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***Corresponding author:**
Saadit Rasool;
Email: saadit.2084@gmail.com

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Application of Colistin to Combat Bacterial Diseases in Broiler Chickens

Saadit Rasool*, Qasim Ali, Tahir Rasool

Department of Microbiology, University of Agriculture, Faisalabad, Pakistan.

Abstract
The high production rate and more efficiency of feed conversion ratio of poultry broilers make them more susceptible to diseases than ever before. Among these diseases, gastrointestinal diseases are the major threat to commercial poultry production. So for that, the supplementation of antibiotics is the vital choice for minimizing and controlling a number of bacterial diseases, as these bacterial diseases cause serious economic losses by affecting poultry production. Hence, colistin is considered one of last alternative drug in poultry medicine in response to the treatment of infections caused by multidrug-resistant *Pseudomonas aeruginosa*, *Acinetobacter baumannii* and Enterobacteriaceae (*Escherichia coli*, *Klebsiella pneumoniae*), due to which mortality of birds can be exceptionally high. So the current article gives the latest knowledge about the impact and need of colistin for poultry health.
Keywords: Poultry, Broilers, Bacterial diseases, Colistin.

INTRODUCTION

Multidrug-resistant Gram negative bacteria cause nosocomial infections that report high morbidity and mortality of broilers (Schorr, 2009). It is important to control various bacterial diseases that are responsible for high risk of early chick mortality. So initially, in this respect, it is important to use antibiotics to control the economic losses in poultry. It was concluded that quality of all brands of antibiotic tested was acceptable and can be used for *E. coli* and *S. aureus* infections due to moderate resistance (Ali *et al.,* 2016). Different gram negative bacterial species (*Salmonella* spp., *Pasteurella* spp., *Mycoplasma* spp., and *E. coli*) and gram positive bacterial species (*Clostridium* spp., *Corynibacterium* spp. and *Staphylococcus* spp.) produce toxin in the gut microflora that adversely affect the digestion and absorption of feed in the birds and damage the architecture of the villi (Sumano and Ocampo, 2006). *Ornithobacterium rhinotracheale* cause Ornithobacteriosis (ORT) to the avian species. This bacterial infection causes respiratory symptoms and high mortality among chickens (Baksi *et al.,* 2017). Several studies have documented the use of antibiotics, compounds and plant products to control bacteria (Amin *et al.,* 2017; Hussain *et al.,* 2016; Iqbal *et al.,* 2015; Iqbal *et al.,* 2016; Kalim et al., 2016; Shahzad *et al.,* 2017).

Colistin is an antibiotic that is produced by different strains of bacteria such as *Paenibacillus polymyxa*. Commercially available collistin is in two forms i.e. colistin sulfate and colistimethate sodium. Colistin sulfate is cationic that belongs to polymixin group that was discovered in 1947 and this group was isolated from *Bacillus polymyxa*. *Bacillus polymyxa* is a bacterium that has five different compounds i.e. polymixin A, B, C, D and E. Colistin is a combination of different cyclic polypeptides because of this it is known as polymixins E or colistin sulfate. First time it was discovered in 1949 in Japan during fermenting *Bacillus polymyxa* var. colystinus by Japanies scientist Koyama (Coria *et al.,* 2011), while colistimethate sodium is anionic that is used for the treatment of pseudomonas aeruginosa in cystic fibrosis patients (Reis *et al.,* 2003; Towner, 2008).

In vitro colistin is also able to inactivate the bacterial toxins (Ziv *et al.,* 1978). That's why an antibiotic polypeptide colistin sulfate is used mainly against gram negative bacterial species such as *Salmonella* spp., *Pasteurella* spp., *Mycoplasma* spp., *Heamophilus* spp., *Brucella* spp., *Bordetella bronchiseptica* and *E. coli*. Colistin sulfate is orally given for the treatment of enteritis in the birds (Ziv, 1981; Roy *et al.,* 1997; Van Hattum *et al.,* 2000; EMEA, 2002). Whereas gram positive bacterial species are less sensitive by colistin sulfate, however some gram positive bacterial species are more sensitive such as *Staphylococcus* spp., *Bacillus* spp., *Streptococcus pyogenes* and *Corynebacterium* spp. (FAO, 2006).

