ANTIMICROBIAL RESIDUE IN FOOD AND ITS PUBLIC HEALTH HAZARD: A REVIEW

Submitted by:
Selim Mia
Roll No: 2015/65;
Reg. No: 01493
Intern ID: 60
Session: 2014-2015

A clinical report submitted in fulfillment of the requirements for the degree of Doctor of Veterinary Medicine (DVM)

Faculty of Veterinary Medicine
Chattogram Veterinary and Animal Sciences University Khulshi, Chattogram-4225

September, 2020

ANTIMICROBIAL RESIDUE IN FOOD AND ITS PUBLIC HEALTH HAZARD: A REVIEW

A clinical report submitted as per approved style and content by

---

Signature of supervisor
(Dr. Sharmin Chowdhury)
Professor
Department of Animal Pathology and Parasitology

Faculty of Veterinary Medicine
Chattogram Veterinary and Animal Sciences University Khulshi, Chattogram-4225, Bangladesh
September, 2020

\

INDEX

Abstract

Antibiotics are life saving drugs for both human and animal health. But indiscriminate application of antibiotics in food animal might result in deposition of residues in meat, milk and eggs which are not permitted in food intended for human consumption. Although use of antibiotics is necessary in treatment of animal diseases, a withdrawal period must be observed until the residues are negligible or no longer detected. Concern over antibiotic residues in food of animal origin occurs in two ways; one is production of direct toxicity in human, second is whether the low levels of antibiotic exposure would result in alteration of microflora, cause disease and the possible development of resistant strains which cause failure of antibiotic therapy in clinical situations. A withdrawal period is established to safeguard human from exposure of antibiotic added food. Heavy responsibility is placed on the veterinarian and livestock producer to observe the period for a withdrawal of a drug prior to slaughter to assure that illegal concentration of drug residue in meat, milk and egg do not occur. But their indiscriminate use will produce toxicity in consumers. In this report we reviewed different published articles and discussed about different kinds of commonly used antibiotics in Bangladesh, their mode of action, uses, withdrawal period and also antimicrobial residue, Maximum Residue Limit (MRL) for veterinary residues, prevalence of antimicrobial residue, treatment effects of antimicrobial residue, acceptable daily intake and public health importance of antimicrobial residue in livestock and poultry.

Keywords: Antibiotic, Antimicrobial Residues, Health Hazard, Drug, Treatment, Withholding period

1. Introduction

Antimicrobials are substances either produced naturally by living organisms or produced synthetically in the laboratory and they are able to kill or inhibit the growth of microorganisms at minimum concentration without causing any harm to host cells (Goodman et al., 1985; Harrison and Svec, 1998). These drugs are not only used for prevention and treatment of diseases, but also used for enhancement of growth and food efficiency especially in food producing animals. Nearly 80% of all food producing animals receives antimicrobials partly or throughout their lives as medication or as growth promoters mostly in developing countries of the world (Lee et al.,2001). Antimicrobials are inclusive of anti-bacterials, anti-virals, anti-fungals, antiprotozoals, coccidiostatic, and antimycotics. On the other hand "Antimicrobial residue" is the small amount of an antimicrobial drug or its breakdown product (s) that remains in or on an agricultural product following treatment with that antimicrobial. Indiscriminate and overuse of antimicrobials could leave high concentrations of residues in edible tissues and tissue by-products. These residues cause antimicrobial resistance and create many harmful effects on human health. Indiscriminate and irrational use of antibiotics in livestock without following withdrawal period may result in unexpected residues in food supplies and could cause serious health hazards to consumers.

2. Materials and methods

The information in this report was gathered after reviewing different scientific articles published in different peer reviewed journals, magazines, proceedings; and internet resources. All the articles were collected from different data bases, such as - PubMed, Scopus, and Google Scholar.

3. What is Antibiotic?

The term antibiotic was first used in America in the 1700s and described as a compound that killed micro-organisms. Sir Alexander Fleming, a Scottish biologist, defined new horizons for modern antibiotics with his discoveries of enzyme lysozyme (1921) and the antibiotic substance penicillin (1928). The discovery of penicillin from the fungus Penicillium helped treating several bacterial infections such as, syphilis, gangrene and tuberculosis. He also contributed immensely towards medical sciences with writings on various topics of bacteriology, immunology and chemotherapy.

Antibiotics are drugs of natural or synthetic origin that have the capacity to kill or to inhibit the growth of microorganisms (FAO, 2005). Any chemical substance produced by or derived from one organism that has the capacity to dilute solutions to destroy or inhibit the growth of other organisms. Usually the product of bacteria or fungi, often chemically modified (semi-synthetic antibiotics) that is used to treat infectious diseases of humans or domestic animals (chemical dictionary of science and technology).

3.1. Classification of antimicrobials

Antimicrobials are classified in various ways. According to their chemical structure, each class of antimicrobials is characterized by a typical core structure, and the various members of the class are differentiated by the addition or removal of secondary chemical structures from the core structures (Kennedy et al., 1998; Guardabassi and Dalsgaard, 2004). They can be classified as broad and narrow spectrum, depending on the range of bacterial species against which they are active, or as bacteriostatic or bactericidal on the basis of their mechanism of action. An antimicrobial that exhibits a large dilution difference between inhibitory and cidal effects is considered to be a bacteriostatic drug, whereas an antimicrobial that kills the bacterium at or near the same drug concentration that inhibits its growth is considered to be a bactericidal drug (Prescott, 2000a; Prescott and Walker, 2000b; Mitchell et al.y 1998). Classification of antimicrobials based on mode of action:

I. Inhibition of cell wall synthesis (3-lactam antibiotics: e.g., penicillin, cephalosporin etc);
II. Damage to cell membrane function (Polyene antibiotics: e.g., amphotericin, nystatin etc);
III. Inhibition of nucleic acid synthesis or function (e.g., ciprofloxacin, enrofloxacin etc);
IV. Inhibition of protein synthesis (Aminoglycosides e.g., streptomycin, tetracycline); and
V. Inhibition of folic acid synthesis (e.g., sulphonamide) (Prescott, 2000a; Prescott and Walker, 2000b).

