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Environmental and public health impact of sub-therapeutic antibiotic use in the poultry industry

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Abstract

The use of antibiotics at sub-therapeutic concentrations in poultry farm is believed to be an important factor for development of antibiotic resistance genes (ARGs) thereby resulting in proliferation of antibiotic-resistant bacteria in farm environment. ARGs are emerging environmental contaminants and pose threat to human health. In our study, the persistence of antimicrobial resistance genes in bacteria from poultry and farm soils from some districts of Tamil Nadu were assessed. Mean resistance levels were highly variable for tetracyclin and erythromycin antibiotics. These high resistance determinants were observed inside poultry farms. The prevalence of resistance in staphylococcal and enterobacterial isolates against antibiotics commonly used as growth promoters in poultry farms was evident. These results indicated the need for monitoring the use of antibiotics in poultry industry.

Introduction

Antibiotics are routinely used in the livestock industry to treat and prevent diseases. In the modern poultry industry, antibiotics are used in high quantities not only for therapy and prophylaxis, but also as antimicrobial growth promoters in animal feeds (Singer and Hofacre, 2006). Sub-therapeutic use of antibiotics in poultry industry resulted in the development of antimicrobial resistance (AMR) in intestinal microbiota of broilers and through the animal excreta it is disseminated to soil and aquatic environments (Ji *et al.*, 2012). Antibiotic resistance genes (ARGs) responsible for AMR traits are recognized as environmental pollutants posing potential worldwide human health risk (Apata, 2009). The environmental burden of imprudent antimicrobial use in poultry farms and its impact on human health is discussed in this article.

Poultry Industry in India

Poultry industry is a fast growing and dynamic subsector of agriculture, recognized for

sustainable employment, income generation that ensures food security through egg and meat production. Production of chicken meat is growing into the largest component of the poultry industry in India. India ranks third in poultry egg and meat production in the world. In India Andhra Pradesh ranks first in top five states of meat production followed by Maharashtra, Tamil Nadu, Haryana and West Bengal. The main hubs of broiler production in Tamil Nadu are Thiruvallur, Namakkal and Salem districts.

Commercial Poultry Production

Chicken is the most common type of poultry in the world. The term broiler is applied to chickens that have especially been bred for meat that grow rapidly (35-42 days) to attain the average slaughter weight (2 kg approx.). Broiler strains are based on hybrid crosses between Cornish White, New Hampshire and White Plymouth Rock. Their life-cycle is categorised into pre-starter (1-10 days), starter (11-25 days) and finisher (26th day onwards). They are fed with antibiotics mixed feed throughout the life-cycle, as an integral part of commercial farming (Prabakaran, 2003).

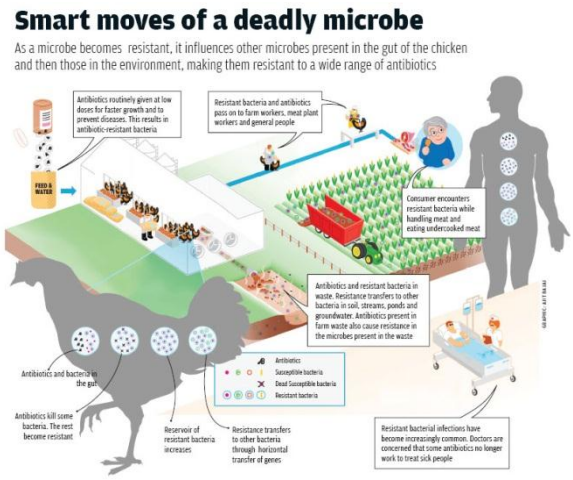
Use of Antibiotics in Poultry Farming

Antibiotics are used in poultry farming as: (i) therapeutic agents for treatment of diseases, (ii) prophylactic agents for prevention of diseases and (iii) growth promoters to increase growth-rate and productivity. Its use as growth promoters, especially in poultry production is quiet prevalent in India primarily due to economic considerations as they are inexpensive, safe, easy to use and they tend to improve growth performances, laying capacity, general confirmation in consistent manner regardless of the system of husbandry. Antibiotic growth promoters are known to suppress the gut bacteria leaving more nutrients for chicken to be absorbed for greater weight gain. In particular broilers are mostly fed with antibiotic mixed diet and the antibiotics used were also shown to control endemic disease in poultry population. Classes of antibiotics that are used in poultry production include ß-Lactams (Penicillins and Ceftiofur), Macrolides (Azithromycin, Spiramycin and Tylosin), Quinolones (Fluoroquiniolones-Sarafloxacin and Enrofloxacin), Polypeptides (Bacitracin), Strepto-gramins (Virginiamycin), Sulphonamides (Sulphadimethoxine, Sulphamethazine and Sulphisoxazole), Tetracyclines (Chlortetra-cycline, Oxytetracycline and Tetracycline) and Ionophores (Monensin, Salinomycin, Semdur-amicin and Lasalocid). Antibiotics of same classes are used in animals and humans. This overlap significantly contributes to the emergence of resistant bacteria in human (Apata, 2009).

