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# Antibiotic Resistance in the poultry industry: The need for a global solution

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**Abstract:** Poultry production is one of the fastest sources of meat production worldwide. The poultry sector and livestock shifted to antimicrobial agents for disease prevention and growth promoters for more rapid meat production. Antibiotic usage increases day by day in meat-producing birds and animals. Overuse of antibiotics leads to antimicrobial resistance in human beings. The emergence and speared of resistant bacterial strains like Escherichia Coli (E. Coli), and Campylobacter sp. Enterococcus sp. from poultry products to consumers put humans at risk for bacterial infection treatment. For the sustainability of poultry development and to produce antimicrobial residue-free meat, the poultry sector must be shifted to herbal supplements and natural or organic acids as a therapeutic agent and growth promoters. These are the best replacement or alternative to antimicrobial drugs prebiotics, probiotics organic acids which boost production and maintain bird health without causing the loss of productivity or product quality. It reduces the risk of antimicrobial resistance in humans. Herbal supplements like ginger. Ginger root extract is high in vitamins which have been shown to reduce intestinal oxidative stress and enhance intestinal mucosal development in chicks. It helps neutralize free radicals, activates antioxidant enzymes, mitigates inflammation by inhibiting pro-inflammatory pathways and enzymes, and promotes digestion through enzyme stimulation and gastro-protective effects. Ginger helps to stimulate appetite. Using symbiotics is still a better option for improving poultry development. Especially the use of probiotic microorganisms that can positively influence antibiotic alternatives for poultry birds without sacrificing the welfare of birds and producing safe edible products.

**Keywords:**

Poultry, antimicrobial resistance, antibiotics, alternative, probiotics

## Introduction

One of the fastest-growing meat sources in the world is poultry, which accounted for nearly one-fourth of all meat produced in 2000 (Taha, 2003). In less than a month and a half, a modern production unit can produce broiler chickens that are ready for the market. Genetic selection, improved feeding, and health management practices that use antibiotics as therapeutic agents to treat bacterial diseases in intensive farming systems contributed to this development (Kahn et al., 2019). In addition, they can be utilized as growth promoters in feed at concentrations below the therapeutic range and as preventatives in the water of healthy birds (Upadhayay et al., 2014).

Bacitracin, chlortetracycline, tylosin, avoparcin, neomycin, oxytetracycline, virginiamycin, and others are utilized for these reasons.

The rate of weight gain and efficiency of feed-to-meat conversion are enhanced by subtherapeutic dosing. In the 1950s, the recommended feed levels of antibiotics were 5-10g $kg^{-1}$, but these levels have since increased ten to twenty times. The majority of antibiotics used on poultry in many developing nations are used to treat infections (Hosain et al., 2021). Anti-microbials are additionally used to neutralize the unfavorable outcomes of stress reactions. The intensive production of poultry and livestock has been transformed by the economic and health advantages of antibiotics (Singer & Hofacre, 2006).

As a general rule, when an anti-microbial is applied in poultry cultivating, the medication kills the delicate bacterial strains, abandoning or choosing those variations with strange characteristics that can oppose it (Banda, 2003). The population then becomes dominated by these resistant bacteria, which multiply at a rate of one million times per day. Through mutation or plasmid-mediated transmission, these bacteria transmit their genetically defined resistance characteristics to the strains' offspring and other bacterial species (Drago et al., 2013).

The ability of a bacterial population to withstand the effects of inhibitory concentrations of antimicrobial agents is what WHO defines as resistance to antibiotics (Catry et al., 2003). Consuming or handling contaminated meat can lead to the potential spread of resistant bacteria from poultry products to humans (Van den Bogaard and Stobberingh, 2000). The genes coding for antibiotic resistance can be transferred to other bacteria that are part of the human endogenous flora, jeopardizing the effectiveness of antibiotic treatment for bacterial infections once they have been acquired (De Leener, 2005).

To identify the transfer of resistant bacteria or resistant genes from animal origin to people and vice versa, it is crucial to track the incidence of antibiotic resistance in both human and animal populations (Argudin et al., 2017). There are vast regions of Africa and Asia where we know very little about antibiotic resistance, even though the European Union, the United States, and Australia have acknowledged the grave health risks associated with antibiotic resistance in major animal production sectors (Ferri et al., 2017). This review aims to give information on the emergence of antibiotic resistance, the prevalence of antibiotic resistance in poultry, the implications for public health, a strategy for containing the spread of evolving bacterial resistance, and the use of probiotics as a substitute for subtherapeutic antibiotic use.