3.2. Purposes and uses of antimicrobials and other drugs in Livestock and poultry

Globally antimicrobials are commonly used for the treatment, prevention of infectious diseases and for promotion of growth in food-producing livestock, poultry and fish since their discovery

(Donoghue, 2003) and now-a-days represent as an extremely important tool in the efficient production of animal products such as meat and eggs (Phillips, 2007). However, many industrial based livestock producing countries for example, India, China and South Africa have been using antimicrobials in a limited scale (Sarmah et al., 2006). Like other developing countries, farmers in Bangladesh also use antimicrobials widely for different purposes in livestock and poultry. Antimicrobials such as ceftiofur are reported to use in freshly hatched chicks to prevent E. coli septicemia (Hasan et al., 2011). In addition, commonly used antimicrobials in poultry production belong to aminoglycosides, tetracyclines, P-lactams, fluroquinolones, macrolides, polypeptides, amphenicols, sulphonamides and trimethoprim (Personal communication to consulting veterinarians in Bangladesh).

In poultry, growth promoters, such as bacitracin, virginiamycin and avoparcin are used to control Clostridium perfringens infections, which are potentially fatal, in addition to improving feed conversion efficiency. Moreover, vitamins, minerals, and amino acids are required in small quantities in the diet for both livestock and human for various metabolic functions to maintain health and promotion of growth.

3.3. Consequences of antimicrobial uses

3.3.1. Development of antimicrobial resistance

Indiscriminate uses of antimicrobials for different purposes have been reported to cause antimicrobial resistance against different poultry diseases caused by bacteria. However, the rate of resistance varied according to locations and trends of using of antimicrobials in different purposes (Enabulele et al., 2010). Antimicrobial resistance has been recognized as a global health problem. It has now been escalated by major world health organizations to one of the top health challenges facing the twenty-first century (FDA, 2000; CDC, 2010).

The use of antimicrobials in raising food animals has contributed significantly to the global pool of antimicrobial resistant organisms. Antimicrobial resistance in zoonotic enteropathogens including *Salmonella* spp., *Escherichia coli*, and Enterococci in food animals is of special concern to human health because these bacteria are likely to transfer from the food chain to humans (Endtz et al., 1991). The emergence of multi drug resistant bacteria has increased the need for new antimicrobials or modifications of older antimicrobials (Tollefson and Miller, 2000).

The use of antimicrobials in poultry leads to resistant organisms within the chickens themselves and throughout the production environment. Resistant strains of many organisms, including Staphylococcus, Streptococcus, Clostridium, Pseudomonas, and Aeromonas, have been isolated from these sources (Bass et al., 1999). Resistant *E. coli* are frequently isolated from live chickens and strains with multiple resistance to tetracycline, streptomycin, sulfonamides, gentamicin, fluroquinolones, and virtually all other antibiotics, have been isolated (Blanco et al. 1997). Some of its causes are widely accepted, for example, the inappropriate and overuse of antibiotics for nonbacterial infections such as colds and other viral infections and inadequate antibiotic use in the clinical arena (Levy, 2002). This practice is reported to have caused high resistance to antibiotics by pathogenic micro-organisms in poultry (Sprum and Sunde, 2001).

Single, double and multi-antimicrobial resistances have been reported against bacterial pathogens isolated from broiler chickens in India, Pakistan, Nepal and Bhutan. The common resistant antimicrobials in those studies were streptomycin, tetracycline, gentamicin, ampicillin and nalidixic acid. Similar findings have been observed in many earlier studies in poultry in Bangladesh (Akter et al.y 2007; Ferdous et al., 2013). In Bangladesh antimicrobial agents are readily available to people in local drug stores without prescriptions by registered veterinarians (Kwaga and Adesiyun, 1984 and Hasan et al., 2011). This malpractice of choosing drugs by non veterinarians increases the prevalence of antimicrobial resistance. Available locally produced drugs with the cheap price rate such as ampicillin, amoxicillin, erythromycin, quinolone, neomycin, kanamycin, pefloxacin and sulfamethoxazole could encourage to use them more commonly than the older drugs and therefore drugs become resistant which is evident in poultry farms of India, Bhutan and Brazil (Hart and Kariuki, 1998; Prakash et al., 2005; Dahal, 2007; Haung et a l 2009 and Eliana et al., 2012). A detailed description of development of antimicrobial resistance is given in Table 1.

Table 1: Developing of resistance of antimicrobials against pathogens

Antimicrobial type	Mode of action	Resistant Method
beta-lactam antibiotics: Penicillin, ampicillin, cephalosporine.	Inhibit cell wall synthesis	• Change their outer membrane structure to prevent entrance of the drug. • Modify the enzyme so that the

		drug no longer binds. • Synthesize P-lactamases that cleave the functional lactam ring of the drug. • Genes for lactamases are often carried on R-plasmids.
Aminoglycoside: Gentamycin, kanamycin, neomycin, streptomycin etc. Macrolids: Azithromycin, erythromycin, telirheomycin etc. Tetracyclines: Doxycycline, tetracycline etc	Inhibit protein synthesis	• Uptake of these drugs is energy dependent, so anaerobic bacteria with less ATP available are less susceptible; aerobic bacteria alter membrane pores to prevent uptake or synthesize enzymes that alter or degrade the drug once it enters; rarely bacteria alter the binding site on the ribosome; some bacteria make biofilms when exposed to the drugs. • Develops via changes in ribosomal RNA that prevents drugs from binding, or via R-plasmid genes coding for the production of macrolide digesting enzymes: resistance genes are same as those of lincosomides. Bacteria may: ■ Alter gene for pores in the outer membrane; new pore prevents drug from entering cell. ■ Alter binding site on the ribosome to allow tRNA to bind even in presence of drug. ■ Actively pump drug from cell.
Fluoroquinolones: Ciprofloxacin, moxifloxacin, cinofloxacin etc.	Inhibit nucleic acid synthesis	Ciprofloxacin, moxifloxacin, cinofloxacin etc. Inhibit nucleic acid synthesis • Result from chromosomal mutations that lower affinity for drug, reduce its uptake, or protect gyrase from drug.
Sulfonamides: Sulfadiazine, sulfadoxine, sulfanilamide etc.	Block second metabolic steps in the formation of folic acid from para amino butyric acid (PABA).	• Pseudomonas is naturally resistant due to permeability barriers; cells that require folic acid as a vitamin are also naturally resistant; chromosomal mutations result in lowered affinity for the drugs.

4. Antimicrobial residue

The term "Antimicrobial residue" is the small amount of an antimicrobial drug or its breakdown product (s) that remains in or on an agricultural product following treatment with that antimicrobial. Indiscriminate and overuse of antimicrobials could leave high concentrations of residues in edible tissues and tissue by-products (Botsoglou and Fletouris, 2001). The most common causes for the persistence of antimicrobial residues in different organs of poultry are overdosing and violations of withdrawal periods (Pena et al., 2007). Veterinarians in Bangladesh usually do not advice farmers to follow drug withdrawal period for food producing animals and therefore farmers have no knowledge about persistence of drug residues in poultry products which can easily enter into human bodies and become drug resistant against human pathogens (Apata, 2009) and cause other problems such as allergic reactions, cancer etc (Botsoglou and Fletouris, 2001; Donoghue, 2003; Companyo et al., 2009).

