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# Antibiotics in Poultry: Examining Alternatives for Safer Food Production

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***Abstract*****—** *Chicken is the most commonly farmed species with over 90 billion tons of chicken meat produced per year. Many food-producing animals are given antibiotics daily to grow faster and prevent diseases in many parts of the world. When antibiotics are used for the purposes of growth promotion a small amount is often administered as compared to therapeutic use. Therefore, this may cause bacteria to develop antibiotic resistance (World Health Organization, 2017). There are several challeneges related to antibiotic free bird production. Several alternatives to antibiotics, including probiotics, prebiotics, competitive exclusion, enzymes, and organic acids, have shown promise in replacing antibiotics. The use of prebiotics aids in preventing the colonization of the digestive system by harmful pathogens, achieved by creating an unfavorable environment through pH alterations in the intestinal content. Probiotics, which are live strains of strictly selected microorganisms have beneficial effects on health. The incorporation of enzymes in poultry diets offers several advantages, including reduced digesta viscosity, improved digestion and nutrient absorption, increased feed intake, and enhanced weight gain. Maximizing performance and sustaining poultry productivity will rely on employing well-balanced combinations of diverse alternatives alongside effective management practices. This approach remains essential for accomplishing our ultimate goal of reducing antibiotic usage.*

***Keywords*****— Chicken farming, antibiotic resistance, alternatives to antibiotics, probiotics and prebiotics, poultry productivity.**

## I. INTRODUCTION

Poultry is among the major widespread food industries worldwide. Chicken is the most commonly farmed species with over 90 billion tons of chicken meat produced per year [1]. Antibiotics are mostly used for treatment, prophylaxis and growth promotion in poultry. Many food-producing animals are given antibiotics daily to grow faster and prevent diseases in many parts of the world [2]. This trend is likely to continue to meet the growing demand for the protein of animal origin. When antibiotics are used for the purposes of growth promotion a small amount is often administered as compared to therapeutic use. Therefore, this may cause bacteria to develop antibiotic resistance [3]. The emergence and spread of antibiotic resistance compromise the nutritional and economic potential of poultry and other food-producing animals. This is a global concern that affects both animal and human ecosystems. The European Union (EU) banned antibiotic use in animal production in 2006 [4]. Scientific proof suggests that the extensive use of

antibiotics has led to increase of antibiotic resistance [5-7] and presence of antibiotics residues in feed and environment [8-9], compromises human and animal health [10]. Hence, there is an increasing need to find effective alternatives to control infectious diseases and control the spread of resistant bacteria, but more importantly keep antibiotics a useful tool for the future.

## II. USE OF ANTIBIOTICS IN BROILER CHICKEN PRODUCTION

Over the past 50 years, the use of antibiotics along with strict biosecurity and hygiene measures has helped the poultry industry to grow by preventing the negative impacts of many avian diseases [11]. Even as biosecurity may be sufficient, vaccination can also be used as an additional measure. A vaccine provides assistance to the immune system by preparing it against certain pathogens such as viruses or bacteria to which it may be exposed in the future. Vaccination protocols and the type of vaccine used vary from country to country and from farm to farm. Many factors can influence the choice of vaccination method such as species, place, number of manpower, type of production, and production cycle. The choice of vaccination method also depends on general health status of poultry, maternal immunity, and vaccine costs. Livestock vaccination against specific diseases is compulsory (e.g., Newcastle disease) in many countries (Belgium, Netherlands, Germany), while in other such as France only long-lived poultry (laying and breeding) are vaccinated [12].

## III. ANTIBIOTIC-FREE POULTRY PRODUCTION:

There is little convincing scientific evidence that antibiotic use in food-producing animals contributes to antibiotic resistance challenges in human medicine [13-15]. However, consumer perception in first-world countries implies that this is accurate. Consumer preferences, such as purchasing ABF products, are mostly dependent on perception rather than scientific findings [16]. For example, most people are unaware that all chicken meat is ABF or contains levels below limits considered safe for humans. For decades, regulatory organizations such as the USDA-FSIS have routinely monitored drug residues by sampling and testing tissues to verify that no drug residues (including antibiotics) are discovered to be above the tolerance or maximum residue limit (MRL) specified for each drug**.** The poultry business, in particular, has an excellent track record of adhering to drug withdrawal periods and residual tolerances [17,18]. There are several challenges related to ABF bird production. While several different compounds have distinct physiological, immunological, and/or bacteriostatic actions in the intestine, none (to date) convey the range and extent of the antibiotics' effects [19]. Other researchers have proposed that the unique and highly reproducible effects of in-feed antibiotics may be due to the prevention of immunologic stress [20] or their anti-inflammatory effect [21], rather than their antimicrobial effect, and that this should be taken into account when looking for new compounds to be used as replacements.

## IV. IMPORTANT ALTERNATIVES TO ANTIBIOTICS

### 4.1 Probiotic and Prebiotic

Antibiotics have been known to positively impact poultry performance, but their excessive use as growth promoters poses risks to human health. However, discontinuing antibiotics can negatively affect poultry performance. Some researchers argue that using antibiotics to enhance animal growth and feed efficiency reduces the cost of meat and eggs. Therefore, banning antibiotics could increase the price of animal products. Balancing safety and optimal performance is crucial in addressing this challenging issue. To find viable alternatives, researchers are exploring options such as natural herbs and medicinal plants as substitutes for antibiotics in poultry production [22]. Several alternatives to antibiotics, including probiotics, prebiotics, competitive exclusion, enzymes, and organic acids, have shown promise in replacing antibiotics [23]. Prebiotics, for instance, are potential alternatives for promoting growth in poultry. They are indigestible carbohydrates that selectively stimulate the growth of beneficial bacteria in the colon. The concept of prebiotics was introduced by Gibson and Robertroid (1995) [24], and their effects were noticed in animal feeds as early as the 1980s. Prebiotics can effectively replace antibiotics in the poultry sector due to their ability to support a healthy intestinal microbial population [25]. Moreover, prebiotics offer other advantages such as aiding in the prevention of colon cancer, reducing disease-causing bacteria like Salmonella and E. coli, and positively altering gastrointestinal microbiota [26].