## Antimicrobial drug use and resistance in poultry

Since the 1950s, antimicrobial drugs have been regularly utilized in poultry to increase growth and feed efficiency (Niewold, 2007; Torok et al., 2011). They are also utilized to lower morbidity and mortality linked to illnesses that affect poultry. Worldwide, livestock for human consumption use 73% of all antimicrobial drugs that are sold in most retail establishments (Van Boeckel et al., 2019). The approved applications of these antimicrobial medicines differ throughout nations and regions, and they are typically given intravenously or orally in feed plus drinking water (Gyles, 2008). Antimicrobial drugs are still used worldwide to boost growth in food animals, except in the European Union (EU), where they were declared illegal in 2006, and the United States, where they were phased out in 2017 (Roth et al.2019). The various uses of antimicrobial +++agents in poultry production are shown in Table 1.

Antimicrobial drugs are overused and/or misused in aquaculture, human treatment, and animal husbandry due to an over-dependence on them (Livermore, 2002; Sommer et al., 2009; Yuan et al., 2019).  According to (Yang et al., 2004), this raises the possibility of selecting microbes resistant to the antimicrobial agent. The emergence of resistance to frontline antimicrobial agents, like fluoroquinolones, is a significant concern. These agents are highly valuable for treating human infections due to their broad-spectrum coverage and low toxicity (Livermore et al., 2002; Yang et al., 2004). It is now generally acknowledged that antimicrobial resistance (AMR) is a significant global public health issue that causes over 2 million resistant infections as well as several fatalities (Hoelzer et al., 2017).

The advent and spread of "superbugs" that are resistant to various antibiotic classes is predicted to make this worse (McKenna, 2013; Yuan et al., 2019). Antimicrobial resistance infections not only endanger human health but also seriously jeopardize animal health due to increased morbidity and mortality, which lengthens disease and reduces productivity (Yang et al., 2004).

**Table 1: Uses of Antimicrobial Agents in poultry production**

| Class of Antibiotic | Name of Antibiotics | Mechanism of Action | Effective Against Pathogens | Used in Species | References |
|---|---|---|---|---|---|
| Aminoglycosides | Gentamicin, kanamycin, streptomycin, spectinomycin, tobramycin, neomycin | Defective protein production, inhibition of protein synthesis | Gram-negative and Gram-positive bacteria | Broiler chickens, turkeys, ducks | (Mingeot et al., 1999; Udumula et al., 2013; Javed et al., 2008) |
| Aminocyclitol | Spectinomycin, apramycin | Irreversible inhibition of protein synthesis, bactericidal and bacteriostatic | Gram-negative and Gram-positive bacteria | Chickens and ducks | (Hofacre et al., 2013; Kirst & Marinelli, 2013) |
| Beta-Lactams | Amoxicillin, penicillin, nafcillin, cloxacillin, ampicillin, cephalosporin, monobactam | Bactericidal, inhibits cell wall synthesis, inhibits transpeptidase, | Gram-negative and Gram-positive bacteria | Fattening Turkeys broiler chickens | (Maasjost et al., 2015; Williamson et al., 1986; Tipper, 1985) |