4.1. Drug withdrawal period

The term "Drug withdrawal period" is often used more broadly to describe the time needed after drug administration to any food animal where drug residue may be found in marketed meats, eggs, organs, or other edible products (Eiichi et al., 2006). Until the withdrawal period has elapsed, the animal or its products must not be used for human consumption. Following table shows the withdrawal period of different antibiotics.

Table 2: Withdrawal periods of different antimicrobials in poultry

Antimicrobial type	Withdrawal period (days)
Oxytetracycline	7
Ciprofloxacin	6
Amoxicillin	5
Trimethoprim	10
Sulphaquinoxaline	10
Sulphachloropyrazine	5
Sulphadimethoxine	5

(Source: Rana, 1988; Maqbool, 1988; Calnek et al, 1991; Nawaz et al, 1996;; Mumtaz et al.2000)

The occurrence of antimicrobial residues may be due to the failure to observe the withdrawal periods of antimicrobial drugs. To ensure that drug residues have declined to a safe concentration following the use of drugs in animals, a specified period of drug withdrawal must be observed prior to providing any products for human consumption.

4.2. Prevalence of antimicrobial residues

Estimation of the prevalence of antimicrobial residues in livestock and poultry products has been documented in many different countries of the world and overall prevalence estimates include 14% for penicillin, 8-52% for tetracycline, 28% for oxytetracycline, 4% for streptomycin, 12.5-50% for sulphonamide, 28% for sulphadiazine in poultry products (Diezet et al., 2002; Salem, 2004; Reyes-Herrera et al.v 2005; Shareef et al., 2009). In another study, ciprofloxacin was reported as highest in proportion (6.7%) followed by oxytetracycline (4.2%), amoxicillin (2.5%) and sulfonamides (2.5%), respectively. Some non-systematic studies in Bangladesh estimated prevalence of antimicrobial residues as follows: 37.5% for tetracycline in liver samples of poultry followed by 7.5% for ciprofloxacin and 5% for sulphonamide (Mahmud, 2012; Karim, 2013).

4.3. Concentration of antimicrobial residues

Concentration levels of antimicrobial residues in livestock and poultry products has also been studied worldwide including Bangladesh, and generally there is evidence that concentrations of amoxicillin (50 ng/kg), ampicillin (50 Mg/kg), tetracycline (100-148 ng/kg), sulphonamides (100 ng/kg) and gentamicin (750 ng/kg) routinely exceed upper threshold limits in muscle tissues of poultry (EC, 1998; Diez et al., 2002; Salem, 2004 Hossain et al, 2011; Karim, 2013). However, the cited studies in Bangladesh were cross-sectional and non-systematic studies to quantify concentration of antimicrobial residues; however this investigation was designed as controlled broiler farm setting to assess antimicrobial residues in broiler chicken products for the first time in Bangladesh. Acceptable limits of different antibiotics are shown in Table 3.

Table 3: Acceptable limits of antimicrobial residues in livestock and poultry products

Antimicrobial type	Minimum (microgram/kg)	Maximum(microgram/kg)
Amoxicillin	5	40
Tetracycline	15	100
Oxytetracycline	15	100

Chlortetracycline	15	100
Sulphonamide	25	100
Trimethoprim	8	50
Erythromycin	12	40
Quinolones	47	147

4.4. Treatment effects on antimicrobial residues

Different heat stabilities of antimicrobials between drug classes, between temperature levels, and among the same classes of drugs were studied. Ranking of heat stability by antimicrobial classes at 121°C was the highest for sulphonamide, followed by lincomycin, colistin, tetracyclines and B-lactams while at 100°C sulphonamides equaled lincomycin and was greater than colistin but variability was observed in different tetracyclines and B-lactams. Enrorofloxacin residue determined from 15 samples of chicken remained stable at 100°C for 3 hours (Lolo et al., 2006). Javadi et al. (2009) analyzed that the enrofloxacin residue using microbial inhibition method is reduced in concentration after different cooking process. Sulfamethoxazole, sulfamonomethonine and sulfaquinonaline residues except sulfadiazine residue detected in the muscle of chickens roasted at 170°C for 12 minutes reduced the concentration from 100ng/kg to 25^g/kg (Furusawa and Hanabusa, 2002).

Table 4: Heat stability of antimicrobials after autoclaving at 121°C for 15 minutes

Stable	Partially stable	Labile
Ciprofloxacin	Amoxillin	Amoxicillin and clavulanic acid
Gentamicin	Ampicillin	Cefixime
Norfloxacin	Nitrofurantoin	Ceftriaxone
Trimethoprim	Penicillin G	Cefuroxime
Sulfamethoxazole and Trimethoprim	Polymyxin B	Doxycycline
Nalidixic acid	Ampicillin and sulbactum	Erythomycin
Clindamycin	Rafampicin	Tetracycline

(Source: Furusawa and Hanabusa, 2002; Lolo et al.9 2006; avadi et al.9 2009)

Different treatment strategies have potential effects in reducing the prevalence and concentration of antimicrobial residues in animal and poultry products. Some studies in limited scale have been conducted to examine the cooking effects on reducing antimicrobial residues in poultry meat and meat by-products in Chittagong, Bangladesh (Hossain et al. 2011; Mahmud, 2012; Karim, 2013).

4.5. Harmful effects of antimicrobial residues

Antibiotic residues in foods of animal and bird origin might cause problems for several reasons. In addition to toxic effects, effects on intestinal micro-biota and the immune system are important (Gorbach, 1993; Waltner-Toews and McEwen, 1994; Perrin-Guyomard et al., 2001). Microbiological endpoints were considered more valid and sensitive in the safety evaluation of antimicrobial residues in production animals than standard toxicological endpoints (Boisseau, 1993).

