2014

Antimicrobial use in the poultry industry in Dar-es-Salaam, Tanzania and public health implications

Mubito, Ezekiel

American Journal of Research Communication

Antimicrobial use in the poultry industry in Dar-es-Salaam, Tanzania and public health implications

Ezekiel P. Mubito, Francis Shahada, Martin E. Kimanya and Joram J. Buza

School of Life Science and Bio Engineering, Nelson Mandela African Institution of Science and Technology, Arusha Tanzania
*__Corresponding author__: Joram Buza, E-mail: joram.buza@nm-aist.ac.tz

Abstract

A structured questionnaire was administered to Dar es Salaam poultry farmers and pharmaceutical outlets/shops to obtain information on antibiotic usage, awareness of withdrawal periods and public health concerns on drug residues. Of 100 layer's chicken production farmers interviewed in this study, 54% were females and 46% males. The average flock size was 560. All interviewed participants apply antibiotics through oral route of drug administration. Of these participants, 93% treat their chicken in accordance with directives from veterinary drug vendors, 4% follow the manufacturer's instructions and 3% depends on their own experience. The survey found that most frequently used antibiotic drugs belong to the group of tetracycline and sulfonamides. Furthermore, some prohibited antimicrobial agents like furazolidone were found in some veterinary drug stores and poultry farms. All interviewed poultry farmers were aware of drug withdrawal period but none of them declared to observe this requirement because they fear investment losses. It was concluded that there is high risk of exposure to unacceptable levels of drug residues from poultry products, as a result of failure to observe antibiotic withdrawal periods. Consulted efforts involving various stake holders such the producers of poultry products, consumers and regulatory authorities are needed to bring awareness on public health implications associated with drug residues in foods.

Key words: antibiotic residues, poultry products, tetracycline, sulphonamides, Tanzania

{**Citation:** Ezekiel P. Mubito, Francis Shahada, Martin E. Kimanya and Joram J. Buza. Antimicrobial use in the poultry industry in Dar-es-Salaam, Tanzania and public health

implications. American Journal of Research Communication, 2014, 2(4): 51-63} www.usa-journals.com, ISSN: 2325-4076.

Introduction

The poultry industry in Tanzania like any other developing country consist of traditional and commercial production system (Goromela *et al.*, 2007). The Ministry of livestock and Fisheries development estimated the poultry population in Tanzania at 58 million birds which include 23 indigenous, 35 commercial and 1.2 million ducks (Msami, 2008). Indigenous chickens are the major types found in the traditional system and covers over 70% of the national flock, supplying most of the poultry meat and eggs consumed in rural areas and about 20% in urban areas (Minga *et al.*, 2001; Msami, 2008). The productivity of commercial chicken is very high and its production is always concentrated in big cities and towns, contributing more than 80% of all eggs consumed in urban and peri-urban areas (Msami, 2008). Chicken farming in Tanzania is growing due to increased demand of poultry meat and eggs for protein supplementation (Nonga *et al.*, 2009). However, both commercial and traditional poultry systems are constrained by diseases as a consequence to poor quality feeds, inadequate technical support services, low genetic potential of the local breed and weak farmer organizations (Njombe and Msanga, 2010; Lwelamira, 2012).

In order to meet the growing global population; chicken are commercially reared as broilers for meat or layers for eggs, under intensive management system. Veterinary drugs are essential in intensive system of poultry production where they are used for therapy, prophylaxis and for growth promotion (Donoghue, 2003; Doyle, 2006; Singer and Hofacre, 2006; Löhren *et al.*, 2009). Antimicrobials are supplemented in poultry feeds at sub-therapeutic levels for the following reasons (i) growth improvement, (ii) prevention/reduction of disease outbreaks, (iii) improving digestion, (iv) acceleration of weight gain, and (v) increase in feed conversion ratio (Donoghue, 2003; Dibner and Richards, 2005; Sawant *et al.*, 2005). The rationale for prophylaxis stems from the fact that antibiotics are more efficient when used for prevention rather than for therapeutics (Gustafson and Bowen, 1997). However, misuse of antimicrobials may lead to carryover of residuies in animal products which may lead to detrimental effects on

consumers and public health in general (Anderson *et al.*, 2003;Hurd *et al.*, 2004;Kabir *et al.*, 2004).

