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Review Article

Antibiotic Resistance of Escherichia coli and Salmonella Species in Chicken Meat: A Review

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ABSTRACT

There has been several documented association between the raise in antibiotic resistant diseases and the ninety billion tons of chicken meat that are delivered throughout the world every year. Antibiotics, for example, avoparcin, virginiamycin, streptomycin and chlortetracycline are not just used for treatment of diseases. Sub therapeutic portions are added regularly through feed to increase feeding efficiency and the rate of weight gain in cows, pigs and poultry. This review is intended to discuss the prevalence, of antibiotic resistance of E. coli and salmonella species isolated from chicken meat and the various factors contributing to antibiotic resistance in chicken meat. An antimicrobial agent is characterized as a "naturally occurring", semi-manufactured or manufactured substance that exhibits antimicrobial properties (kills or hinders the growth of microorganisms) at focuses attainable in vivo. *Escherichia coli* is an important bacteria belonging to the bacterial populace of the gastrointestinal tract of animals and humans. *Salmonella* is a gram-negative bacillus belonging to the Enterobacteriaceae family, grouped into roughly 2,600 serotypes. Various research work have shown antibiotic resistance of Escherichia coli in chicken meat. Comprehensive studies conducted around the world indicates that *Salmonella* strains isolated from chicken has shown resistant to various antibiotic. Most of the cases, this development of resistance is related to the extensive use of this antibiotic in production of food animal.

INTRODUCTION

Bacterial resistance to antimicrobial medications has become an issue of expanded public concern and logical interest during the most recent decade [1]. This came about because of a developing worry that the utilization of antibiotics in veterinary medication and animal farming may bargain human health if antibiotic resistant create in animals and are moved to humansthrough the food chain [2]. Antibiotic resistance is a developing worldwide health worry with the gigantic cultural danger of returning to a pre-antibiotic period if not tended to. There has been several documented association between the raise in antibiotic resistant diseases and the ninety billion tons of chicken meat that are delivered throughout the world every year [3]. While much attention has been centered on the clinical abuse of antibiotics, up to 70 percent of antibiotics produced in the United States in 2014 were sold for use in domesticated animals alone. Agricultural antibiotic guidelines from the USDA have changed since 2014, and the agricultural utilization of "medically important" antibiotics reduced by 36% from 2014 to 2018 [4].

Medications are regularly added to the feed of commercial poultry to forestall different illnesses and to improve growth. Antibiotics, for example, avoparcin, virginiamycin, streptomycin and chlortetracycline are not just used for treatment of diseases. Sub therapeutic portions are added regularly through feed to increase feeding efficiency and the rate of weight gain in cows, pigs and poultry [5]. In Germany, antibiotics are used to treat broiler for 10 days within its 39-day production period. This massive utilization of antibiotics amplifies and speeds up the rise and spread of antibiotic resistant bacteria and then leads to transmission of resistant bacteria from animals to humans through the food chain [6]. The impact of this practice on general health has been addressed for quite a long time taking into account information recommending that medication use in animals may prompt an expansion in antimicrobial resistance (AMR), in the animal commensal flora, and additionally in human microbes [7]. In consequence, poultry have been connected as a significant source of human infections. Whilst a considerable lot of these pathogenic microbes recuperated from poultry have been checked, several published research have covered antimicrobial resistance in pathogenic microorganisms found in poultry, especially *Salmonella* spp and *Escherichia coli* [8]. It is notable that antibiotic-resistant microorganisms that have been identified in animals may pollute likewise meat being acquired from those animals, and it is conceivable that inadequate heating or cooking of those meats can cause infection of the human gastrointestinal tract [9]. Antimicrobial resistance has expanded for quite a long time and now establishes a danger to the productive treatment of bacterial, viral, parasitic, and fungal infections [10]. Studies on bacterial antimicrobial resistance of retail meats are significant, as antimicrobial resistant microorganisms could be moved to the human microbiome through retail meat [11].