4.5.1. Effects on human gut microbiota

The microbiota in the human gastrointestinal tract form an extremely complex, yet relatively stable, ecological community, containing more than 400 bacterial species (Carman et al., 1993). The concentration of anaerobic microbiota is 1011-1012 CFU g-1 facces, and the concentration of aerobic microbiota much lower and less than 0.1% of the normal microbiota consists of aerobes (Vollard and Cleaner, 1994). In addition to the resident dominant anaerobic microbiota, the microbiota consists of a subdominant microbiota, a resident minority microbiota and a variable microbiota composed of bacteria which might be present for a variable period of time (Boisseau, 1993). Colonisation resistance meant the natural defence by normal microbiota against colonization and translocation by exogenous potentially pathogenic microbes or against the overgrowth of indigenous opportunisms (van der Waaij et al., 1971; Barza etal., 1987, Corpet, 1993).

Administration of antimicrobial agents might cause disturbances in these functions (Nord and Edlund, 1990). To what extent disturbances in the ecological balance between host and microorganisms occur depends on the spectrum of the antimicrobial agent, the dose, pharmacokinetic and pharmacodynamic properties, and in-vivo inactivation of the agent (Sullivan et al., 2001). Four microbiological endpoints have been identified that could be of public health concern: modification of the metabolic activity of microbiota, changes in bacterial populations, selection of resistant bacteria, and perturbation of the barrier effect (Boisseau, 1993; Gorbach, 1993; Sundlof et al., 2000; Perrin- Guyomard et al., 2001).

In cases of reduced colonization resistance not only are the minimal infectious or colonization doses of pathogenic or resistant bacteria considerably lower, but animals also excrete these bacteria in higher numbers and over a longer period of time compared to animals with an intact colonization resistance (van den Bogaard and Stoppinger, 1999).

Some data had been reported on antimicrobial susceptibility and emergence of resistant bacteria with low doses of antimicrobials (Rollins et al., 1975; Mamber and Katz, 1985; Corpet, 1987; Tancrede and Barakat, 1989).

Tetracyclines, in relatively low doses, had some impact on the fecal anaerobic micro-biota of humans (WHO, 1991; Waltner-Toews and McEwen, 1994). A close relationship between tetracycline, streptomycin, gentamicin and chloramphenicol residues and the resistance of bacteria isolated from the samples was found, suggesting that the presence of low levels of antimicrobials might exert a positive pressure towards the selection and expression of resistance in bacteria colonizing animal tissues (Vazquez-Moreno et a l 1990). It is possible, although not proven, that low doses of antimicrobial drugs could alter intestinal enzyme activity and had an effect on certain hormones and drugs (Gorbach, 1993).

4.5.2. Hypersensitivity reactions

Drug hypersensitivity was defined as an immune-mediated response to a drug agent in a sensitized patient, and drug allergy is restricted to a reaction mediated by IgE (Riedl and Casillas, 2003). Drugs are foreign molecules, but their molecular weight is usually too small to be immunogenic. For drugs to be immunogenic, they must act as haptens, which must combine with carrier proteins to be immunogenic and elicit antibody formation (Dewdney etal., 1991). Immunologic reactions may manifest from life-threatening anaphylactic reactions to milder reactions, such as rashes. Drug-induced allergic reactions may occur acutely (within 60 min of challenge), sub acutely (1-24 h), or as latent responses (1 day to several weeks). The acute and some sub acute disorders are often due to Type I (IgE)- mediated reactions and, more rarely, due to IgG antibodies (Type II). Immune complex disorders (Type III) are much rarer in this context. Type IV (cell mediated) responses develop more slowly. The principal types of disorder are: Type I: anaphylactic shock, asthma and angioneurotic edema; type II: hemolytic anemia and agranulocytosis; type III: serum sickness and allergic vasculitis, and type IV: allergic dermatitis (Dayan, 1993; Riedl and Casillas, 2003). In anaphylaxis exposure rapidly leads to severe acute bronco constriction, often risking a degree of asphyxia, marked hypotension, possibly edema at the site of challenge, and severe general illness (Dayan, 1993). Antimicrobial drug residues in animal tissues may cause hypersensitivity reactions in humans. An allergic reaction may be triggered by antimicrobial residues in a previously sensitized individual. In relation to primary sensitization, it is unlikely that residues could contribute to the overall immune response in view of the very low concentrations that are likely to be encountered. The duration of exposure is also short (Dewdney et al., 1991; Sundlof et al., 2000).

Notwithstanding their non-toxic nature, B-lactams appear to be responsible for most of the reported human allergic reactions to antimicrobials (WHO, 1991; Sundlof, 1994; Fein et al., 1995). Aminoglycosides, sulphonamides and tetracyclines may also cause allergic reactions (Paige et al., 1997). Certain macrolides may in exceptional cases be responsible for liver injuries, caused by a specific allergic response to macrolide metabolite-modified hepatic cells (Dewdney et al., 1991).

However, only a few cases of hypersensitivity have been reported as a result of exposure to residues in meat. Anaphylactic reactions to penicillin in pork and beef have been described (Tscheuschner, 1972; Kanny et al., 1994; Raison-Peyron et al., 2001). In one case anaphylaxis was possibly caused by streptomycin residues (Tinkelman and Bock, 1984), and angioneurotic edema and tightness o f chest by penicillin residues in meat (Schwartz and Sher, 1984). Failure to associate minor reactions, e.g. urticaria, with exposure to allergenic residues may be one reason for the lack of reported cases, although it might also be due to a genuine dearth of reactions (Woodward, 1991). Harmful effects of chloramphenicol observed in association with clinical use in humans include dose-related, reversible suppression o f the bone marrow, gray baby syndrome, which is a circulatory collapse in children less than 30 days on high doses, and irreversible, idiosyncratic, non-dose related aplastic anemia (Schmid, 1983; WHO, 1988; Waltner-Toews and McEwen, 1994). Aplastic anemia could occur in susceptible individuals exposed to concentrations of chloramphenicol that might remain as residues in edible tissues of chloramphenicol-treated animals (Settepani, 1984). Aminoglycosides can produce damage in urinary, vestibular and auditory functions (Clark, 1977; Shaikh and Allen, 1985). Toxic and allergic reactions in humans and animals caused by tetracyclines have only been observed at therapeutic doses (Berends et al., 2001).

4.6. Public health importance of antimicrobial residues in livestock and poultry

Administration of drugs to food-producing animals requires not only consideration of effects on livestock and poultry but also effects on humans who consume food from these livestock and poultry. In short, after food-producing animals have been exposed to drugs in order to cure or prevent disease or to promote growth, the effects of the residues of such treatment may have on humans should be known. These residues consist of the parent compound or compounds derived from the parent drug (or both) including metabolites and residues bound to macromolecules (Weber, 1982).

Concern has been expressed about possible harmful effects on humans through the use of
Drugs are as follows:

I. Increased microbial drug resistance,
II. Drug residues in food,
III. Allergic reactions and sensitization to antimicrobials, and
IV. Drug toxicity (Black, 1984).

