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Poultry feed: a probe for antibiotics

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ABSTRACT

This study reviewed and compiled data over the last decade on the amounts of several antibiotic residues in poultry feed. The usage of antibiotics was evident in chicken growth and production. This review focused on poultry feed samples worldwide that were treated with several types of antibiotics, e.g., Aminoglycosides, β-Lactams, Lincosamides, Macrolides, Polypeptides, Quinolones, Tetracycline's and Ionophores. They exceeded the FAO/WHO permissible limits in poultry in many cases. A considerable portion of antibiotics was released from poultry feed treated with these antibiotics. The detection methods used for these antibiotics were TLC (thin-layer chromatography), Nouws Antibiotic Test (NAT), ELISA (enzyme-linked immunosorbent assay), PREMI®TEST, Mass spectrometry, Gas chromatography (GC) and high-performance liquid chromatography in conjunction with various detectors. This paper also indicated that a suitable antibiotic withdrawal time was not followed for using antibiotics. Furthermore, the consequences of these antibiotics on the environment and public health were also highlighted here. Finally, this paper proposes several recommendations in this context.

***Key Words**: Poultry feed, antibiotic residue, detection methods, MRL and Health hazards.*

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I. Introduction

Bangladesh is a developing country with a growing poultry industry. Poultry farming is an integral aspect of the livestock industry. It plays a crucial part in the agricultural economy of Bangladesh (Islam et al., 2014). Due to enormous demands for chicken meat, egg, and related items from the world's constantly growing population, the poultry business has risen among the world's major industries (Yeom et al., 2017). The poultry industry has provided opportunities for people to improve their lifestyles and eating habits. It has helped guarantee nutritional security by reducing reliance on

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cattle and sheep meat as protein sources (Ali and Hossain, 2014). This industry has risen at roughly 20% per year for the past two decades. As a critical component of animal agriculture, this business is dedicated to providing the public with a low-cost source of high-quality, nutritious protein intake from meat and eggs. It strengthens buying power and helps to alleviate poverty on a big scale. Farming practices provide around 44% of animal protein for individuals ' daily consumption (Akter and Uddin, 2009; Islam et al., 2014).

The demand for poultry meat, particularly chicken meat, has grown globally, with tremendous growth occurring in emerging, mainly Asian countries. The consumption rate of chicken meat climbed from 11 kg per person in 2000 to 14.4 kg in 2011 (Evans, 2016). As per a Food and Agriculture Organization estimate, chicken meat output would approach 134.5 million tons in 2023, marking it the meat industry's primary contributor. Throughout 2014, commercial poultry output was anticipated to reach 108.5 million tons, and chicken contributed 95.5 to 96 million tons (Muaz et al., 2018). Excess supply had put poultry producers facing pressure to deliver chicken throughout a minor period with the highest yield. Producers and feed manufacturers combine several antibiotics within feeds as growth boosters in this context. Different governments and public bodies worldwide have already noted the existence of residues of antibiotics in chicken food that exceeds the allowable limit (Singh et al., 2011). Antibacterial drugs residual in chicken products can be passed on to humans by consuming contaminated consumable tissues, resulting in numerous pathological consequences that are regarded as severe health hazards (Mund et al., 2017).

The critical target goal of this review study is to document the investigation into the usage of antibiotics in poultry feed and by far the most effective assessment methodologies for evaluating antibiotics and their effects on the ecosystem, public health, and other animals.

II. Poultry Feed

Feed is a prerequisite for growing broiler and layer. Their body growth, maintenance and development are primarily dependent on feed. Commercially produced feeds are used in small-scale and commercial poultry farms due to the availability of required nutrients. There are many commercial poultry feed producers in Bangladesh. The basic materials used to manufacture chicken feed come from various sources. These sources were exposed to anthropogenic contaminants, weighty metals (Manyi-Loh et al., 2018). Different antibiotics could reach our food supply chain via poultry feeds. Antibiotics mixed with feed at excessively high concentrations are considered potentially toxic and have adverse food effects on humans and animals.