| | | | | | |
|---|---|---|---|---|---|
| | | affects cell wall integrity | | | |
| Ionophores | Flavomycin, ambermycin, flavophospholipol | Inhibition of cell wall synthesis | Gram-positive bacteria | Broiler chicken and Turkeys | (Barros et al., 2012; Salmon & Stevens, 1990) |
| | Monensin, salinomycin, semduramicin | Cell wall disruption | Protozoan parasites (*Eimeria sp)* | Chicken and Turkey | (Koutoulis et al., 2013; Logan et al., 1993; Combs et al., 1958) |
| Tetracycline | Chlortetracycline, oxytetracycline, doxycycline, tetracycline | Inhibit protein synthesis | Gram-negative and Gram-positive bacteria, *Nocardia, Mycobacterium, Streptomyces, Mycoplasma* | Pigeons, ducks, turkeys, ostriches | (Chopra et al., 2001; Chopra et al., 1992; Schnappinger & Hillen, 1996) |
| Macrolides | | Inhibit protein synthesis | Gram-positive bacteria, *Mycoplasma, Mycobacterium, Chlamydia* | Layer and broiler chicken | (Ungureanu, 2010; Shryock et al., 1998; |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Nakajima, 1999) |
| Polymixin | Polymixin B & E | Inhibit cell membrane function | Gram-negative bacteria | Chickens | (Van Bambeke et al., 2009; Zavascki et al., 2007) |
| Streptogramins | Virginiamycin | Inhibit proteins synthesis | Gram-positive bacteria | Chicken and Turkey | (Kieke et al., 2006) |
| Quinolones | Diaminopyrimidins, quinolines, trimethoprim, aditoprim | Inhibit DNA replication | Gram-negative and Gram-positive bacteria | Chicken and Turkey | (Butaye et al., 2003; Laue et al., 2007) |
| Cyclic peptides | Bacitracin | Inhibit cell wall and protein synthesis | Gram-negative and Gram-positive bacteria | Pigeons, turkeys, layers, ducks | (Castanon, 2007) |
| Orthosomycin | Avilamycin | Inhibit protein synthesis | Gram-positive bacteria | Broiler chicken and Turkey | (Wellenreiter et al., 2000) |
| Glycopeptides antibiotic | Vancomycin, avoparcin, telcoplanin | Inhibit cell wall synthesis | Gram-positive bacteria, | Broiler chicken | (Elwinger et al., 1998; Kruse et al., |

| | | | | | |
|---|---|---|---|---|---|
| | | | *Actinomycetes, Nocardia* | and Turkey | 1999; Bager et al., 1997) |

## Transmission and Spread of Antimicrobial Resistance

Antimicrobial resistance is a long-standing and natural occurrence, as noted by (Apostolakos & Piccirillo, 2018) and (Yuan et al., 2019). Microbes frequently use the synthesis of antimicrobial agents to prevent competition with one another (Newman et al., 2003; Yuan et al., 2019). Over millions of years, microorganisms have developed the ability to synthesize antimicrobial compounds (Baltz, 2008; Yuan et al., 2019). According to (Katale et al., 2020), a greater degree of variation in AMR genes suggests that many sources of resistant bacteria may exist, or that genes may migrate across different strains due to mobile genetic components. Therefore, to successfully evade the risks posed by rival antibiotics, producers of antibiotics must naturally contain self-protection mechanisms (Cordero et al., 2012; Wright, 2007; Yuan et al.2019)

Point mutations, re-assortment, or horizontal gene transfer (HGT) can all lead to the emergence of this resistance (Hoelzer et al., 2017). AMR development and transmission under external stress are crucially influenced by enteric pathogens and normal intestinal microbiota, as demonstrated by studies (Witte, 1998; Zhou et al., 2012). HGT is mediated by mobile genetic elements (MGEs), including integrons, transposons, and plasmids. Studies (Fricke et al., 2009) that suggest the gut microbiota may act as reservoirs for antibiotic resistance and the propagation of resistance to zoonotic infections further supported this.

MGEs contain a large number of the widely known antimicrobial resistance genes (ARGs), which can be transferred to other bacteria belonging to the same or different species (Allen et al., 2010; Yuan et al., 2019). According to (Kraupner et al., 2013) and (Yuan et al., 2019), ARG subtypes connected to the same antibiotic class typically give bacterial hosts variable tolerance to this antibiotic. According to (Wee et al., 2020), cattle have been identified as the primary reservoir for antimicrobial resistance (AMR) that can be transmitted to humans. Additionally, environmental margins and proximity to animals have been identified as the primary risk factors for AMR transmission.

The World Health Organization, better known as the WHO, states that antibiotics used to treat a variety of infectious diseases in livestock may be similar to those used to treat human infections, which could result in the spread and transmission of antimicrobial resistance (AMR) in people who are in close contact with these animals or livestock (Novais & Freitas, 2020). Furthermore, increasing environmental use of additional antimicrobials such as metals and disinfectants is thought to be a potential factor for AMR selection (Novais & Freitas, 2020). Therefore, food exposure, manure, wastewater, and a host of other channels are just a few of the many ways that variable and compound AMR bacteria, MGEs, and genes spread throughout the environmental, animal, and human sectors. This composite process encourages the continuous evolution, recombination, and genetic exchange of AMR features.