Antimicrobial residues in foods of animal origin may cause problems for several reasons. In addition to toxicity, effects on intestinal microbiota and the immune system are important (Gorbach, 1993; Waltner-Toews and McEwen, 1994; Perrin-Guyomard et al., 2001).

5. Conclusion

In the age of global antibiotic health hazard, securing public health and to generate confidence that we are practicing medicine in their best interests is the prime target area of veterinarians. Both veterinarians and food producers have become extremely conscious for the need of high public confidence in the products they produce. The surveillance study in target areas indicated that a large number of antibiotics were frequently used for treating various infections in both dairy and poultry industry'. In addition, stakeholders involved do not adhere to withdrawal periods. None adhere to withdrawal period is the major cause of chemical residues. These practices provide conditions favorable to the selection and spread of resistant bacteria and resistant genes. Many management strategies can be implemented to reduce the need for antimicrobials in food animals. Evidence suggested that more judicious use of antimicrobials in food producing animals will reduce the selection of resistant bacteria and help to preserve these valuable drugs for both human and veterinary medicine. Addressing this issue of antimicrobial-resistance is one of the most urgent public priorities today. National authorities should adopt a proactive approach that promotes programs aimed at reducing the news for antimicrobials in food animals and ensuring their prudent use. Antimicrobial agents are critical resources for controlling a great number of infection diseases in both animals and the continued availability of effective antimicrobials for humans and animals will ultimately depends upon the responsible use of these products. This necessitates that all effort including awareness creation, observance of withdrawal period, effective surveillance, monitoring and control on the use of veterinary drugs to prevent drug residues in animal derived products be employed.

6. Recommendations

Indiscriminate or excessive use of drugs should be restricted through education and motivation of broiler farmers and practicing veterinarians. Veterinarians should be more rigorous when prescribing veterinary medicinal products and aware of the rules for the prudent use of antimicrobials. Owners should respect the prescribed withdrawal periods of drugs. It is also necessary to organize seminars on the risk of the excess use of antimicrobial substances in food animals for public health. Drug withdrawal periods should be strictly maintained before slaughtering the birds for human consumption.

References:

Ahmed S and Hamid MA. 1992. Status of poultry production and development strategy in Bangladesh. In Proc. Workshop on Livestock Development in Bangladesh (16-18 July, 1991), Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, pp. 132-139.

Akter MR, Choudhury KA, Rahman MM, Islam MS. 2007. Seroprevalence of salmonellosis in layer chickens with isolation, identification and antibiogram study of their causal agents. Bangladesh Journal of Veterinary Medicine. 5 (1&2): 39-42.

Al-Bahry SN, Al-Mashani BM, Elshafie AE, Pathare N, Al-Harthy AH. 2006, Plasmid profile of antibiotic resistant E. coli isolated from chickens intestines. Alabama Journal of Medical Sciences, 77: 152-159.

Al-Ghamdi MS, Al-Mustafa ZH, El-Morsy F, Al-Faky A, Haider I and Essa H. 2000, Residues of tetracycline compounds in poultry products in the eastern province of Saudi Arabia. Public Health. 114 (4): 300-304.

Apata DF. 2009. Antibiotic resistance in poultry, International Journal of Poultry Science 8 (4): 404-408.

Bangladesh Bureau of Statistic's (2008). Farm poultry and livestock survey 2007-08. http://www.bbs.gov.bd/userfiles/Image/SY2010/Chapter-04.pdf (Accessed August 19, 2020).

Bass L, Liebert CA, Lee MD, Summers AO, White DG, Thayer SG and Maurer JJ. 1999. Incidence and characterization of integrons, genetic elements mediating multiple-drug resistance, in avian Escherichia coli. Antimicrobial Agents and Chemotherapy. 43(12):2925-2929.

Bergwett AA. 2005. Rapid assays for detection of residues of veterinary drugs. In: Rapid Methods For Biological and Chemical Contaminants in Food And Feed. Wangeningen Academic Publishers, pp. 28-34.

Black WD. 1984. The use of antimicrobial drugs in agriculture. Canadian Journal of Physiology and Pharmacology. 62: 1044-1048

Blanco JE, Blanco M, Mora A and Blanco J. 1997. Prevalence of bacterial resistance to quinolones and other antimicrobials among avian Escherichia coli strains isolated from septicemic and healthy chickens in Spain. Journal of Clinical Microbiology. 35: 2184-2185.

Botsoglou NA, Fletouris DJ, 2001. Drug residues in foods. Pharmacology, Food Safety and Analysis, (First Edition). Marcel Dekker, Inc., ISBN: 0-8247-8959-8, New York, USA.

Brogden KA, Ackermann M, McCary PBJM and Tack BF. 2003. Antimicrobial peptides in animals and their role in host defences. International Journal of Antimicrobial Agents. 22: 465-478.

Calnek BW, Barnes HJ, Beard CW, Reid WM and Yoder HW. 1991. Diseases of Poultry, 9th Edn. Iowa State Univ. Press, Ames, Iowa, USA. pp: 784-9.

CDC. 2010. Get smart: know when antibiotics work. Centers for Disease Control, Atlanta, GA. www.cdc.gov/Features/GetSmart. (Accessed Augustr 20, 2020)

Companyo R, Granados M, Guiteras J and Prat MD. 2009. Antibiotics in food: legislation and validation of analytical methodologies. Analytical and Bio-analytical Chemistry. 395: 877-891.

Dahal N. 2007. Prevalence and antimicrobial resistance of salmonella in imported chicken carcasses in Bhutan (PG Thesis). http://vphcap.vet.cmu.ac.th/file/THESIS/02nd-student/full/Dahal.pdf (Accessed August 16, 2020).

DANMAP. 2010. Use of antimicrobial agents and occurrences of antimicrobial resistance in bacteria from food animals, food and humans in Denmark. http://www.danmap.org (Accessed August 16,2020).

Darwish WS, Eldaly EA, El-Abbasy MT, Ikenaka Y, Nakayama S and Ishizuka M. 2013. Antibiotic residues in food: the African scenario. Japanese Journal of Veterinary Research 61(Suppl): S13-S22.

Diez P, Medina E, Martin M, Calderon V. 2002. Validation of the five-plate screening test for the detection of antibiotic residues in food. Estimation of the limit of detection. Revista del Comite Cientifico de la AES AN 16: 109-130.