Antibiotics in the Poultry feed

Antibiotics are compounds that can cause death or prevent the development of bacteria (Waksman, 1947). They have a diverse set of uses in managing and preventing infectious illnesses. These have been used clinically to safeguard health and wellbeing. Nowadays, most antimicrobials are synthesized commercially and a few of them can be prepared from the microbes. It has been used extensively in the animal food industry since the early 1940s. Recently, the FDA had authorized twenty-one antimicrobials with one or even more applications in farm animal feeds (Feinma and Matheson, 1978). Table 01 shows that usage of different groups of antibiotics is for therapeutic and growth promoting purposes.

Antibiotics usage in poultry feed

Veterinary medications, particularly antibiotics, are one of the most components used in livestock feed manufacturing. Presently, veterinary medications are prescribed to treat nearly 80% of the food-producing livestock for a certain period or during their lifetimes (Pavlov et al., 2008). Antimicrobials routinely employed for food-producing livestock include β-lactams, tetracyclines, aminoglycosides, lincosamides, macrolides, pleuromutilins, and sulfonamides (Lee et al., 2001).

Antibiotics are administered in poultry production for the following purposes: medicinal, prophylaxis, and growth booster (Oluwasile et al., 2014). Prophylactic usage entails exposing animals to low-dose antibacterial for extended periods (Khalil et al., 2017). Antibiotics in below therapeutic dosages, i.e. 10 or 100 fold below therapeutic concentrations, were given over an extended period or for the whole

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animals' lives to promote growth (Chowdhury et al., 1970; Marshall and Levy, 2011). Over 24.6 million pounds of pharmaceutical antibiotics have been applied on farm animals each year in the United States alone. A massive portion of this used growth boosters instead of infection treatment (Fox et al., 2011).

Table 01. Regularly used antibiotics in poultry feed are listed below

Name of Antibiotics	Class of Antibiotic	Purpose	References
Gentamicin, neomycin	Aminoglycosides	Therapeutic	Kumar et al. (2005)
Penicillin	β-Lactams	Therapeutic, growth-promoting	Moyane et al. (2013)
Lincomycin	Lincosamides	Therapeutic, growth-promoting	GUAN et al. (2017)
Tylosin and erythromycin	Macrolides	Stimulating growth	Ahmed et al. (2015)
Bacitracin	Polypeptides	Improved feed conversion	Robert et al. (2015)
Sarafloxacin, enrofloxacin	Quinolones	Therapeutic	De Alwis and Heller (2010)
Chlortetracycline, oxytetracycline, tetracycline	Tetracyclines	Therapeutic	Pan and Chu (2017)
Monensin, salinomycin, semduramicin, bambermycin	Ionophores	Feed utilization and development	Ahmed et al. (2015); Pan and Chu (2017)

Antibiotic is mainly used to treat sick animals to increase their productivity and growth rate of animals. Tetracycline and penicillin, for instance, boost reproductive performance, feed efficiency, and egg quality in chicken feed but do not influence mortality. Chlortetracycline, oxytetracycline, and penicillin raise growth rates while not affecting mortality (Bengtsson and Greko, 2014). Antibiotics' growth-promoting properties were found in 1940 when hens had provided feed containing tetracycline fermented by-products. In this scenario, the chickens grew faster than birds not fed a by-product-containing diet (Phillips et al., 2004).

The daily growth rate of animals in the groups with antibiotic supplemented feed increased by about 1–10% more than without antibiotics (Hughes and Heritage, 2002). Tetracycline & penicillin were used in poultry feed, which resulted in a substantial boost in egg production, hatching, and feed consumption (Gustafson and Bowen, 1997). Several results from various studies revealed residues of antibiotics in poultry meat and eggs (Salman & State, 2014). According to the report, it was proved that antibiotics are linked to chicken production (Mund et al., 2017).

Bacitracin, oxytetracycline, chlortetracycline, tylosin, avoparcin, neomycin, virginiamycin and are used for sub-therapeutic purposes. Dosing at a lower-than-therapeutic level in feed increases bodyweight and helps in increasing the efficiency with which feed is converted into meat. The acceptable concentration of antibiotics in feed was 5-10 mg/kg in the 1950s and since, they've risen ten to twentyfold (Apata, 2009). Chlortetracycline and oxytetracycline are wide-ranging antibiotics that have been permitted to be use in a variety of cattle and poultry applications. Tetracyclines help poultry, swine, beef cattle, and other livestock develop weight quicker by increasing feed conversion. For poultry, tetracycline claims include prevention of CRD (Chronic respiratory disease), infectious sinusitis, blue comb, hexamitrasis, synovitis, treatment of coccidiosis, paratyphoid and *E. coli* infections (Burbee et al., 1985). Antibiotics introduced to feed provide a more rapid conversion of feeding to animal foods, as well as a significant reduction in costs. The regular growth rate of animals fed antibiotic-supplemented feeding is 1–10 per cent more than those of animals fed normal feed (Chattopadhyay, 2014). Meat from antibiotic-fed animals seems to be of superior quality, including more proteins and less fatty than food animals never given antibiotics (Hugheset al.,1998).