One of the major features of colistin sulfate is that when it is provided orally to the birds, it is almost not absorbed in the gastrointestinal tract (Collell and Segura, 2013). So in this situation colistin sulfate have selective and specific activity against intestinal bacteria in the intestinal lumen. When gastric fluid is produced from proventriculus it comes in contact with colistin and hence decreases the antimicrobial activity (Rhouma *et al.,* 2015). Its reason is that, the utilization of protective cover in antibiotics increases the effectiveness of the antibiotics because the protective cover increases the interaction of the antibiotic with the cell wall of the bacteria (Shastri *et al.,* 2004).

The main bacterial species of normal digestive microbiota of most poultry birds and animals is the Colibacillosis that is produced from the *E. coli*. The main impact of colibacilosis in poultry production is that it causes large economic losses in response of more cost of treatment and that it also decreases the different production parameters of broiler birds such as feed intake, weight loss, increased conversion rates and mortality (Turcas *et al.,* 2012). From several studies it has been proved that colistin sulfate has great importance for the reduction of growth of *E. coli* and also in the protection of toxins.

An important disease in poultry is the salmonellosis that is caused by salmonella spp and from infected poultry farms the salmonellosis causes public health issues. Not only colistin but also a new molecule known as sodium biformate that consists of formic acid and sodium formate has proved effective against pathogenic bacteria (salmonella) along within the GIT (Luckstadt and Theobald, 2009). As after the transportation of broiler birds, the slaughtered poultry bird products showed increased concentration of Salmonella. The serotypes of Salmonella found on slaughtered poultry products are actually raised from live birds which revealed that they are of intestinal origin. Salmonella contaminated poultry products (meat and eggs) cause diarrhea and vomiting in humans (Flores, 1981). Enteritis is often described as bloody or watery diarrhea followed by fever and that the enteric disorders are considered one of vital groups of poultry diseases which world widely effect the poultry production in response of increased medicine cost to control high mortality rate, decreased body weight and increased feed conversion rates (Hafeez, 2011). Researchers indicated that the use of colistin sulfate in poultry feed reduces the contamination of *Salmonella enteritidis* in the broiler farm and its utilization also increases the live body weight gain by 14 % and feed conversion rates by 8 % (Bozorgmehri, 2004).

As colistin was introduced over 50 years ago, into clinical practice. So there is no standardized dosing of colistin. Therefore the optimal dosing of colistine is unknown. Over dose of colistin in poultry birds cause nephrotoxicity and neurotoxicity.

Mode of Action

Gram negative bacteria have an extra outer membrane. The outer membrane consists of lipopolysaccharides that naturally protect the bacteria from the action of bile salt and digestive enzymes. Along that it also facilitates resistance to hydrophobic antibiotics and detergents. In this condition orally provided colistin sulfate alter the permeability of the cell membrane of the bacteria. This reaction occurs in the presence of the electrtostatic interactions between the colistin (cationic polypeptides) and anionic molecules of lipopolysaccharides of outer membrane of gram negative bacteria. Colistin displaces the magnesium and calcium. The magnesium and calcium destabilizes the lipopolysaccharide molecules of outer cell membrane of gram negative bacteria that leads to the permeability of outer cell membrane, leakage of the contents and ultimately causes cell death (Coria *et al.,* 2011).

CONCLUSION

It has become very important to use antibiotic or nonantibiotic growth promoters to get better poultry health, growth and feed conversion. So the use of colistin sulfate has been advantageous to improve the production parameters and also to control the effects of diseases such as colibasillosis and salmonellosis in poultry industry.

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CONFLICT OF INTEREST

The authors declare that no competing interests exist.

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