Dipelou MA, Alonge DO. 2002. Residues of streptomycin antibiotic in meat sold for human consumption in some states of SW Nigeria. Archivos de zootecnia 51:477-480.

Donoghue DJ. 2003. Antibiotic residues in poultry tissues and eggs: human health concerns? Poultry Scicnce. 82: 618-621.

European Community (EC). 2001. Notice to applicants and note for guidance. Establishment of maximum residue limits (MRLs) for residues of veterinary medicinal products in foodstuffs of animal origin. Volume 8. http://ec.europa.eu/health/files/eudralex/vol-8/pdf/vol8_10-2005_en.pdf. (Accessed August 12, 2020).

Eiichi K. 2006. On a new withdrawal time of veterinary drugs under Positive List System Journal of Livestock Medicine 516: 363-365.

Eliana N, Castiglioni T, Ana MIK, Greice FZS, Renato LL, Antonio GMC, Ana LSPC. 2012. Important aspects of Salmonella in the poultry industry and in public health, Salmonella-a-dangerous food borne pathogen, Dr. Barakat SMM (ed). [Cited 2013 Jan 10]; Available from: http://www.intechopen.com/books/salmonella-a-dangerousfoodbomepathogen/important-aspects-of-salmonella-in-the-poultry-industry-and-in-public-health. (Accessed August 12, 2020).

EMEA. 2004. MRL summary reports on the scientific evaluations carried out by the Committee for Veterinary Medicinal Products (CVMP). http://www.ema.europa.eu/docs/en_GB/document_library/Maximum_Residue_Limits_-_Report/2012/02/WC500123138.pdf. (Accessed September 1, 2020).

Enabulele SA, Amune PO, Aborisade WT. 2010. Antibiograms of Salmonella isolates from poultry farms in Ovia North East local government area, Edo State, Nigeria, Agriculture and Biology Journal of North America. 1: 1287-1290.

Endtz HP, Ruijs GJ, Van Klingeren B, Jansen WW, Vander Rayden T, Mouten RP, Smith SM, Chmel H, 1991. Quinolone resistance in Campylobacter isolated from man and poultry following the introduction of fluroquinoloncs in veterinary medicine. Journal of Antimicrobial Chemotherapy. 27: 199-208.

Eng RHK, Munsif AN and Yangco BG, 1989. Seizure propensity with imipenem. Archives of Internal Medicine. 149:1881-1883.

European Community (EC). 1998. Regulation n 2316/98, October 26, 1998. Available athttps://estudogeral.sib.uc.pt/bitstream/l0316/10604/1/Determination%20of%20Tetracycline%20Antibiotic%20Residues%20in%20Edible%20Swine%20Tissues.pdf. (Accessed August 16, 2020).

Eiichi K. 2006. On a new withdrawal time of veterinary drugs under Positive List System Journal o f Livestock Medicine 516: 363-365.

Eliana N, Castiglioni T, Ana MIK, Greice FZS, Renato LL, Antonio GMC, Ana LSPC. 2012. Important aspects o f Salmonella in the poultry industry and in public health, Salmonella-a dangerous food borne pathogen, Dr. Barakat SMM (ed). [Cited 2013 Jan 10]; Available from:http://www.intechopen.com/books/salmonella-adangerousfoodbomepathogen/important-aspects-of-salmonella-in-the-poultryindustry-and-in-public-health. (Accessed August 12, 2020).

EMEA. 2004. MRL summary reports on the scientific evaluations carried out by the Committee for Veterinary Medicinal Products (CVMP). http://www.ema.europa.eu/docs/en_GB/document_library/Maximum_Residue_ Limits_ _Report/2012/02/WC500123138.pdf. (Accessed September 1, 2020).

Enabulele SA, Amune PO, Aborisade WT. 2010. Antibiograms of Salmonella isolates from poultry farms in Ovia North East local government area, Edo State, Nigeria, Agriculture and Biology Journal of North America. 1: 1287-1290. Endtz HP, Ruijs GJ, Van Klingeren B, Jansen WW, Vander Rayden T, Mouten RP, Smith SM, Chmel H, 1991.

Quinolone resistance in Campylobacter isolated from man and poultry following the introduction of fluroquinoloncs in veterinary medicine. Journal of Antimicrobial Chemotherapy. 27: 199-208. Eng RHK, M unsif AN and Yangco BG, 1989.

Seizure propensity with imipenem. Archives o f Internal Medicine. 149:1881-1883.

European Community (EC). 1998. Regulation n 2316/98, October 26, 1998. Available athttps://estudogeral.sib.uc.pt/bitstream /l 0316/10604/1/Determination%20of%2 0Tetracycline%20Antibiotic%20Residues%20in%20Edible%20Swine%20Tissu es.pdf. (Accessed August 20, 2020).

FDA. 2000. FDA 1 ask Force on Antimicrobial Resistance: key recommendations and report, Washington, DC. FDA, Washington, DC. http://www.fda.gov/downloads/forconsumers/consumerupdates/ucml43458.pdf. (Accessed August 20,2020).

Ferdous TA, Kabir SML, Amin MM, Hossain KMM. 2013. Identification and antimicrobial susceptibility o f Salmonella species isolated from washing and rinsed water o f broilers in pluck shop. International Journal o f Animal and Veterinary Advances. 5: 1-8.

Ferhan N and Aydin H. 2000. Quinolone antibiotic residues in raw milk and chicken liver in Kenya, Eurasian Journal o f Veterinary Science, www.eurasianjvetsci.org. (Accessed September 2, 2020).

Fitzpatrick SC, Brynes SD, Guest GB, 1995. Dietary intake estimates as a means to the harmonization o f maximum residue levels for veterinary drugs. Journal of Veterinary Pharmacology and Therapeutics. 18: 325-327.

Furusawa N and Hanabusa R. 2002. Cooking effects on sulfonamide residues in chicken thigh muscle. Food Research International. 35: 37-42.

Ghani A. 2005. Practical Phytochemistry, Prakash Publication, Dhaka, Bangladesh, pp: 55-69.

Gaudin V, Maris P, Fuselier R, Ribouchon C, Cadieu N and Rault A. 2004. Validation o f a microbiological method: The Star protocol, a five plate test for the screening o f antibiotic residues in milk. Food Additives and Contaminants 21: 422-433.

Goodman LS, Gilman AG, Rail TW and Murad F. 1985. The Pharmacological Basis o f Therapeutics, Goodman and Gilman’s Seventh Edition.

Gorbach SL. 1993. Perturbation of intestinal microflora. Veterinary and Human Toxicology. 35: 15-23.