An antimicrobial agent is characterized as a "naturally occurring", semi-manufactured or manufactured substance that exhibits antimicrobial properties (kills or hinders the growth of microorganisms) at focuses attainable in vivo. Anthelmintic and substances classed as disinfectants or antiseptics are excluded from this definition" [12]. This review is intended to discuss the prevalence, of antibiotic resistance of *E. coli* and salmonella sppisolated from chicken meat and the various factors contributing to antibiotic resistance in chicken meat.

Escherichia coli

Escherichia coli is an important bacteria belonging to the bacterial populace of the gastrointestinal tract of animals and humans. Escherichia coli strains are grouped into three major groups: commensal strains, intestinal pathogenic strains, and extraintestinal pathogenic *E. coli* (ExPEC) strains [13]. Several strains of this bacterium are agents of coli bacillosis, the main cause of morbidity and mortality, in broiler chickens, bringing about critical financial losses to the poultry business [14]. This disease is characterized by an upper respiratory tract infection that can cause pericarditis, perihepatitis, peritonitis, and salpingitis. Antimicrobial agents are broadly used to control colibacillosisin poultry. Therefore, multiresistant *E. coli* strains may arise and turn into a reason for concern [13]. Enteropathogenic, enteroinvasive and enterotoxigenic sorts of *E. coli* can be a main source of food-borne diarrhea [15]. Serious outbreaks of gastrointestinal diseases brought about by food borne pathogenic *E. coli*, particularly 0157:H7, have happened during the previous twenty years. Resistant strains of *E. coli* emerging from the exposure of animals to antimicrobials may perhaps become infectious organisms in humans [16].

Escherichia coli is a significant cause of urinary tract infections (UTIs), enteric infections, and systemic infections in humans. The fundamental infections incorporate bacteremia, nosocomial pneumonia, cholecystitis, cholangitis, peritonitis, cellulitis, osteomyelitis, and irresistible joint inflammation. *E. coli* is likewise driving reason for neonatal meningitis [17].

Antibiotic resistance of *E. coli* isolated from chicken meat

Various research works have shown antibiotic resistance of *E coli* in chicken meat. In a study conducted by Moawad et al., (2017), The resistance levels of *E coli* isolated from raw chicken to various antibiotics were as follows; tetracycline 80.9%, ampicillin 71.4%, streptomycin 61.9%, trimethoprim/sulphamethoxazole 61.9% and amoxicillin–clavulanic acid with 61.9%(9).Lee et al., (2018) isolated *E. coli* from chicken meats and they showed highest resistance to the following antibiotics; ampicillin (75%), tetracycline (69%), ciprofloxacin (65%), trimethoprim/ sulfamethoxazole (41%), ceftiofur (22%), and amoxicillin/clavulanic acid (12%). Nhung et al., (2015) observed highest adjusted prevalence of *E. coli* isolates resistance to tetracycline (84.7%), followed by ampicillin (78.9%), trimethoprim sulfamethoxazole (52.1%), chloramphenicol (39.9%), amoxicillin-clavulanic acid (36.6%), and ciprofloxacin (24.9%).Sarker et al., (2019) noted in their studies that all of the tested isolates of *E. coli* showed 100% resistance to tetracycline and ampicillin but resistance to trimethoprim-sulfomathoxazole was 94.59% and nalidixic acid also 91.89%. Their results also indicated that 56.76% of *E. coli* isolates were sensitive to Ceftriaxone and gentamicin whereas colistin was 48.65%. Al Azad et al., (2019) indicated that the resistance level in *E. coli* isolates to ampicillin, tetracycline and trimethoprim-sulfamethoxazole showed 100%. Zahraei Salehi & Farashi Bonab, (2006) also note the highest rate of resistance against Nalidixic acid (100%), Lincomycin (100%), Erythromycin (97%), Oxytetracycline (95%), Chlortetracycline (95%), Tetracycline (94%), Flumequine (94%), Tiamulin (91%), Doxycycline (88%), Difloxacin (83%), Neomycin (81%), Streptomycin (81%), Trimethoprim-Sulphamethoxazole (80%), Kanamycin (77%), Enrofloxacin (76%), Norfloxacin (68%), Ciprofloxacin (67%), Chloramphenicol (67%), Furazolidone (66%), Nitrofurantoin (56%), Amoxicillin (53%), and Ampicillin (47%).