Development of Antimicrobial resistance

Antimicrobial resistance (AMR) is strongly linked with antibiotic use, misuse and overuse in humans and animals. Overuse in animals occurs in the treatment of mild and self limiting infections and long-term low dose administration for prophylaxis. Under-use of antibiotics is common in poultry practice as in group dosing which often results in uneven consumption and also in use of antibiotics in sub-therapeutic concentration as in growth promoters. They inhibit sensitive flora and select resistant flora which multiply and pass to environment may thereby transport resistant gene to other bacterial species present in the host and environment. Sub-therapeutic concentration may

induce antimicrobial resistance including transfer of R-factor. The resistant bacteria from animals may be transferred directly to humans via food chain (Barton, 2000; Barton and Hart, 2001). Although most of the AMR is carried by commensal bacteria, ARGs can be transferred to pathogens of both animals and humans through horizontal gene transfer (HGT).



(**Source:** CSE Study: Antibiotics in Chicken Meat, 2014)

Impact of AMR in Environment

Antibiotic resistance genes (ARG) can be transferred to other bacteria via AMR bacteria present in water, soil and air. Animals excrete a significant amount of the antibiotics to the environment, making their manure a potential source of both antibiotics and antibiotic-resistant bacteria (Grohmann and Arends, 2012; Yannarell and Mackie, 2012).

In a study conducted in Delmarva Peninsula of the United States, resistance genes *erm(B), erm(A), msr(C), msr(A/B)* and mobile genetic elements associated with the conjugative transposon Tn916, were found in isolates recovered from poultry farm environment. *erm(B)* was the most common resistance gene in enterococci, while *erm(A)* was the most common resistance gene in staphylococci (Graham *et al.*, 2009). Similarly our study had quantified antibiotic-resistant bacteria in eight different broiler farms located in Nammakal, Salem and Thiruvallur districts of Tamil Nadu and investigated the prevalence and persistence of antimicrobial resistance genes such as tetracycline resistant and macrolide resistant determinants. Bacteria resistant to tetracycline and erythromycin were detected in soil samples of eight different farms. Antibiotic resistance levels were calculated as the ratio of bacteria able to grow on plates supplemented with antibiotics against no antibiotics. Mean resistance levels were highly variable for tetracycline and erythromycin antibiotics, ranging between 59–93% and 23–78% respectively. Statistical significance was observed among the eight sites based on resistance levels. The most frequent gene was *erm(A)* (56.2%) followed by *tet(K)* (43.7%) and *erm(C)* (32.2%). Higher tetracycline and macrolide resistance determinants were observed inside the farms compared to outside.

Incidence of Antibiotic Resistance in Broilers and its Impact on Public Health

The use of antibiotics as growth promotors that are critically important in human medicine is concerned with the emergence of new forms of multi-drug resistant bacteria that infect people. These include new strains of multi-resistant food borne bacteria such as *Salmonella sp.*, *Campylobacter sp.*, Methicillin-Resistant *Staphylococcus aureus* (MRSA), Vancomycin Resistant *Enterococci* (VRE) and *E. coli* that produce the Extended-spectrum beta-lactamases (ESBL) and/or AmpC enzymes that inactivate nearly all beta-lactam antibiotics (which include

penicillins and the critically important 3rd and 4th generation Cephalosporins) (Phillips *et al.*, 2004; Furtula *et al.*, 2013; Mehndiratta and Bhalla, 2014).

In a study conducted in our laboratory, we assessed the prevalence of antibiotic resistant *Enterobacteriaceae* and *Staphylococcus sp*. from broilers. Among the enterobacterial isolates, highest resistance was observed to amikacin (27%) followed by cotrimoxazole (12.2%), ciprofloxacin (5.6%), cefotaxime (3.1%) and gentamicin (3.1%). Among the staphylococcal isolates, highest resistance was observed to penicillin (86.6%) followed by tetracycline (73.7%), erythromycin (60%), clindamycin (60%), cotrimoxazole (26.6%) and ciprofloxacin (20%).