In order to ensure safety of global health, the international recognized bodies such as Codex Alimentarius Commission which is a Joint FAO/WHO body for food standardization and the European Union have established a series of maximum residue limit for veterinary drugs in edible tissues of animal origin (Reig and Toldrá, 2008; Turnipseed and Andersen, 2008; Peters *et al.*, 2009).

In Tanzania, legislations regarding antibiotic drug application in farm animals as well as monitoring and control of their residues are not adequately enforced (Nonga *et al.*, 2009). The inadequacy has probably led to the reported high rates of antimicrobial residues in poultry products. For example, 100% of screened eggs were positive for antimicrobial residues in a study conducted in Morogoro, 2010 (Nonga *et al.*, 2010). Another study also conducted in Morogoro, 2009 indicated that 50% of broiler tissues were positive while 70% of the chicken farms visited were positive to antimicrobial residues (Nonga *et al.*, 2009). In addition, studies conducted in the same region reported elevated levels of antimicrobial residues in milk, beef and chicken meat (Kurwijila *et al.*, 2006; Nonga *et al.*, 2009). Dar es Salaam is the largest producer and consumers of commercial chicken products in Tanzania (Msami, 2008), but information related to antimicrobial application in poultry production in the city is not available. To address this gap, this study was conducted to assess antibiotics application pattern in poultry farming in Dar es Salaam.

Materials and Methods

Study area

This study was conducted in Dar es Salaam which is the largest city in Tanzania. Dar es Salaam is the major centre for commercial chicken production and the major consumer of poultry products in Tanzania (Msami, 2008). Within the city, there are numerous fast food vendors along the streets, in bars and hotels whose menu is mainly comprised of chicken meat and eggs.

Generally, the city represents the small, medium and large commercial chicken farms in the country.

Poultry farms selection

A total of 100 commercial chicken farms comprising of medium and large scale producers were randomly selected from different wards to participate in this antibiotic usage survey. At least three wards were randomly selected from each of the three districts in Dar es Salaam region. The study wards included Kitunda, Kipunguni, Chanika and Tabata/Segerea in Ilala District; Kigamboni, Mbagala and Mtoni kijichi in Temeke District; and Wazo Hill Kiluvya and Kibamba in Kinondoni District.

Questionnaire survey

A semi structured questionnaire was administered to the randomly selected chicken keepers for the purpose of collecting information about common antibiotics drugs used, how and when they are used, and reason for using antibiotics. Information on awareness of specific drug withdrawal periods and any known health effect of antibiotics residues to public health was also sought. To obtain specific information on antibiotics used during the study period; all used drugs sachets and empty bottles were collected and the data recorded. Also information on frequently sold antibiotics was sought from veterinary drug store owners in the study area, which are common sellers of veterinary drugs to farmers in each study ward. The data was coded, entered into an excel sheet and then analysed using Microsoft Excel 2007.

Results

Types or formulations of antimicrobials in use

Different antibiotics which are in different groups are sold in Dar es Salaam. The observed groups of antibiotics are shown in (Table 1).

Table 1: The antibiotic and antimicrobial agents available in veterinary pharmaceutical stores in Dar es Salaam