## History of Antimicrobial Resistance in poultry production:

The narrative of resistant antibiotics in poultry farming is one of inventiveness tempered by unintended repercussions. First used in the chicken business in the middle of the 20th century, antibiotics were mainly used to treat bacterial illnesses (Landers et al., 2012). According to (Van Boeckel et al., 2015), this original use was heralded as an achievement because it significantly decreased the rates of sickness and mortality in chicken flocks. Upon realizing the advantages, farmers and other agricultural workers quickly embraced the use of antibiotics as regular feed and water additives to stimulate expansion and fend off illness, in addition to healing diseases. Because it is so successful at increasing growth rates and improving feed efficiency, this practice—known as subtherapeutic antibiotic use—became widely adopted, resulting in a notable decrease in expenses and an increase in chicken production (Singer et al., 2007).

But shortly, a more sinister aspect of chicken farming's widespread and frequently uncontrolled consumption of antibiotics emerged. Since bacteria are extremely adaptive organisms, they started to grow resistant to the antibiotics that were being administered. When bacteria adapt to being exposed to medications meant to kill them, a phenomenon known as antimicrobial resistance

(AMR) takes place (Marshall & Levy, 2011). Resistant types of bacteria, including Salmonella, Campylobacter, and Escherichia coli, thrived in the cramped and densely populated settings of industrial poultry farms. (Manyi et al., 2018) found that these bacteria were resistant to antibiotics, which presented a direct risk to animal health as well as an indirect risk to human health. The ingestion of tainted meat and poultry products or environmental routes, such as soil and water tainted with poultry excrement, could expose humans to these resistant strains. A serious public health emergency was sparked by the spread of resistant germs from animals to humans. The (Centers for Disease Control and Prevention, 2013) reported that infections that were previously easily treated with simple antibiotics become more difficult and expensive to control, increasing morbidity and death.

An international review of the use of antibiotics in agriculture has been sparked by the increase in AMR in chicken farming. Globally, nations have begun to impose more stringent laws governing the use of antibiotics in livestock, encouraging the development of alternative methods to preserve animal health as well as better husbandry practices and enhanced hygiene. To tackle germs that are resistant to antibiotics, there has also been a concentrated effort to innovate and conduct research to create new medicines. A sobering reminder of the intricate relationship between agricultural practices and public health is provided by the history of antimicrobial resistance in poultry production. This relationship emphasizes the need for sustainable and responsible antibiotic use to protect the health of both humans and animals (Economou & Gousa, 2015).

## Antibiotic resistance in poultry Environment:

In general, when an antibiotic is used in chicken farming, the medication kills the susceptible strains and leaves them behind or favors the variants with unique characteristics that are resistant to it. After that, these resistant bacteria proliferate, growing by a million times per day to become the majority microorganism in the population. These bacteria use plasmid-mediated or mutation-induced mechanisms to pass on their genetically determined resistance traits to other bacterial species as well as to subsequent strain progeny (Drago et al., 2013). Antibiotics used to treat illnesses caused by human or animal pathogens are ineffective because of the widespread distribution of antibiotic-resistance genes in bacteria (Jian et al., 2021).

## Misuse of Antibiotics in poultry leads to resistance in humans:

Low dosages of antibiotics are frequently used in animals that produce food, such as those that produce meat, eggs, and milk. According to (Wendlandt et al., 2015), there is a complex interaction between the overuse of antibiotics and the development and spread of antibiotic resistance in the microbiota of animals, humans, birds, and the environment. Thus, the selective pressures brought on by the indiscriminate use of antibiotics can be linked to the development of antibiotic resistance (Zhang et al., 2018). According to (Berendonk et al., 2015), the release of antibiotic-resistant genes (ARGs) and bacteria (ARBs) from sources with high anthropogenic activity, along with the consequences of antibiotic misuse in the veterinary and medical sectors, are currently regarded as environmental challenges.

Significant risks to the health of poultry, humans, animals, and the environment are posed by microbial contaminants and ARGs because they can persist and disperse in the environment by multiplying within their hosts, spreading to other bacteria, or undergoing other evolutionary processes. This is in contrast to the majority of chemicals and organic contaminants in the environment, which can readily degrade or diminish in concentration over time (Maier & Gentry, 2015).