Indeed, antibiotics, in effect, may accelerate growth rate by thinning mucous membranes throughout the intestines, altering gut motility, creating a favorable environment for healthy intestinal microorganisms by destroying harmful bacteria, and partitioning proteins for muscle development. They also promote development by lowering immune function and minimizing nutritional wastage and toxin production (Darwish et al., 2013).

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III. Detection method

Minimal antibacterial concentrations used mainly for growth enhancement provide a quantifiable threat (Phillips et al., 2004). To meet the requirement for adequate antibiotic usage analysis, new theories have been applied that incorporate chemical extraction, chromatography separation, as well as consequent assessment of antibacterial properties by microbiological tests (Blasco et al., 2007; Cronly et al., 2010; De Alwis and Heller, 2010; Stolker et al., 2007).

The availability of accurate and convenient analytical tools to determine the presence of veterinary antibiotic residues in animal products is crucial (Aerts et al., 1995). Antibiotic residual detection techniques are primarily divided into screening and confirmatory. The purpose of screening procedures is to determine whether or not the sample has antibiotic residue. The concentration of the analyte is commonly quantified in confirmatory studies (Cháfer-Pericás et al., 2010). If the results are positive, it is critical to utilize a practical approach for residue verification, identification, and quantitation (Liousia and Vangelis, 2015).

TLC (thin-layer chromatography) is a method for isolating the substances in a mixture and assessing it. It may be used to figure out how many components are in a combination, how to identify compounds, and how pure a chemical exists. Spotting, development, and visualization are the three stages of TLC (Sherma and Fried, 2003). In research on the haphazard usage of antibiotics in chicken feed and residues in broilers in Mymensingh, Bangladesh, it was revealed that enrofloxacin (46.67%) had the most significant proportion of antibiotics being used in feedstuffs, followed by ciprofloxacin (30.00 %) and amoxicillin (23.33%). TLC also revealed that combinations of amoxicillin and ciprofloxacin (30.00%) and ciprofloxacin and enrofloxacin (43.33%) were regularly discovered in the livers broilers. Antibiotic residues were found in the livers of all broilers and antibiotic residues were found in the breast meat of 20% of the broilers (Sarker et al., 2018).

Shareef et al. (2009) observed the thin layer chromatography might be used to screen for antimicrobial residues in preserved poultry products, notably in liver, breast, and thigh muscle samples (TLC). TLC was used to evaluate 75 preserved poultry items, including liver, breast, and thigh muscle samples, for the existence of four antibiotic residues: oxytetracycline, sulfadiazine, neomycin, and gentamycin. The research finds that 52% of the samples were positive. Seven (28 %) of the liver and chest muscles screened positive to sulfadiazine and tetracyclines out of 25 liver, chest, and leg muscle specimens tested positive for sulfadiazine and oxytetracycline. In contrast, 7 (28%) of leg muscles tested positive for oxytetracycline, and 4 (16%) tested positive for sulfadiazine. In Chromatogram, no neomycin or gentamycin metabolites were found in any samples tested. Amongst four antibiotics investigated, oxytetracycline was the most common (28 %), preceded by sulfadiazine (24 %). The liver and chest muscle had the exorbitant percentage of antibiotics found (56%), next by the leg muscle (44 %).

Nouws Antibiotic Test (NAT) is a new alternative for screening antibiotic residues in food-producing animals' tissues. The test was developed as a more effective alternative to the New Dutch Kidney Test (NDKT). This method effectively detects most frequently used antibiotics in veterinary antibiotics above or below their maximum residue level. The test did not perform antibiotic residue screening at the required level due to the limited sensitivity of the test strain (Pikkemaat et al., 2008).