Trade name	Antibiotic ingredients
Aliseryl	Erythromycin thiocyanate 35 mg, Oxytetracycline (OTC) 50 mg, Streptomycin sulphate 35 mg, Colistin sulphate 200000 IU, Vitamins, Minerals
OTC 20%, 50%	Oxytetracycline, hydrochloride 20%, 50%
Neobact	Neomycin sulphate 30 % w/w
Trisulmycine	Sulfadiazine 18.68 g, Trimethoprim 4 g
Limoxin	Oxytetracycline hydrochloride
Neoxyvital	OTC hydrochloride, Neomycin sulphate, Vitamins, Trace elements
Amprolium 20%	Amprolium hydrochloride
Coridix	Sulfamethoxypyridazine 125 mg/g, Trimethoprim 25 mg/g, Tylosin 30 mg/g, Sodium sulphate
Piperine	Piperazine citrate
Doxycol	Doxycycline hyclate 5000 mg/g, Colistin sulphate 5000 mg/g
Tetracolivit	Colistin sulphate 7 g, OTC 10 g
20% CTC	Chlortetracycline hydrochloride 20%
Agracox	Oxytetracycline 100 mg/g, Pyrimethamine 25 mg/g, Sulfadiazine sodium, Sulfadimerazine sodium, and Vitamins
Esb3	Sulfachloropyrazine 30%, Sodium monohydrate
Oxytet 50%	Oxytetracycline 50%
Amprolium 20%	Amprolium hydrochloride
Typhoprim	Sodium sulfadiazine, Trimethoprim
Ashoxy Egg	Oxytetracycline 6 g/100 g, Vitamin, Minerals
Fluquin	Enrofloxacin
Fluban	Enrofloxacin 100 mg/ml
Ganadexil	Enrofloxacin 10 g/100 ml
Flumequine	Flumequine 100% w/w, Sodium sulphate 1g
Anflox gold	Norfloxacin 20%
Poltricin Mayai	Oxytetracycline 25 mg, Vitamins, Minerals
Coccid	Amprolium hydrochloride 20%
Astrisul 480	Sulphadiazine-trimethoprim
Novamox	Amoxicillin trihydrate 75 %w/w, Amoxicillin BP
Amprolium	Amprolium hydrochloride
Eggmycin	Oxytetracycline 55 g/kg, Vitamins, Minerals
Anticox	Diaveridine sulfadimidine sodium
Ancoban	Amprolium hydrochloride, Sodium sulphate
Vitox	Oxytetracycline 55 mg/g, Vitamins, Minerals
Trimazin	Sulfadiazine 250 mg/g, Trimethoprim 50 mg/g
Extra egg formula	Oxytetracycline 50 mg/g, Vitamins, Minerals
Neotreat	Neomycin sulphate, Oxytetracycline 61.38 mg, Vitamins, Minerals
Levoral 75%	Levamisole hydrochloride 750 mg/g
Intertrim	Sulfamethoxazole 200 mg/ml, Trimethoprim 400 mg/ml
Koksidex	Amprolium hydrochloride100 mg/g, Vitamin K3 2 mg/g, Sulfaquinoxalline 100 mg/g
Alamycin Egg Formula	Oxytetracycline 5 %w/w, Vitamins, Minerals
Oxyvit Plus	Oxytetracycline 60 g/kg, Vitamins, Minerals
Tylosin	Tylosin tartarate
Colivit-OTC	Colistin sulphate 3.5 g+ Oxytetracycline 100 g, Vitamins, Minerals
Coccivet	Sulfadimidine sodium 800 mg, Diaveridine 80 mg
Amcox	Amprolium 200 mg/g
Skazon	Furazolidone
Prococ	Amprolium hydrochloride 200 mg/g, Sulfaquinoxalline, Vitamin K3

Drug use pattern and chicken production in Dar es Salaam

(i) Flock size and farmer's occupation

Of 100 layer's chicken production farmers interviewed in this study, 54% were females and 46% were males**.** The predominant age group involved in chicken farming business ranged from 31-40 years (60%) followed by 41-50 years (23%), 20-30 years (12%) and lastly, 51-60 years old (5%). The average flock size was 560, with a minimum numbers being 200 while the maximum number was 6000. Furthermore, the survey found that about 77% of layer chicken keepers are typically involved in poultry farming activities only, while 13% were employed at others organization and 10% were self-employed, apart from chicken keeping.

(ii) Choice of antibiotics for use

All interviewed participants acknowledged that they frequently apply antibiotics in chicken production, either for treatment or prevention of diseases. The most used drugs belong to different groups of antibiotics. But farmers preference was in the following order; tetracyclines (32.2%), sulfonamides (20.8%), fluroquinolones (9.8%), macrolides (9.4%), polypeptides (8.0%), amprolium (6.5%), aminoglycosides (6.4%), trimethoprim (5.5%), furazolidone (0.8%) and quinoxalines (0.4%).

Application of antibiotics and antimicrobials and awareness of public health implications

All antimicrobials used were administered through drinking water. Up to 93% of farmers reported that they treat their flock themselves after receiving advice from veterinary drug vendors, 4% declared that they follow manufacturer's instructions while 3% depends on their own experience. On the other hand, 83% reported to apply antibiotics to their chicken as soon as clinical symptoms appear, 11% uses antibiotics for prevention of infectious diseases whereas 6% use antibiotics drug as routine animals husbandly. When asked if there is any known restriction for application of certain group of antibiotics in layers chicken production, about 93% of respondent were unaware, whereas 7% said that some antibiotics are restricted during the laying period while other groups of antibiotics are strictly prohibited in layers production. All interviewed chicken producers were aware of antimicrobial withdrawal periods but none of them

declared to observe it due to fear of capital losses. It was further found that about 90% of farmers had no knowledge about health effect associated with antibiotic dugs residues.

