. The antibiotic resistance effect endangers the nutritional and economic potential of poultry and other food-producing animals. Foodborne diseases continue to be a significant and growing public health problem worldwide. Antibiotic resistance is a worldwide phenomenon that impacts the work of medical and veterinary researchers. The World Health Organisation (WHO) has released a report on antibiotic resistance, which reveals a rise throughout the Asian continent. Many factors contribute to the irrational use of antibiotics, including attitudes, policymakers' views of understanding, manufacturers, prescribers, consumers, and dispensers (Shallcross &

Davies, 2014). The use of antibiotics in animal feed should be regulated worldwide (WHO, 2017b).

Smallholder farmers may improve hygienic farm conditions and maintain farm biosecurity rather than relying on antibiotic drugs for disease treatment and prevention (Selaledi & Mohammed *et al*., 2020). These would essentially act as a technique for preventing disease introduction and spread among animals. According to Khan *et al.* (2012), antibiotic alternatives such as probiotics, prebiotics, enzymes, plant extracts, and organic acids may play a role in reducing reliance on currently available antimicrobial drugs (Yadav *et al.,* 2016). When combined with excellent management practices, the absence of antibiotics in broiler farming has little effect on animal health and welfare (Iannetti *et al.,* 2021). Antibiotic-free farming should be standardised to ensure both animal welfare and consumer health. Due to the strong demand for antibiotic-free meat, high stocking density should be avoided, and particular recommendations for antibiotic-free agriculture should be developed (Iannetti *et al*., 2021).

11. CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this manuscript.

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