Antibiotic Residues in Meat

Antibiotics administered in poultry feed may result in minute residues of antibiotics in meat and eggs. The possible adverse effects of antibiotic residue were first reported in UK in 1969. In India, Pollution Monitoring Laboratory (PML), at the Centre for Science and Environment, New Delhi tested for antibiotics in chicken samples. Twenty eight samples of chickens out of 70 (40%) showed the presence of antibiotic residues. Tetracyclines were detected in 10 samples (14.3%) in the range of 16.01 – 46.02 $\mu g\ kg^{-1}$. Fluoroquinolones were detected in 20 samples (28.6%) in the range 3.37 – 131.75 $\mu g\ kg^{-1}$. (CSE Study: Antibiotics in Chicken Meat, 2014).

Conclusion

Antimicrobial resistance is becoming an increasing health concern because antimicrobial resistant commensal bacteria function as a huge resistance reservoir and can spread ARGs to the environment and humans. The results of our study and others clearly indicated the impact of AMR in environment and the persistence of resistant bacteria in broilers, and highlighted the role of antibiotics with its use as feed additive in poultry production to be the inducer of resistance in microbes. There is an urgent need for monitoring the use of antibiotics in poultry industry and a regulatory body may be constituted for the same in India with a viewpoint of containing antibiotic resistance.

References

Apata, D (2009). Antibiotic resistance in poultry. *Int. J. Poult. Sci.*, **8**(4): 404- 408.

Barton, M. D. (2000). Antibiotic use in animal feed and its impact on human health. *Nutr. Res. Rev.*, **13**(02): 279 -2 99.

Barton, M. D and Hart, W. (2001). Public health risks: Antibiotic resistance. *Asian-Australas. J. Anim. Sci.*, **14**(3): 414 - 422.

Furtula, V., Jackson, C. R., Farrell, E. G., Barrett, J. B., Hiott, L. M and Chambers, P. A. (2013). Antimicrobial resistance in *Enterococcus* spp. isolated from environmental samples in an area of intensive poultry production. *Int. J. Environ. Res. Public Health.*, **10**(3): 1020 - 1036.

Graham, J. P., Price, L. B., Evans, S. L., Graczyk, T. K and Silbergeld, E. K. (2009). Antibiotic resistant enterococci and staphylococci isolated from flies collected near confined poultry feeding operations. *Sci. Total Environ.*, **407**(8): 2701-2710.

Grohmann, E and Arends, K. (2012). Molecular detection of resistance and transfer genes in environmental samples, Environmental Protection Strategies for Sustainable Development. Springer, pp. 163 - 191.

Ji, X., Shen, Q., Liu, F., Ma, J., Xu, G., Wang, Y and Wu, M. (2012). Antibiotic resistance gene abundances associated with antibiotics and heavy metals in animal manures and agricultural

soils adjacent to feedlots in Shanghai; China. *J. Hazard. Mater.*, **235**: 178 - 185.

Mehndiratta, P and Bhalla, P. (2014). Use of antibiotics in animal agriculture & emergence of methicillin-resistant Staphylococcus aureus (MRSA) clones: Need to assess the impact on public health. *Ind. J. Med. Res*., **140**(3): 339.

Phillips, I., Casewell, M., Cox, T., De Groot, B., Friis, C., Jones, R., Nightingale, C., Preston, R and Waddell, J. (2004). Does the use of antibiotics in food animals pose a risk to human health? A critical review of published data. *J. Antimicrob. Chemother.*, **53**(1): 28 - 52.

Prabakaran, R. (2003). Good practices in planning and management of integrated commercial poultry production in South Asia**.** Food & Agriculture Organization of the United Nations Rome, **159**: 97pp.

Singer, R. S and Hofacre, C. L. (2006). Potential impacts of antibiotic use in poultry production. *Avian Dis.*, **50**(2): 161-172.

Yannarell, A. C and Mackie, R. I. (2012). Environmental impacts of antibiotic use in the animal production industry in Ecology and Animal Health. Leif Norrgen and Jeffrey M.Levengood eds., Baltic University, Sweden, **2**: 228 – 241.