Discussion

This survey was aimed at studying antibiotics use patterns and practice in the Dar es Salaam chicken production industry to obtain information that will be informative for public health and policy. All chicken farmers interviewed use antibiotics routinely and the majority of whom apply antibiotics to their flock for therapy rather and growth enhancement. This result was predicted due to facts that small and medium scale farmers may not afford the cost of sub-therapeutic application of drugs against infectious diseases. The survey also showed that all poultry farmers apply antibiotics for therapy via oral route by mixing in drinking water. This is mainly due to the fact that antibiotics formulations commonly used can easily be dissolved in water even at low dose concentration than mixing in feeds. Another reason brought forward is that sick birds may stop eating but will continue drinking water.

The survey found that tetracycline and sulfonamides were the most used drugs in poultry production in Dar es Salaam. The two anti-microbials have long history worldwide for application in poultry production both for therapy, prophylaxis or sometimes used for growth promotion. Tetracycline is very active against mycoplasma, Gram positive and Gram negative bacteria (Sirdar, 2010). On other hand, sulfonamides are used in chicken for treatment and prevention of coccidiosis which is the most important disease affecting chicken industry worldwide (Donoghue, 2003;Sirdar *et al.*, 2012b). The popularity of tetracycline and sulfonamides emanates from their availability at affordable price in different proportions as a single parent drug or in combinations with other different antibiotic agents, vitamin and minerals. The popularity of tetracycline and sulfonamides in poultry industry was also reported in other studies conducted in Morogoro, Tanzania (Nonga *et al.*, 2009) and in other countries such as Kuwait, Saud Arabia, Sudan and Kenya (Al-Ghamdi *et al.*, 2000; Mitema *et al.*, 2001; Al-Mazeedi *et al.*, 2010; Sirdar, 2010).

The study observed that antimicrobial agents that are prohibited for use in food-producing animals like skazon (furazolidone) were used as coccidiostats in some sections of Dar es Salaam. Furazolidone and other nitrofurans (furaltadone, nitrofurazone and nitrofurantoin) are prohibited within European Union (Commission Regulation 1995) and the USA for administration in food producing animals due to their carcinogenic and mutagenic effects, but they are still used in pet animals.(Franek *et al.*, 2006;Cooper and Kennedy, 2007). Despite its effectiveness against exceptionally antibiotic resistant infections (Kennedy, 2004), furazolidone exhibit various adverse effects even at lowest therapeutic concentrations (Vass *et al.*, 2005; McCracken and Kennedy, 2007; Thongsrisomboon *et al.*, 2010; Yibar *et al.*, 2012). But because of their availability at affordable cost, nitrofuran are abused especially in low income countries (Shitandi *et al.*, 2008). This observation correlate with other studies conducted in EU. In these studies, nitrofuran contamination was found in animal products from Taiwan, Indonesia, Malaysia, India, Bulgaria, France, Spain Germany and Italy (Vass *et al.*, 2005). Also the study conducted in Turkey and Portugal reported positive nitrofuran residues in chicken products (Cooper and Kennedy, 2007;Yibar *et al.*, 2012). The battle against antimicrobials abuse in food producing animals is of great concern in food safety. Unfortunately, most research on antimicrobial residues in poultry products in Tanzania and other East African countries are focused on approved drugs (Sasanya *et al.*, 2005;Kurwijila *et al.*, 2006). Findings of this study indicate that prohibited drugs such as nitrofuran, chloramphenicol and clenbuterol should also be included in surveys that target monitoring of drug residues in poultry products.