Factors contributing to antibiotic resistance of *E. coli* in chicken meat

Lee et al., (2018) showed that antibiotic resistance of *E. coli* isolates were due to usage of antibiotics for animal production.Momtaz & Jamshidi., (2013) indicated in their study that the high presence of serogroups, virulence factors, and multiple antibiotic-resistant properties of E. coli isolated from samples of chicken meat were due to the excessive prescribing of antibiotics, poor sanitary conditions and crowding. The huge expansion in the occurrence of resistance against antibiotics in the *E. coli* strains isolated from broiler chickens is likely because of expanded utilization of antibiotics as feed additives for growth promotion and prevention of diseases, utilization of inappropriate antibiotics for treatment of diseases, resistance move among various bacteria and conceivable cross resistance between antibiotics utilized in poultry [23].

Salmonella species

Salmonella is a gram-negative bacillus belonging to the Enterobacteriaceae family, grouped into roughly 2,600 serotypes by the Kauffmann-White scheme [24] *Salmonella* is a significant cause of food-borne diseases in humans throughout the world and is a huge reason for morbidity, mortality, and economic loss [8], Among the excess of 2,500 Salmonella serotypes, Salmonella enteritidis and Salmonella typhimurium are the most continuous serovars related with human disease [25].

Human *S. enteritidis* cases are for the most part connected with the utilization of contaminated eggs and poultry meat, while S. typhimurium cases with the utilization of contaminated pork, poultry, and beef meat [26]. The most well-known serotypes are known to cause enteritis and are causative agent of food borne diseases [27]. The ability of *Salmonella* species to cause human disease includes connection and colonization of intestinal columnar epithelial cells and particular microfold cells overlying Peyer's patches [28]. In human, enteric disease side effects incorporate sickness, regurgitating, and non-bleeding looseness of the bowels. Symptoms may include fever, headache, cold, abdominal pain, joints pain and can advance to bacteremia and endocarditis [29,30].

The development of multidrug-resistant (MDR) *Salmonella* is an overall concern since the event of MDR *Salmonella* in food is a risk condition, leading to food borne disease severity, prompting expanded hospitalization rates and increased chances of death. Observation by Kim et al. (2012) support the likelihood that chicken meat may be one of the expected wellsprings of anti-microbial resistant Salmonella diseases in human

Antibiotic resistance of *Salmonella* species in chicken meat

Comprehensive studies conducted around the world indicates that salmonella strains isolated from chicken has shown resistant to various antibiotic [32]. In Brazil, the advancement of resistance in Salmonella sppin chickens has been accounted for more than 10 years as has the presence of resistant isolates in various food sources associated with outbreaks of salmonellosis [33].

Resistance to erythromycin and penicillin has been accounted for as the most well-known resistance profile in retail meat products [34].Singh et al., (2013) discovered that resistance to penicillin and vancomycin was 100% in poultry and poultry environment in India. Thung et al., (2016) indicated in their study that all salmonella isolates were resistance to erythromycin, penicillin, and vancomycin but in any case, low degree of resistance was seen to nalidixic acid (9.09%) and streptomycin (9.09%).Medeiros et al., (2011) observed that all *Salmonella* strains isolated from chicken in Brazil were resistant to at least one class of antimicrobial and 53.2% showed multidrug resistance to at least three classes. Serotypes Heidelberg and Enteritidis showed the most elevated level of multi-resistant strains where Streptomycin (89.2%), sulfonamides (72.4%), florfenicol (59.2%), ampicillin (44.8%), nalidixic acid (40%), and enrofloxacin (19.2%) were the antimicrobials with the highest resistance. Kim et al. (2012) stated in their study all of the Salmonella isolates from chicken meat were resistant to erythromycin (100%), cephalothin (87%), followed by nalidixic acid (85%) and streptomycin (70%). Research by Voss-Rech et al. (2015) indicated that salmonella isolates expressed resistance to tetracycline (52.44%), streptomycin (24.39%), trimethoprim/ sulfamethoxazole (17.07%), ceftiofur (12.19%), and gentamicin (6.09%).