The ability of the bacterial population to withstand the effects of an inhibitory concentration of antimicrobial drugs is defined by the WHO as antibiotic resistance (Catry et al., 2003). By eating or handling meat contaminated with pathogens, there is a chance that resistant germs from poultry products will be transferred to the human population (Van den Bogaard and Stobberingh, 2000). After being obtained, these bacteria can colonize an individual's digestive tract and transfer the genes responsible for antibiotic resistance to other Indigenous microflora bacteria, hence increasing the difficulty of treating bacterial infections successfully (Stanton, 2013).

## Public health linkage

The effects of introducing microorganisms resistant to antibiotics to humans have received a lot of attention. When people have common infections that were once easily treated with antibiotics, it can put them, their families, and the entire community in grave peril and cause them great misery. The effectiveness of antibiotic chemotherapy for patients who contracted the new strains of infectious disease will be negatively impacted by the emergence of resistant bacterial strains (Doyle et al., 2006; Chastre, 2008). Moreover, it promotes the requirement for more costly and hazardous pharmaceuticals. Certain resistant infections can be fatal. By interfering with antibiotics' mode of action through a variety of effector mechanisms, such as the creation of inactivating enzymes, resistant bacteria interfere with antibiotic treatment. Modification of the target sites' unique configuration and suppression of or adjustments to membrane transport mechanisms to get rid of the antibiotic (Cetinkaya et al., 2000).

## Recommendations Alternatives of antibiotics

Due to the drug resistance associated with the use of antibiotics in poultry farming, there has been a significant push to find alternative treatment alternatives for common infections affecting chickens. Antibiotic substitutes are necessary to keep the gut healthy and functional by reducing infections and improving nutritional digestion and absorption (A Jamal, 2023). Using fermentable sugars, entire-grain cereals, live microbial cultures, and feed processing/sterilization are a few methods to cut down on antibiotic usage in chickens. Notable alternatives in the production of poultry include organic acids, probiotics, prebiotics, symbiotics, herbal remedies, vitamins, minerals, and plant extracts (essential oils) (Dhama et al., 2014).

## Probiotics

Probiotics are a blend of live microorganisms that provide the host with health benefits when taken in sufficient doses (Clavijo and Florez, 2017; Smith, 2014). By promoting the growth of healthy microbiota, they improve the animal hosts by lowering and preventing the colonization of enteric pathogens, regulating immune function, promoting the health of the epithelium, improving digestion, and aiding in the maturation of intestinal tissue. (Clavijo and Florez, 2017) have provided a detailed review of these health benefits. Since their introduction in 1973 to manage Salmonella in grill chickens, 8 have been used in poultry (Clavijo and Florez, 2017; Nurmi and Rantala, 1973). However, this first application of probiotics had a drawback since it might have introduced infections According to (Clavijo and Florez, 2017) review, a variety of probiotics have been created, each with a different level of efficiency. The varieties of Lactobacillus and Bacillus found in the market are often diverse. A study was carried out in Kenya to determine how dietary probiotics affected the natural levels of immunoglobulin in poultry (Khobondo et al., 2015). In this study, 150 2-month-old chicks were divided into five treatments at random, with each treatment consisting of 25 chicks. The researcher then dissolved 5 milliliters of probiotic Molaplus into varying-sized drinking water containers, ranging from 250 to 2,000 milliliters. Immunoglobulin levels were determined using the indirect enzyme-linked immunosorbent assay (ELISA) technique in addition to the advantageous microbes (Clavijo and Florez, 2017).

However, the results showed that dietary probiotic supplements had no discernible effect on the amounts of immunoglobulin that bind keyhole limpet hemocyanin (KLH). (Atela et al., 2015) concluded that adding probiotics to drinking water can greatly increase the weight of indigenous chicken in Kenya, based on a similar study examining the impact of probiotics on chicken weight.

## Prebiotics

Prebiotics are indigestible feed additives that help the host by increasing the development rate of a small number of good bacteria in the colon and/or multiplying them, hence improving gut health. These provide the stomach's helpful bacteria with something to eat. As stated by Cummings (Ricke, 2015), prebiotics have the following main effects: they change the GI microflora, boost immunity, inhibit pathogen invasion and prevent colon cancer, lower cholesterol, and odor compounds, improve gut health by encouraging enzyme reactions, lower ammonia and phenol products, and ultimately lower production costs (Yadav et al., 2016). Gluco-oligosaccharides (GOS), fructooligosaccharides (FOS), mannan-oligosaccharides (MOS), stachyose, and oligochitosan are the main prebiotics that have been studied in chickens (Jiang et al., 2006).