Based on responses received from respondents in Dar es Salaam, it is evident that antibiotics used by poultry farmers are not used as per prescription by Veterinarians or qualified personnel. Most poultry farmers admitted to relying on directives from drug store vendors most of whom are not necessarily qualified to do so. Other farmers depended on their own experience for antimicrobial administration although drug formulations available keep changing from time to time. These findings from Dar es Salaam are comparable to results from studies conducted in Morogoro Tanzania which reported that, about 90% of broiler chicken farmers get advice from drug sellers for dosage prescription (Nonga *et al.*, 2009). The application of antimicrobials in feeds or water without proper information on dosage rates may lead to underdosage or overdosage both of which may be detrimental to chicken and public health. The possible reasons for these observations include drug stores being run by unqualified personnel, drug leaflets are

written in English language which may not be understood by users, and poor or lack of enforcement of law related to drug prescription (Tanzania Food, Drugs and Cosmetic Act No 1, 2003 (74)). It is therefore evident that what is lacking is not the presence of appropriate laws, but rather, the lack of enforcement of available laws.

Another important observation of this study is the fact that, all interviewed chicken producers have knowledge of antibiotics withdrawal period but none of them declared to observe it due to fear of capital losses. Non adherence to antibiotic withdrawal periods is the major causatives of antimicrobial residues in foods of animal origin (Donoghue, 2003; Doyle, 2006; Passantino and Russo, 2008; Young *et al.*, 2010). Findings from this study agree with previous studies in Tanzania which reported that, about 80% of chicken farmers had knowledge on drugs withdrawal period but sold eggs within withholding times (Nonga *et al.*, 2010). Similar observations were reported in Uganda (Sasanya *et al.*, 2005), Sudan and Ghana (Annan-Prah *et al.*, 2012; Sirdar *et al.*, 2012c). One possible reason for failure to observe withdrawal period by poultry producers is lack of knowledge on public health implications of drug residues in food stuffs. Furthermore, some farmers thought adherence to withdrawal period is a voluntary issue rather than regulatory one. It is therefore important for regulatory authorities to make it clear to producers that observation of drug withdrawal periods shall not be left a voluntary issue but mandatory one (Löhren *et al.*, 2009).

Finally the study found that about 90% of poultry farmers in Dar es Salaam have no knowledge of antibiotic restrictions and adverse effects of residues to public health. This result correlate with other previous studies which suggest that, almost 85% poultry farmers in Morogoro were unaware of possible effects of drugs residues in human health (Nonga *et al.*, 2009). Another study conducted in Khartoum, Sudan reported that poultry farmers lack knowledge about antimicrobial residues and the risk associated by the consumption of residues (Sirdar *et al.*, 2012c). Consulted efforts are needed to create awareness on detrimental public health consequences associated with misuse of antibiotics.

Conclusion

Failure to observe antibiotics withdrawal periods by poultry farmers in Dar es Salaam is likely to expose consumers to products containing residues above tolerable limits. Responsible authorities should immediately kick off implementation of regulations associated with antimicrobial administrations in poultry production and monitoring programs.

Acknowledgements

The authors would like to thank the Tanzania Commission for Science and Technology (COSTECH) who sponsored the study through the Nelson Mandela African Institution of Sciences and Technology (NM-AIST).

References

Al-Ghamdi, M. ;Al-Mustafa, Z. ;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.

Al-Mazeedi, H. M. ;Abbas, A. B. ;Alomirah, H. F. ;Al-Jouhar, W. Y. ;Al-Mufty, S. A. ;Ezzelregal, M. M. and Al-Owaish, R. A. (2010). *Screening for tetracycline residues in food products of animal origin in the State of Kuwait using Charm II radio-immunoassay and LC/MS/MS methods*. Food Additives and Contaminants, 27 (3): 291-301.

Anderson, A. D. ;Nelson, J. M. ;Rossiter, S. and Angulo, F. J. (2003). *Public health consequences of use of antimicrobial agents in food animals in the United States*. Microbial Drug Resistance, 9 (4): 373-379.

Annan-Prah, A. ;Agbemafle, E. ;Asare, P. and Akorli, S. (2012). *Antibiotic use, Abuse and their Public Health Implication: The Contributory role of management Flaws in the Poultry Industry in two Agro-Ecological Zones in Ghana*. Journal of Veterinary Advance, 2 (4): 199-208.

Cooper, K. M. and Kennedy, D. G. (2007). *Stability studies of the metabolites of nitrofuran antibiotics during storage and cooking*. Food Additives and Contaminants, 24 (9): 935-942.