Guardabassi L and Dalasgaard D. 2004. Occurrence and faith of antibiotic resistant bacteria in sewage. Environmental Project No. 722.

The Royal Veterinary and Agricultural University. Department o f Veterinary Microbiology. Copenhagen, Denmark. Gustafson RH and Bowen RE. 1997. Antibiotic use in animal agriculture. Journal of Applied Microbiology. 83: 531-541.

Habib A, Javed I and Muhammad N. 2006. Estimation of selected residual antibiotics in muscle, kidney, liver and eggs o f layer chiken. Proceedings o f the Pakistan Academy o f sciences. Sci. 43: 29-37.

Hamson JW, Svec TA. 1998. The beginning o f the end o f the antibiotic era? Part I. The problem: Abuse of the ‘miracle drugs’. Quintessence International. 29: 151- 162.

Hart CA, Kariuki S. 1998. Antimicrobial resistance in developing countries. British Medical Journal. 317: 647-650.

Hasan B, Faruque R, Drobni M, Waldenstrom J, Sadique A, Ahmed KU, Islam Z, Parvez MBH, Olsen B, Alam M. 2011. High prevalence of antibiotic resistance in pathogenic Escherichia coli from large and small poultry farms in Bangladesh. Avian Diseases. 55: 689-692.

Haung TM, Lin TL, Wu CC. 2009. Antimicrobial susceptibility and resistance of chicken Escherichia coli, Salmonella spp and Pasteurella multocida isolates. Avian Diseases. 53: 89-93.
Sprum and Sunde, 2001. Resistance to antibiotics in the normal flora o f animals. Veterinary Research, 32: 227-241.

Hermes C. 2003. Avoiding residues in small poultry and game flocks. Pacific Northwest Extension Publication Oregon State University. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20753/pnw564.pdf (Accessed April 20, 2013).

Hossain MZ, Saifuddin AKM, Islam SKM, Islam S, Uddin MI, Hoque MA. 2011. Prevalence o f antimicrobial residue in livestock meat using microbiological and chromatographic techniques in Bangladesh. Proceedings o f the ninth Annual Scientific Conference, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh. 7-8 March 2012, Chittagong, Bangladesh. Abstract book, p 51.

Ibrahim Al, Junaidu AU, Garba MK. 2010. Multiple antibiotic residues in meat from slaughtered cattle in Nigeria. The Internet Journal of Veterinary Medicine 8.

Javadi A, Minzaei H and Khatibi SA. 2009. Effect of roasting process on antibiotic residues in edible tissues of poultry by FPT method, Journal of Animal and Veterinary Advances 8 : 2468-2472. Karim MR. 2013.

Determination of selective antibiotics residues in chicken meat (broiler and deshi) by thin layer chromatography and ultra high performance liquid chromatography. M.Sc.Thesis, Department o f Physiology, Biochemistry and Pharmacology. Chittagong Veterinary and Animal Sciences University, Chittagong, http://www.cvasu.ac.bd/ (Accessed August 08, 2020).

Kennedy DG, McCracken RJ, Cannavan A and Hewitt SA 1998. Use o f liquid chromatography - mass spectrometry in the analysis of residues o f antibiotics in meat and milk. Journal of Chromatography. 812: 77-98.

Kwaga JKP, Adesiyun AA. 1984. Antibiograms of Staphylococcus aureus isolates from some ready-to-eat products. Journal of Food Protection. 47: 865-867.

Lee MH, Lee HJ, Ryu PD, 2001. Public health risks: chemical and antibiotic residues. Review Asian-Australian Journal o f Animal Sciences. 14: 402-413.

Levy SB. 2002. The antibiotic paradox: how the misuse of antibiotics. The New England Journal of Medicine. 347:1213. http://www.nejm.org/doi/full/10.1056/NEJM200210103471524 (Accessed April 22, 2013).

Lohren U, Ricci A, Cummings TS. 2008. Guidelines for antimicrobial use in poultry. In: Guardabassi L, Jensen LB, Kruse H, eds. Guide to Antimicrobial Use in Animals. Oxford, UK: Blackwell Publishing. 126-142pp.

Lolo M, Pedreira S, Miranda JM, Vazquez BI, Franco CM, Cepeda A and Fente C. 2006. Efeect o f cooking on enrofloxacin residues in chicken tissue. Food additives and Contaminants: 23: 988-993.

Mahmud K. 2012. Determination of antibiotic residue in commercial poultry meat and assess the heat tolerance level of that residues at cooking and autoclaving. (MS Thesis). Department o f Physiology, Biochemistry and Pharmacology. Chittagong Veterinary and Animal Sciences University. http://www.cvasu.ac.bd/ (Accessed August 08, 2020).

Maqbool J. 1988. Residues o f slulfachloropyrazin in poultry products. M.Sc. Thesis, Department of Veterinary Pharmacology, University of Agriculture, Faisalabad. http://www.uaf.edu.pk/ (Accessed September 2, 2020).

Mitchell JM, Griffiths MW, McEven SA, McNab WB, Yee AJ. 1998. Antimicrobial drug residues in milk and meat: causes, concerns, prevalence, regulations, tests, and test performance. Journal of Food Protection. 61: 742-756.

Msoffe PLM. 2003. Diversity among local chicken ecotypes in Tanzania. Unpublished PhD thesis, Sokoine University of Agriculture, Tanzania. 218- 223pp. http://www.lib.suanet.ac.tz/ (Accessed August 23,2020).

Mumtaz A, Awan JA and Athar M. 2000. Rational use o f drugs in broiler meat production. International Journal o f Agriculture & Biology. 2: 269-272.

Muriuki FK, Ogara WO, Njeruh FM and Mitema ES. 2001. Tetracycline residue levels in cattle meat from Nairobi slaughter house in Kenya. Journal of Veterinary Science. 2: 97-101.

Naeem M, Khan K and Rafiq S. 2006. Determination o f residues o f quinolones in poultry products by High Pressure Liquid Chromatography. Journal of Applied Science. 6 : 373-379.

Nawaz R, Ahmed R, Akter P, Nawaz M, 1996. Residues o f sulfadimethoxine in blood, eggs, and tissues o f poultry birds. Pakistan Veterinary Journal. 16: 181- 85.

Nisha AR. 2008. Antibiotic Residues - A Global Health Hazard. Veterinary World. 1: 375-377.
Okerman L, Van Hoof J and Debeuckelaere W. 1998. Evaluation o f the European four-plate test as a tool for screening antibiotic residues in meat samples from retail outlets. Journal o f AO AC International. 81: 51-56.