Engvall and Perlmann initially developed ELISA (enzyme-linked immunosorbent assay) in 1971 as a plate-based analytical procedure for accurately measuring soluble compounds such as peptides, proteins, antibodies, and hormones. It may be run in a qualitative or quantitative format. The advantages of the ELISA test include it reduces time to obtain a result, a large number of samples can run in a single analyte, and disadvantages include; any interference giving false positives, not cost-effective and limited storage under the refrigerator (Lequin, 2005). It was observed in a study that in poultry feed, a maximum percentage of sulfonamide was detected (901.78 ppb) higher than the allowed concentration (100 ppb) in ELISA. It also revealed that poultry meat and the liver had the highest value was 360.71 ppb and 127.45 ppb, respectively (Mohammed et al., 2017).

PREMI®TEST is a product of DSM Food Specialties, a Dutch corporation. This approach detects antibiotic residues in meat liquids (muscle, kidney, and liver), fish, eggs, and the urine of antibiotic-treated pigs. It's a comprehensive testing method for detecting different antibiotics often present in

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foodstuffs. It offers easy and fast screening detection of antibiotic residues in animal food products (Cantwell and O'Keeffe, 2006).

Mass spectrometry is an analytical method for determining the structures and chemical characteristics of substances and identifying new chemicals via molar mass estimation. Mass spectrometry, in general, necessitates extraction, ionization, and identification. It allows for direct molecular identification depending on the mass-to-charge ratio and disintegration patterns. As a result, it serves as a high-selectivity qualitative analysis method (Gross, 2006).

Incorporating ultra-high pressure liquid chromatography (UHPLC) linked with concurrent quadrupole mass spectrometry (MS/MS) in research applications has become the most critical breakthrough in food contamination assessment. Recently, numerous chromatographic methods have been employed to detect antibiotics in food; liquid chromatography (LC) with ultraviolet (UV) fluorescence (FL) or mass spectrophotometry (MS) detection is the favoured alternative (Ronquillo and Hernandez, 2017).

Table 02 represents the antibiotic residue that has been detected in the different edible parts of poultry in different countries with their detection method.

Table 02. Quantification of antibiotics in poultry edible tissue

Country	Sample	Antibiotics detected	Levels of residues (µg/kg)	Method for detection	Reference
Nigeria	Frozen chicken muscle	Tetracycline	1,046.3–1,158.9	HPLC	Olusola et al. (2012)
Egypt	Fresh and frozen broiler fillet	Oxytetracycline	156–900	HPLC	Hussein and Khalil (2013)
Malaysia	Breast Liver	Sulfonamides	6–62	HPLC	Cheong et al. (2010)
Pakistan	Breast	Sulfonamides	20–800	HPLC	Mehtabuddin et al. (2012)
Egypt	Breast Thigh Liver	Tetracycline	124–5,812 107–6,010 107–6,010	HPLC	Salama et al. (2011)
China	Muscle	Quinolones	0.7–43.6	HPLC	Zhao et al. (2009)
Portugal	Muscle	Fluoroquinolones	37.6–164.7	LC	Pena et al. (2010)
Iran	Kidney Liver	Chloramphenicol	0.54 155	HPLC	Salehzadeh et al. (2007)
Turkey	Muscle	Quinolones	28-31	ELISA	Er et al. (2013)

***HPLC=High Performance Liquid chromatography, LC= Liquid Chromatography, ELISA=Enzyme Linked Immunosorbent Assay.

High-Performance Liquid Chromatography (HPLC) is a modern analytical procedure for separating, identifying, and quantifying each constituent of a mixture. As a result, it's essentially a more advanced version of column chromatography. Rather than allowing a solvent to flow naturally through a column, it is pushed forward at 400 atmospheric pressures. The HPLC test's advantages include its high sensitivity and automation, leading to higher productivity. Disadvantages include expertise required and relatively expensive (Gemperline, 1999). Dhama et al. (2016) conducted a study to estimate quinolones in 150 poultry samples (120 samples of liver, kidney, and muscles and 30 samples of egg) purchased from local markets in Lahore, Pakistan. The quinolones included in the study were ciprofloxacin, enrofloxacin, levofloxacin, norfloxacin, ofloxacin, flumequine, oxolinic acid and nalidixic acid and poultry products had muscle, liver, kidney, and egg. High-Performance Liquid Chromatography (HPLC) system is used to determine quinolones. The results showed that 58 to 85 per cent of ciprofloxacin and 55 to 92 per cent of enrofloxacin specimens were included in the samples that were found to violate the law. They concluded that enrofloxacin is more plentiful and broadly distributed in the goods and that liver and kidney are more polluted than muscle and egg. In the liver, they discovered enrofloxacin concentrations ranging from 3.10 to 364 mg kg^{-1}.