Dibner, J. and Richards, J. (2005). *Antibiotic growth promoters in agriculture: history and mode of action*. Poultry Science, 84 (4): 634-643.

Donoghue, D. J. (2003). *Antibiotic residues in poultry tissues and eggs: human health concerns?* Poultry Science, 82 (4): 618-621.

Doyle, M. (2006). *Veterinary drug residues in processed meats-potential health risk*. Food Research Institute (FRI Briefings),

Franek, M. ;Diblikova, I. ;Vass, M. ;Kotkova, L. ;Stastny, K. ;Frgalova, K. and Hruska, K. (2006). *Validation of a monoclonal antibody-based ELISA for the quantification of the furazolidone metabolite (AOZ) in eggs using various sample preparation*. Veterinarni Medicina-Praha, 51 (5): 248.

Goromela, E. ;Kwakkel, R. ;Verstegen, M. and Katule, A. (2007). *Identification, characterization and composition of scavengeable feed resources for rural poultry production in Central Tanzania. African*. Journal of Agricultural Research, 2 (8): 380-393.

Gustafson, R. and Bowen, R. (1997). *Antibiotic use in animal agriculture*. Journal of Applied Microbiology, 83 (5): 531-541.

Hurd, H. S. ;Doores, S. ;Hayes, D. ;Mathew, A. ;Maurer, J. ;Silley, P. ;Singer, R. S. and Jones, R. N. (2004). *Public health consequences of macrolide use in food animals: a deterministic risk assessment*. Journal of Food Protection, 67 (5): 980-992.

Kabir, J. ;Umoh, V. ;Audu-Okoh, E. ;Umoh, J. and Kwaga, J. (2004). *Veterinary drug use in poultry farms and determination of antimicrobial drug residues in commercial eggs and slaughtered chicken in Kaduna State, Nigeria*. Food control, 15 (2): 99-105.

Kennedy, G. Analytical methods for nitrofurans: Lessons to be learned and new developments. In*: Joint FAO/WHO Technical Workshop on Residues of Veterinary Drugs without ADI/MRL, Bangkok, Thailand*. 2004; City; Country; 87-91.

Kurwijila, L. ;Omore, A. ;Staal, S. and Mdoe, N. (2006). *Investigation of the risk of exposure to antimicrobial residues present in marketed milk in Tanzania*. Journal of Food Protection, 69 (10): 2487-2492.

Löhren, U. ;Ricci, A. and Cummings, T. S. (2009). *Guidelines for antimicrobial use in poultry*. Guide to antimicrobial use in animals. Blackwell Publishing, Oxford, United Kingdom, 126-142.

Lwelamira, J. (2012). *Genotype-Environmental (G x E) Interaction for Body Weights for Kuchi Chicken Ecotype of Tanzania Reared On-Station and On-Farm*. International Journal of Poultry Science, 11 (2): 96-102.

Malik, H. E. ;Omer, J. E. and Elamin, K. M. (2013). *Effect of Sulfanomides Residues on Egg Quality Traits*. International Journal of Poultry Sience, 12 (5): 312-317.

McCracken, R. and Kennedy, D. (2007). *Detection, accumulation and distribution of nitrofuran residues in egg yolk, albumen and shell*. Food Additives and Contaminants, 24 (1): 26-33.

.

Minga, U. ;Mtambo, M. ;Katule, A. ;Mutayoba, S. ;Mwalusanya, N. ;Lawrence, P. ;Mdegela, R. and Olsen, J. Improving the health and productivity of the rural chicken in Africa: research and development efforts in Tanzania. In*:* 2001; City; Country; 134-139.

Mitema, E. ;Kikuvi, G. ;Wegener, H. C. and Stohr, K. (2001). *An assessment of antimicrobial consumption in food producing animals in Kenya*. Journal of veterinary pharmacology and therapeutics, 24 (6): 385-390.

Msami, H. (2008). *Poultry sector country review*. Central Veterinary Laboratory Dar es Salaam, Tanzania, 61.

Njombe, A. and Msanga, Y. (2010). *Livestock and dairy industry development in Tanzania*. Ministry of Livestock Development and Fisheries, ed. Dar es Salaam: United Republic of Tanzania, 17

Nonga, H. ;Mariki, M. ;Karimuribo, E. and Mdegela, R. (2009). *Assessment of antimicrobial usage and antimicrobial residues in broiler chickens in Morogoro Municipality, Tanzania*. Pakistan Journal of Nutrition, 8 (3): 203-207.