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It should have systemic effects to support the health of the host; it should not be hydrolyzed or absorbed in the upper gastrointestinal tract; it should be appetizing as a feed ingredient; and it should be simple to process on a large scale. By reducing the need for antibiotics, prebiotics can be added to chicken diets, which will eventually diminish bacterial drug resistance (Patterson & Burkholder, 2003). Prebiotics have the potential to decrease the colonization of pathogens, including Vibrio cholera, Escherichia coli, S. Typhimurium, and S. Enteritidis, in chicken diets (Bailey et al., 1991). The meat and coccus had decreased overall viable counts after the oligosaccharide addition. Furthermore, prebiotics lessen the frequency of dangerous gut infections by encouraging the growth of Lactobacillus and Bifidobacteria. (Dhama et al., 2007) Therefore, by changing the population of gut microbes and enhancing the immune system by lowering infections, prebiotics can be used as an alternative to antibiotics to improve the health and performance of chickens. Furthermore, more investigation is needed to fully understand the precise purpose and mode of action of a particular component or set of components. The hens' growth and immunity are influenced by the bacteria in their digestive tract. (Di Bartolomeo et al., 2013) reported that prebiotics can influence the innate immune response by interacting with receptors, increasing endocytosis, and activating cytokines and chemokines. Prebiotics are well known for their ability to promote the growth of beneficial bacteria (Van Loo et al., 1999). Fructose polymer inulin is frequently consumed by both humans and animals as a prebiotic. Even though they cannot be broken down in the intestines, they operate as a growing medium for Bifidobacteria (Kelly, 2008). Moreover, inulin increases the gut's defenses against invasive infections and the ileum's synthesis of secretory immunoglobulin A (SIgA) (Buddington et al., 2002).

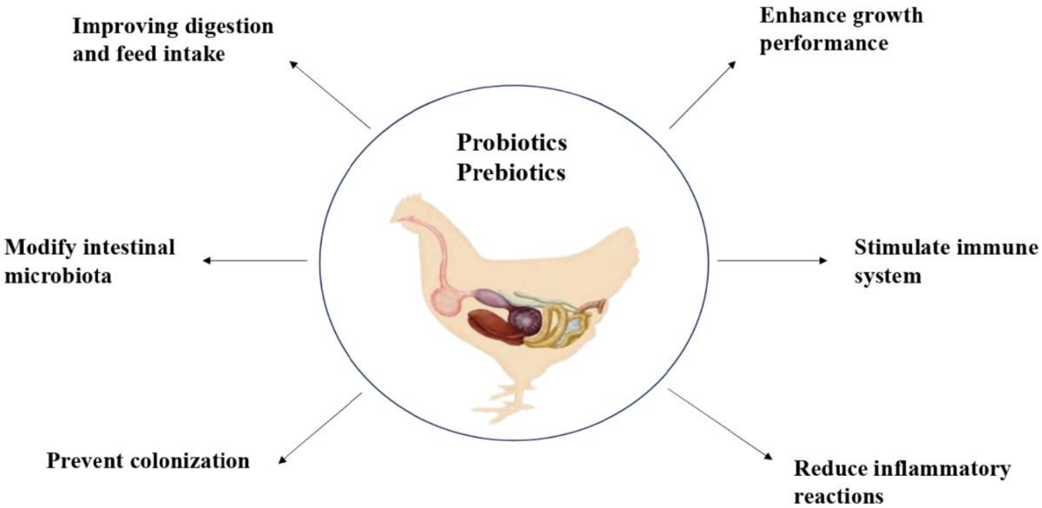


**Fig 1: Beneficial effects of Probiotics and Prebiotics in poultry**

## Bacteriophages

Viruses known as "bacteriophages" infect only bacteria. Thus, using phages to treat bacterial illnesses is known as phage therapy (Clavijo and Florez, 2018). When bacteriophages were discovered in 1915, their applicability to humans was first reported (Abedon et al., 2011). Recently, the application of bacteriophages as a natural, non-toxic alternative therapy for bacterial infections has gained promise due to the advent of multidrug-resistant pathogens (Clavijo and Florez, 2018). Treating a certain type of bacteria specifically without disrupting the typical microbiota is one of its benefits. By doing this, the chance of secondary infections brought on by antibiotic treatments is reduced (Clavijo and Florez, 2018).