Owens RC, Ambrose PG. 2005. Antimicrobial safety: focus on fluoroquinolones. Clinical Infectious Diseases. 41: 144-157.

Pena A, Lino CM, Alonso R, Barcelo D, 2007. Determination of tetracycline antibiotic residues in edible swine tissues by Liquid Chromatography with spectrofluorometric detection and confirmation by mass spectrometry. Journal o f Agricultural and Food Chemistry. 55: 4973-4979.

Peric L, Zikic D and Lukic M 2009. Application of alternative growth promoters in broiler production. Biotechnology in Animal Husbandry. 25: 387-397.

Perrin-Guyomard A, Cottin S, Corpet DE, Boisseau J and Poul JM. 2001. Evaluation o f residual and therapeutic doses o f tetracycline in the human-flora-associated (HFA) mice model. Regulatory Toxicology and Pharmacology. 34: 125-136.

Persoons D, Haesebrouck F, Smet A, Herman L, Heyndrickx M, Martel A, Catry B, Butaye P and Dewulf J. 2011. Risk factors for ceftiofur resistance in Escherichia coli from Belgian broilers. Epidemiology and Infection. 139: 765- 771.

Phillips I. 2007. Withdrawal o f growth-promoting antibiotics in Europe and its effects in relation to human health. International Journal of Antimicrobial Agents.

Popelka P, Nagy J, Germuska R, Marcincak S, Jevinova P, De Rajik A. 2005. Comparison o f various assays used for detection o f /Mactam antibiotics in poultry meat. Food Additives and Contaminants. 22: 557-562.

Population Census Wing, BBS. 2011. Archived from the original on 2005-03-27. Retrieved August 10, 2020. http://www.bbs.gov.bd/home.aspx

Prakash B, Krishnappa G, Muniyappa L, Kumar BS. 2005. Epidemiological characterization o f avian Salmonella enterica serovar infections in India. International Journal of Poultry Science. 4 (6): 388-395.

Prescott JF. 2000a. Antimicrobial drug action and interaction: an introduction. In: Prescott JF, Baggot JD and Walker RD. (eds.) Antimicrobial Therapy in Veterinary Medicine, 3rd edn. Ames, Iowa, USA. 3-11 pp.

Prescott, J. F. 2000b. Beta-lactam antibiotics: penam penicillins. In: Prescott, J. F.., Baggot, J. D. and Walker, R. D. (eds.) Antimicrobial Therapy in Veterinary Medicine, 3rd edn. Ames, Iowa, USA, pp. 105-126.

Rana R. 1988. Residues of sulphaquinoxaline in poultry product. M.Sc. Thesis. Department o f Veterinary Pharmacology, University of Agriculture, Faisalabad. http://www.uaf.edu.pk/ (Accessed April 20, 2020).

Reyes-Herrera I, Schneider MJ, Cole K, Famell MB, Blore PJ, Donoghue DJ. 2005. Concentrations o f antibiotic residues vary between different edible muscle tissues in poultry. Journal o f Food Protection. 6 8 : 2217-2219.

Riveiere JE and Spoo JW. 1995. Chemical residues in tissues of food animals, in: Veterinary pharmacology and therapeutics 8 th Edn. (Edited by Adams HR) Iowa State Univ. press, pgs: 1148-115.

Rose MD, Bygrave J, Farrington W and Shearer G. 1997. The effect o f cooking on veterinary drug residues in food. Part 8 . Benzylpenicillin, Analyst, 122: 1095- 109.

Salem DA. 2004. Monitoring o f some antimicrobial residues in chicken from Assiut, Egypt. Envir. Encyclopaedia Ass. University: Shareef AM, Jamel ZT and Yonis KM. 2009. Detection of antibiotic residues in stored poultry products. Iraqi Journal o f Veterinary Sciences. 23:45-48.

Sarmah AK, Meyer MT and Boxall ABA. 2006. A global perspective on the use, sales, exposure pathways, occurrence, fate and effects of veterinary antibiotics (VAs) in the environment. Chemosphere. 65: 725-759. h t t p : / / w w w . m o a g .g o v . i l / N R / r d o n l y r e s / 8 7 D 4 8 0 3 7 - 9 7 3 C - 4 9 9 A - 9 8 A A - 45 References 8DE9D54F6A77/0/Use_sales_exposurepathwaysofveterinaryantibioticsinenviro nmentChemo2006.pdf (Accesscd July 22, 2020).

Snavely SR and Hodges GR. 1984. The neurotoxicity of antibacterial agents. Archives of Internal Medicine. 101:92-104.

Thangadurai S, Shukla SK and Anjaneyulu Y. 2002. Separation and detection of certain beta-Lactam and fluroquinolone antibiotic drugs by thin layer chromatography. Analytical Sciences. 18:97-101.

Tajick MA and Shohreh B. 2006. Detection of antibiotics residues in chicken meat using TLC. International Journal of Poultry Science. 5: 611-612.

Tinkelman DG and Bock SA. 1984. Anaphylaxis presumed to be caused by beef containing streptomycin. Annals o f Allergy. 53: 243-244.

Tollefson L and Miller MA. 2000. Antibiotic use in food animals: controlling the human health impact. Journal o f AO AC International. 83: 245-254.

Veterinary Residues Committee (VRC), 2005. Annual Report on surveillance for veterinary residues in Food in the UK. 11pp. http://collections.europarchive.org/tna/20100907111047/vmd.gov.uk/vrc/reports /vrcar2005.pdf (Accessed August 20, 2020)

Waltner-Toews D and McEwen S. 1994. Residues o f antibacterial and antiparasitic drugs in food of animal origin: a risk assessment. Preventive Veterinary Medicine. 20: 219-234.

Wang JH, Chao MR, Chang MH, Kuo TF, 2009. Liquid chromatographic determination o f amoxicillin residues in grouper muscle following oral administration o f the veterinary drug. Taiwan Veterinary Journal. 35: 21-28.

Weber NE. 1982. Bioavailability o f bound residues. Toxicological European Reasearch. 4: 271-275.

BIOGRAPHY

Myself, Selim Mia, son of Md Bakul Mia and Rahima begum was Born in 15 February, 1996. I started school when I was 6 years old. I have completed my primary education from Harishangan Govt. Primary School in 2006. From Harishangan High School I have completed my secondary education in 2012 and Higher Secondary education from Panchkandi College in 2014, Monohordi, Dhaka. At present I am continuing my education as an Intern Doctor under Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University. I have deep interest to work in the field of wildlife in future.