Nonga, H. ;Simon, C. ;Karimuribo, E. and Mdegela, R. (2010). *Assessment of Antimicrobial Usage and Residues in Commercial Chicken Eggs from Smallholder Poultry Keepers in Morogoro Municipality, Tanzania*. Zoonoses and Public Health, 57 (5): 339-344.

Passantino, A. and Russo, C. (2008). *Maximum Residue Levels of Veterinary Medicines in Relation to Food Safety: European Community Legislation and Ethical Aspects*. Journal of Consumer Protection and Food Safety, 3 (4): 351-358.

Peters, R. ;Bolck, Y. ;Rutgers, P. ;Stolker, A. and Nielen, M. (2009). *Multi-residue screening of veterinary drugs in egg, fish and meat using high-resolution liquid chromatography accurate mass time-of-flight mass spectrometry*. Journal of Chromatography A, 1216 (46): 8206-8216.

Reig, M. and Toldrá, F. (2008). *Veterinary drug residues in meat: Concerns and rapid methods for detection*. Meat Science, 78 (1-2): 60-67.

Sasanya, J. J. ;Ikeng, J. W. O. ;Ejobi, F. and Muganwa, M. (2005). *Use of sulfonamides in layers in Kampala district, Uganda and sulfonamide residues in commercial eggs*. African Health Sciences, 5 (1): 33-39.

Sawant, A. ;Sordillo, L. and Jayarao, B. (2005). *A survey on antibiotic usage in dairy herds in Pennsylvania*. Journal of Dairy Science, 88 (8): 2991-2999.

Shitandi, A. A. ;Aila, O. ;Ottaro, S. ;Aliong'o, L. ;Mwangi, G. ;Kumar-Sharma, H. and Joseph, M. (2008). *Effect of deep frying on furazolidone anticoccidial drug residues in liver and muscle tissues of chicken*. African Journal of Food Science, 2 (12): 144-148.

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

Sirdar, M. M. (2010). *Antibiotic residues in commercial layer hens in Khartoum state, Sudan, 2007-2008.* University of Pretoria.

Sirdar, M. M. ;Picard, J. ;Bisschop, S. ;Jambalang, A. R. and Gummow, B. (2012b). *A survey of antimicrobial residues in table eggs in Khartoum State, Sudan, 2007–2008*. Onderstepoort Journal of Veterinary Research, 79 (1): 01-09.

Sirdar, M. M. ;Picard, J. ;Bisschop, S. ;Jambalang, A. R. and Gummow, B. (2012c). *A survey of antimicrobial residues in table eggs in Khartoum State, Sudan, 2007–2008*. Onderstepoort Journal of Veterinary Research, 79 (1): 9

Thongsrisomboon, P.; Liawruangrath, B. ;Liawruangrath, S. and Satienperakul, S. (2010). *Determination of nitrofurans residues in animal feeds by flow injection chemiluminescence procedure*. Food Chemistry, 123 (3): 834-839.

Turnipseed, S. B. and Andersen, W. C. (2008). *Veterinary drug residues*. Food Contaminants and Residue Analysis. Comprehensive Analytical Chemistry Series, 51 307-338.

Vass, M. ;Kotkova, L. ;Diblikova, I. ;Nevorankova, Z. ;Cooper, K. ;Kennedy, D. and Franek, M. (2005). *Production and characterisation of monoclonal antibodies for the detection of AOZ, a tissue bound metabolite of furazolidone*. Veterinarni Medicina-Praha, 50 (7): 300.

Yibar, A. ;Cetinkaya, F. and Soyutemiz, G. E. (2012). *Nitrofuran Metabolite 3-amino-2-oxazolidinone Residues in Chicken Liver: A Screening Study*. Asian Journal of Animal and Veterinary Advances, 7 (4): 346-350.

Young, I. ;Rajic, A. ;Letellier, A. ;Cox, B. ;Leslie, M. ;Sanei, B. and McEwen, S. A. (2010). *Knowledge and attitudes toward food safety and use of good production practices among Canadian broiler chicken producers*. Journal of Food Protection®, 73 (7): 1278-1287.