However, Thung et al., (2016) stated that four antibiotics that is amoxicillin/clavulanic acid, gentamicin, tetracycline, and trimethoprim were found to be 100% sensitive, though low degree of sensitivity was showed by cephazolin (54.55%). Low degrees of resistances to nalidixic acid (13.36%) and streptomycin (10.62%) were as well noticed, especially among *S. enteritidis* and *S. typhimurium* that were isolated from retail chicken meats [37]. Dong et al. (2014) indicated in their research that all the Salmonella isolates showed 100% sensitivity to amoxicillin/clavulanic acid, while 98.80% to gentamicin and 92.77% to antibiotic medication. According to the study of Ta et al., (2014), all *Salmonella* isolates were susceptible to cefepime and amoxicillin-clavulanate. The most elevated extent of single resistance was to tetracycline (59.1%), ampicillin (41.6%), chloramphenicol (37.4%), trimethoprim (34.6%), and sulfamethoxazole-trimethoprim (34.6%).

Factors contributing to antibiotic resistance of Salmonella species in chicken

Resistance to penicillin and vancomycin in *Salmonella* isolated from poultry could be because of inappropriate utilization or abuse of a specific antimicrobial making resistance happen [35]. Thung et al., (2016) observed in their study that high resistance of *S. enteritidis* and *S. typhimurium* to erythromycin, penicillin, and vancomycin could be that these antibiotics are generally utilized. The high resistance rate to these sorts of antimicrobial agents may be because of the uncontrolled utilization of antimicrobial agents as growth promoters or in the treatment of bacterial diseases, with farmers having unlimited access to these compounds and their utilization [31,40].

CONCLUSION

From all the studies above, *E. coli* isolates were highly resistant to ampicillin, tetracycline and trimethoprim-sulfamethoxazole. *Salmonella* isolated from chicken meat also showed high resistance to erythromycin, penicillin, and vancomycin.

Most of the time, poultry farmers' use these medicines without concern of the veterinarian Development of bacterial resistance to fluoroquinolone like ciprofloxacin is a global issue. In many cases, this development of resistance is related to the extensive use of this antibiotic in the production of food animal.

In recent practices, ciprofloxacin are extensively used in poultry industries for the treatments of various infections during the last decade in many countries [19]. Retail raw chicken meat goes about as a repository for harboring multi-drug resistance *Salmonella*, which can be an issue and a major food safety concern for public health. Accordingly, it is vital for creating viable intercession methodologies, just as utilizing characteristic biocontrol agent, for example, bacteriophages to guarantee the security of our food supplies [8].

Extensive studies and epidemiological examinations have identified chicken products and raw or undercooked eggs as potential transmission vehicles for *Salmonella* in people (Fallah et al., 2013; Cabral et al., 2014). Some significant variables in the improvement of resistance incorporate particular pressing factors, multiplication of numerous resistant clones, and the inability to detect emerging phenotypes. These particular pressing factors can be due to abuse of antimicrobials for animal farming [28].

Therefore all-inclusive policy response is urgently required. A part of this reaction will require coping with the difficulties of industrialized meat production, including poultry meat. With the expanding globalization of staples like poultry meat, new issues and difficulties will emerge, requiring new integrated intervention strategies along the food chain [6].

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