Gas chromatography (GC) is an analytical method for separating and detecting bioactive components in a test sample to evaluate their presence and amount. It is the quantitative and qualitative examination of complicated mixtures. This methodology is easily adaptable to therapeutic drug monitoring; it not only improves the accurate quantitation of particular drugs in clinical specimens but also enables the detection, identification, and quantitation of drugs and drug metabolites that were previously unknown and not present in the samples (Styczynski et al., 2007).

Because of its mechanization, precise quantitation, simultaneous identification, and high specificity focus on the structural features of the analytes, chromatographic techniques are the most often employed for antibacterial detection (Knecht et al., 2004).

IV. Effect of antibiotic usage

Veterinary medications are utilized extensively in current agricultural operations. To avoid disease outbreaks or enhance animal development, the bulk of these medications are given to animals as food supplements or in their drinking water. Drug-related residues may be found within those products considering the time interval between the treatment and the retrieval of the animal product (withdrawal period). Toxicological factors could have been used to determine the number of drug residues that must be considered minimal. Unfortunately, such globally standardized maximum residue levels (MRLs) are seldom seen in reality (Aerts et al., 1995).

Table 03 shows the residual limit of antibiotics in poultry feed by the different regulatory agencies.

Table 03. Antibiotic medicated diets' highest residual limits

Antibiotics	Samples	MRLs (μg/kg)	Reference
Tetracycline	Egg	200	Commission (2010)
	Liver	300	
	Muscle	100	
Chlortetracycline	Egg	200	Commission (2010)
	Liver	100	
	Muscle	300	
Oxytetracycline	Egg	200	Commission (2010)
	Liver	300	
	Muscle	100	
Tilmicosin	Liver	2400	FAO/WHO (2009)
	Muscle	150	
Lincomycin	Egg	50	Commission (2010)
	Liver	500	
	Muscle	100	

Antibiotics used in food-producing organisms might retain leftovers in animal-derived commodities such as milk, meat, and egg. Any of the following factors could cause these residues: inability to maintain drug withdrawal periods, extended dosing for animals, contaminating of feedstuffs with medicated animals' excreta, or usage of unauthorized antibiotics (Paige, 1994). Residues of antibiotics in animal-derived foodstuffs could be the source of various health consequences. Deleterious effects are the spread of antibiotic-resistant bacteria to humans, immunologically mediated effects, carcinogenic effects (e.g., sulfamethazine, oxytetracycline, and furazolidone), teratogenic effects, renal disease (e.g., gentamicin), hepatic toxicity, developmental problems, bone marrow toxicity (e.g., chloramphenicol), and hypersensitivity is among these issues (e.g., penicillin) (Nisha, 2008).

Effect on different system

Antibiotics' lengthy impacts on public health were unknown in many circumstances, but they might, for instance, cause severe allergies in sensitive persons. Antibiotic residues might cause an allergic response in an already sensitive individual (Sundlof et al., 2000). Considering their essentially non-toxic properties, β-lactams seem responsible for many observed human antibacterial allergic responses (Fein et al., 1995; Sundlof et al., 2000). Allergy symptoms to aminoglycosides, sulfonamide, and tetracyclines are also prevalent (Paige, 1994).