The ability of bacteriophages to effectively combat both antibiotic-resistant and sensitive forms of bacteria is a significant additional benefit (Loc-Carrillo and Abedon, 2011; Nilsson, 2014). (Clavijo and Florez, 2018) have studied in depth the use of phages for humans, animals, plants, and food. To regulate Listeria monocitogenes in food intended for human consumption, the United States licensed a combination of phages in 2006 (Sulakvelidze, 2013). However, using bacteriophages on live animals has not yet received approval. (Clavijo and Florez, 2018) have thoroughly examined several research that have used bacteriophage therapies in different animal models. In particular, the management of Campylobacter and Salmonella. The unpredictability of the outcomes is one of the drawbacks of phage therapy. This may be explained by the target bacteria developing phage resistance, low infection multiplicity, the target microorganism's inaccessibility, and the host deactivating the phages (Clavijo and Florez, 2018). The absence of regulations and approval for their usage with animals is a more significant barrier to their use on farms. Furthermore, because the therapy is a relatively new technology, there is no guarantee that the producer community will accept it (Clavijo and Florez, 2018). But to get such permission, (Hashem & Parveen, 2016) and (Clavijo and Florez, 2018) suggested that studies into the efficacy of proposed research into effectiveness of phages in the commercial conditions of factory farming are required.

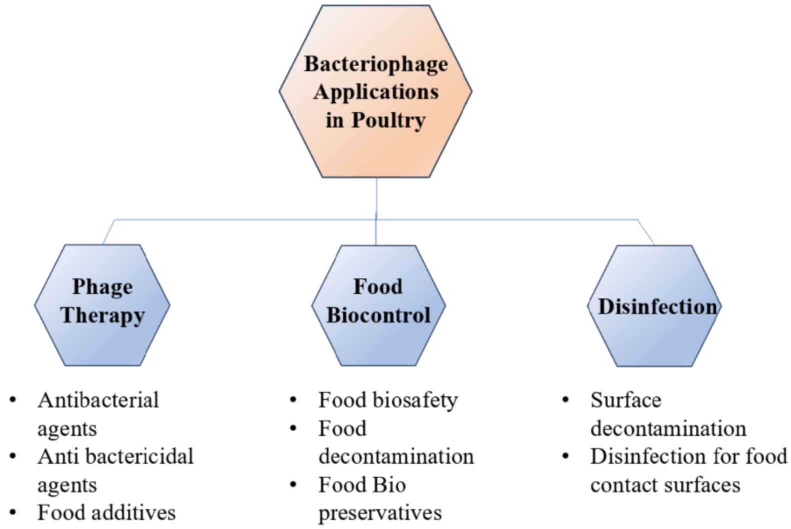


**Fig 2: Applications of Bacteriophage in poultry**

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## Importance of Herbal medicine in poultry production:

Herbal medicines and plant extracts are the best replacement for antibiotics in poultry production (Diaz-Sanchez et al., 2015).