The use of prebiotics aids in preventing the colonization of the digestive system by harmful pathogens, achieved by creating an unfavorable environment through pH alterations in the intestinal content. Within the digestive system, certain beneficial bacteria like *Bifidobacterium* and *Lactobacillus* possess the Manase enzyme. They selectively bind mannan oligosaccharides, which are absent in harmful bacteria lacking this enzyme [27]. Mannan oligosaccharides (MOS) have been observed to increase daily weight gain in broiler chickens by 4–8%

[27, 28]. Studies by Kumprech et al. (1998) [29] have shown that prebiotics offer similar effects to antibiotics without leaving residues or leading to the development of resistance. When chickens are fed MOS, their intestinal villi length increases significantly, though not their width [30]. Probiotics, which are defined as "live strains of strictly selected microorganisms that, when administered in adequate amounts, provide health benefits to the host" [31], are used in poultry feed to promote animal health, stimulate growth, and enhance the host's immunity [32]. Assessing the safety and benefit-to-risk ratio of probiotic strains is a challenging task. These microorganisms are chosen for their beneficial effects on health and must adapt to the specific conditions of the gastrointestinal tract in the targeted animal species [33]. When probiotics are introduced into feeds, they need to adapt to the new environment, including factors like temperature and humidity. In the European Union, the most commonly selected probiotics belong to Gram-positive bacteria, including species like *Bacillus, Enterococcus, Lactobacillus, Pediococcus*, and *Streptococcus.* Probiotics are not limited to bacteria alone; yeast and fungi strains such as *Saccharomyces cerevisiae* and *Kluyveromyces* have also been utilized. Caution is necessary as certain bacteria, like enterococcus, may contribute to the spread of antibiotic resistance, and strains like bacillus cereus have the potential to produce toxins [34].

### 4.2 Enzyme

Feed additives in the form of enzymes, produced through the fermentation of fungi and bacteria, are utilized to optimize feed conversion in poultry. Commonly employed enzymes like endo-b-1-4-xylanases and b-1-3, 1-4-glucanases are added to wheat and barley diets for broiler chickens, enhancing digestibility [35]. The incorporation of enzymes in poultry diets offers several advantages, including reduced digesta viscosity, improved digestion and nutrient absorption, increased feed intake, and enhanced weight gain [36]. Studies on enzyme supplementation in laying hens conducted by Khan et al. (2011) [37] demonstrated significant improvements in feed conversion ratio, egg production, egg weight, and egg mass. A separate experiment by Mabelebele et al. (2017) [38] which involved xylanase in chicken diets, reported increased crude protein digestibility, feed intake, and weight gain due to the enzyme's addition. Hence, the effects of incorporating enzymes into poultry diets seem to yield mixed results.

### 4.3 Plant Extracts

Phytobiotics, also known as plant extracts, have emerged as a viable alternative to antibiotics in poultry production due to their antimicrobial, anti-inflammatory, antioxidant, and antiparasitic properties. They have been successfully used in the poultry industry for an extended period [39,40]. One of the main reasons for their success in poultry is attributed to their diverse properties. Plant extracts contain minor metabolites such as terpenoids, phenolics, glycosides, and alkaloids, present in various forms like alcohols, aldehydes, ketones, esters, ethers, and lactones [41]. These metabolites play a crucial role in enhancing the growth performance and health of poultry [40]. However, it is essential to be cautious about the excessive use of these secondary metabolites, as they can potentially negatively affect digestive efficiency [42]. Nevertheless, compared to antibiotics, plant extracts are considered safe and effective in combating certain bacteria [40]. Studies by Rahimi et al. (2011) [43] indicated that poultry diets supplemented with plant extracts led to an increase in feed intake, feed conversion ratio, and body weight gain, along with improved secretion of endogenous digestive enzymes. Conversely, Al-Kassie et al. (2011) [44] reported no adverse effects on productivity and health in broiler chickens when fed plant extracts as a supplement Additionally, herbs like black pepper act as alternative growth promoters without negatively affecting broiler performance [45,46]. Other studies highlighted the ability of cineol and eucalyptol in eucalyptus and garlic extracts to prevent infectious diseases, facilitate proper air circulation, and enhance bird growth by relaxing the air sacs [47,48].

## V. CONCLUSION

Foodborne infections pose a significant public health problem in both developed and developing countries. According to WHO, approximately 70% of diarrheal cases are caused due to bacterial contamination in food. Hence, there is need for alternatives to antibiotic use in food animals to manage bacterial infections in both human and veterinary fields. Antibiotics are commonly used in humans and animals for healthier and productive animal production. However, the increased use of antibiotics has led to development of antibiotic-resistant bacteria. The rapid emergence of antimicrobial-resistant bacterial strains is closely linked to the high use of these drugs. Therefore, finding viable alternatives to antibiotics becomes crucial in addressing this concerning issue. Various alternatives such as probiotics, prebiotics, enzymes, plant extracts etc. have the potential to reduce dependence on current antimicrobials. Maximizing performance and sustaining poultry productivity will rely on employing well-balanced combinations of diverse alternatives alongside effective management practices.

This approach remains essential for accomplishing our ultimate goal of reducing antibiotic usage.

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