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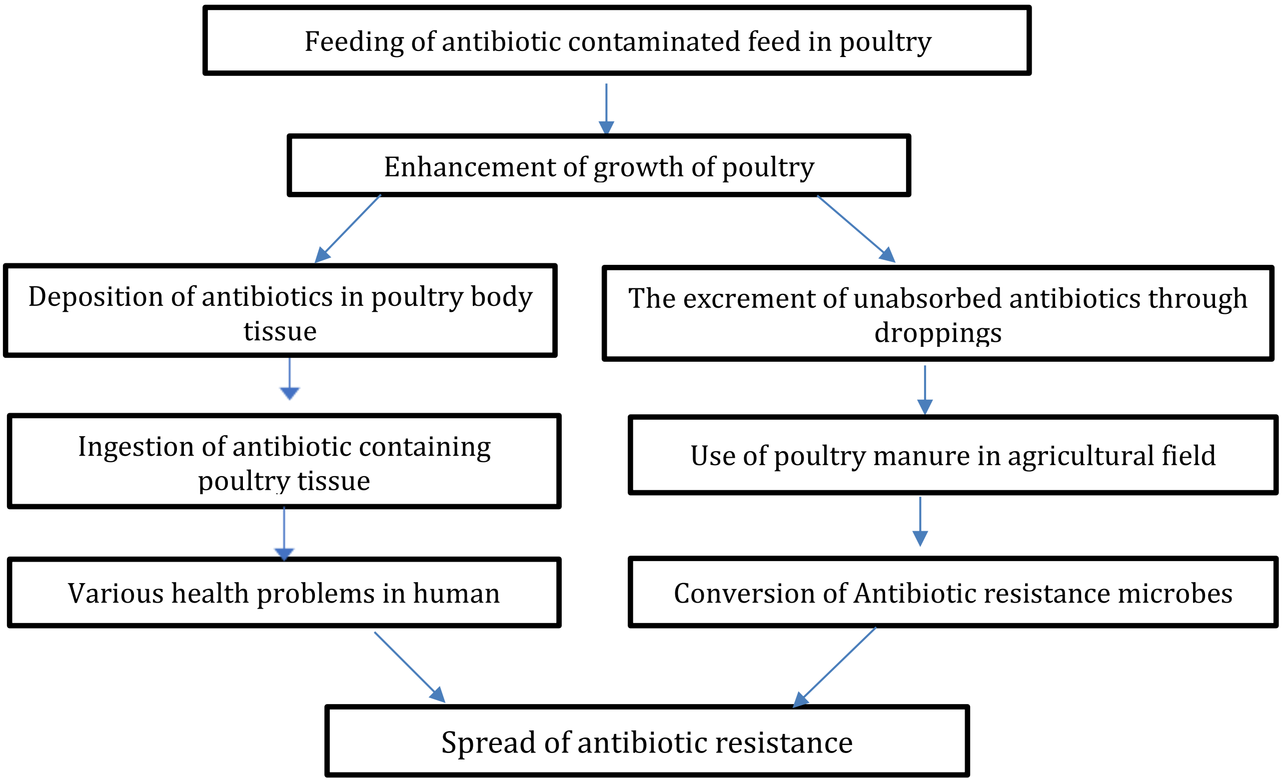

Figure 01. An illustration of the spread of antibiotic resistance

Another negative consequence of antibiotic residues in human diets is disrupting the functioning of human microflora in the gut. The microbes that generally dwell in the intestine operate as barriers, preventing entering harmful germs from establishing themselves and producing sickness. Antibiotics may diminish the overall population of these beneficial microorganisms or specifically kill specific essential species (Myllyniemi et al., 2000). Figure 01 shows how antibiotic resistance can spread by feeding contaminated antibiotic feed to humans and the environment.

Blood alterations such as leukocytosis, abnormal lymphocytes, pulmonary congestion, cytotoxic granulation of polymorphonuclear leukocytes, and thrombocytopenic purpura are consequences of prolonged OTC (Oxytetracycline) exposure. Hepatic damage and impaired blood clotting are other possibilities. It can harm calcium-rich tissues such as bone and teeth, as well as cause nasal cavity erosion. Children younger than seven years old may experience a dark discolouration of their teeth. Infants born to mothers who used OTC throughout gestation may have tooth discolouration (Ratten, 2003).

Risk of antibiotic resistance

Antibacterial substances in feedstuffs are not entirely used, but most have been expelled along with faecal matter and urine (Yeom et al., 2017). According to one assessment, 75 per cent of antibacterial agents prescribed to animals may be removed from the body into the surroundings. Of the obtained antibacterial agents (for example, tetracycline), approximately 25 per cent of the oral ingested dose in faecal matter, while the remaining 50–60 per cent is eliminated from the body as the same as it was via urine (Elmund et al., 1971). Antibiotic-contaminated poultry and livestock excrement is regarded as documentary evidence of these substances released into the environment, like farmland (Jjemba et al., 2010). Those antimicrobials are also still active, making them more dangerous to bacteria and other living creatures in the surroundings, leading to increased resistance in sensitive microorganisms.