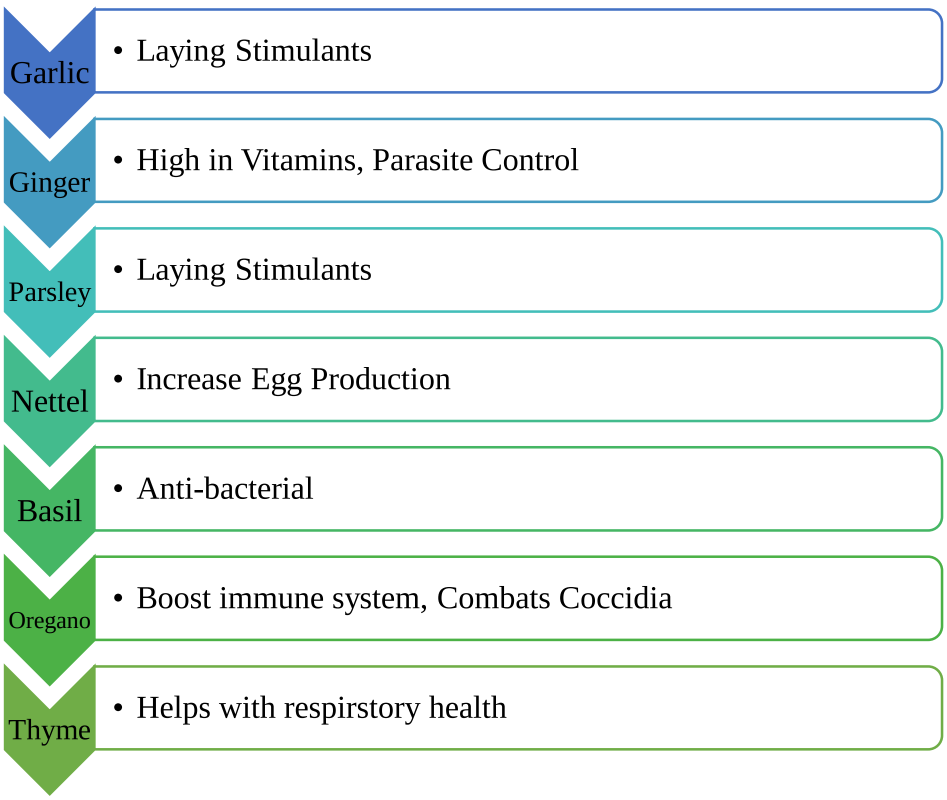


**Fig 3: Benefits of Herbal Medicines**

## Challenges and Future Prospects:

From the review of most of the work done in AMR, concern is raised at the high rates of AMR in poultry from common indicator pathogens. Just as (Van Boeckel et al., 2019) rightly reported, the highest resistance rates are observed in antimicrobial agents most commonly used in animal production, such as tetracyclines, sulfonamides, and penicillin. The rapidly shrinking portfolio of antimicrobial agents used to raise animals for food is expected to have serious consequences for both animal and human health even as it impacts negatively farmers' livelihoods as suggested by (Van Boeckel et al., 2019). Since few new antimicrobials are in development, and even fewer are approved for use, this becomes more frightening as the post-antibiotic era beckons. Research funding and opportunities are also limited, especially in developing countries like Kenya and by extension, much of Africa where resistance appears to be rampant, hence the need for international collaboration and cooperation. There is therefore need to utilize alternative treatments for poultry infections to reduce overreliance on antimicrobial agents. Rational antimicrobial treatment should also be promoted at all stages of poultry production. Non-conventional treatments such as phage therapy could be considered. There is also a need to shift focus towards applying probiotics and/or prebiotics in poultry farming to promote the general health and well-being of poultry. This will help reduce the need for antimicrobial agents in disease treatment or growth promotion. Development of new or alternative antimicrobial agents such as natural or synthetic antimicrobial compounds and peptides can also be considered. Biosecurity safeguards as well as improved nutrition are also key to raising healthy birds, thus cutting down the need for antimicrobials.

## Conclusion

In the chicken industry, antibiotics are frequently used to treat and prevent bacterial infections. They have also been employed as growth promoters in feed at low concentrations. This approach has successfully and economically increased the performance of poultry, but it has also led to an increase in antibiotic-resistant bacterial strains such as Escherichia coli, Staphylococcus sp., and Enterococcus sp. These strains can spread from poultry to humans through the food chain and have a serious negative impact on public health. Antibiotics are therefore no longer necessary to promote growth; instead, search for alternatives that can aid in constructive acts. A great deal of research has been done in the past few years to develop antibiotic substitutes, which has expanded the use of probiotics, prebiotics, herbal remedies, etc.

Probiotics, prebiotics, symbiotic, plant extracts, and organic acids may help with digestion and nutrient absorption; they may also change the metabolism of birds; they may influence the immune system; and they may enhance the gut's health and function by keeping pathogens out of the intestinal tract and ensuring that poultry products are safe for human consumption. Nonetheless, additional investigation is still necessary to examine various combinations of these choices with an emphasis on enhancing efficiency. In order to provide poultry products with desired qualities and alternatives to antibiotics in poultry production that don't compromise the welfare of the chickens, further research must be done. Given the desire from customers for functional meals, this is being done.

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