Resistance to antibiotics is currently a problem all over the world. Since the number of microorganisms resistant to antibiotics has risen dramatically, many pathogenic bacteria have become resistance towards the usually prescribed treatment. According to the Centres for Disease Control and Prevention, antibiotic-resistant is among the world's most urgent health issues. The WHO has already highlighted antibiotic resistance as among the three most serious dangers to public health (Singh et al., 2011).

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Reports released periodically on the identification of bacterial species from livestock resistant to commonly used antibiotics administered to their diet have banned the issue even more. It is also obvious that the likelihood of bacterial species' resistance to beneficial therapeutic antibiotics for people cannot be avoided by replacing the antibiotic using their analogues in livestock feed. Avoparcin, for instance, is indeed a glycopeptide antibacterial not being used in man. This antibiotic as a food supplement has already been linked to establishing avoparcin-resistant bacteria that are resistant to the glycopeptide antibacterial vancomycin, which is used in men (Marshall and Levy, 2011).

Research in Australia on antibiotic usage in animal feed and its influence on human health discovered that antibiotic resistance has grown quite widespread in E. coli throughout the 50 years that antibiotics have been used in animal feed. Rear and flocks medicated with tetracycline, aminoglycoside, and sulphonamide showed extensive resistance. Resistant to fluoroquinolones had lately been found in areas where ampicillin and olaquindox are less common. Antibiotic resistance against salmonella has also been discovered shortly after antibiotics were administered to animals at sub-therapeutic doses (Barton, 2000).

Antibiotics could promote the development of antibiotic resistance in microbes, creating infections therapy increasingly challenging. As a result, it has been suggested that antibiotics used in human medicine shouldn't be used in animal. The extensive use of antibacterial drugs for disease management and animal healthcare has coincided with an upsurge in resistant pathogens in those species. Resistant bacteria subsequently disseminate throughout animal groups, notably fish, or to the surrounding (i.e., local soil, air, and water) via manure dispersion or contaminated foodstuffs consumed by people. Although good cooking technique destroys microorganisms, bioaccumulation may arise due to incorrect treatment before cooking (Carlet et al., 2012).

Commercial gardeners frequently acquire deep litter poultry manure (DLPM) to fertilize vegetable crops and aesthetic nursery crops. Tomatoes and some other vegetables with substantial growth abnormalities were developed on soil samples with DLPM derived from hens fed medication coccidiostat clopidol. There had been an impurity in the clopidol formulation that was converted in the hens to a compound secreted in the faeces and resembled the strong herbicide tordon (Reece, 1988).

V. Conclusion

To fulfil the future demands for poultry meat, chicken farms worldwide are already using antibiotics on a big scale. Antibacterial use across the globe varies significantly due to legislation's diverse regulatory, policy, and monitoring methods. Some nations have rules governing antibiotics in food animals, though their usage is not consistently regulated. Long-term antibacterial usage reduces the number of susceptible bacteria. As a result, the microbiota has a massive number of resistant bacteria. The authorities must take appropriate actions to mitigate the detrimental effects of such uncontrolled antibiotic usage.

- Numerous incidences among these resistance germs are being transferred to a human. Furthermore, antibiotics recognized as crucial by many regulatory bodies, including the World Health Organization and the FDA, must be used with caution in farming.
- Due to a shortage of interaction with veterinarians, antibiotics may be administered incorrectly, posing additional hazards.
- Farmers' understanding of the consequences of inappropriate antibiotic usage in livestock on public health and the ecosystem is also critical in improving the judicious and reasonable use of antibiotics in food animals.
- To avoid the adverse effect on the environment caused by antibiotic residues and assure the safety of food, great attention is needed.
- Antibiotic usage as a feed additive or for some other reason should be limited by employing excellent farming management approaches and keeping animals in a sanitary setting.

Alternative solutions to Antibiotic growth promoters should be emphasized, such as efficient farming techniques and probiotics, probiotic bacteria, and organic antibacterial agents

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