Assessment of veterinary drug use and determination of antimicrobial residues in broiler chicken meat in Urban district, Zanzibar, Tanzania

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SUMMARY

A cross-sectional study was conducted between October 2009 and January 2010 to assess veterinary drug usage by broiler chicken farmers and to determine antimicrobial residues in broiler meat in Urban district, Zanzibar, Tanzania. Fifty five smallholder farmers were interviewed on types of antimicrobials, reasons for use, their awareness on antimicrobial withdrawal periods and effects of antimicrobial residues in humans. Interviews with key informants were used to supplement the information from farmers. Up to 66% of the respondents were aware of drug withdrawal periods, however, only 45.5% reported to comply in fear of losses and limited awareness of health effect associated with antibiotic residues. Key informants reported that there was no inspection of chicken meat for residues and the indiscriminate use of veterinary drugs was fueled by trade liberalization. To determine antibiotic residues, 72 broiler meat samples were analysed by agar well diffusion and Delvo tests. Laboratory results indicated that 76.4% of the broiler meat samples contained antimicrobial residues. High proportion of positive samples in this study suggests that there is high risk of public exposure to antimicrobial residues through consumption of chicken meat in Urban district. Poultry farmers should be educated on the importance of drug withdrawal periods and the possible human health effects associated with consumption of foods with antimicrobial residues. It is further stressed that there is a need for stricter regulation regarding the use of veterinary drugs in particular antimicrobials in the poultry industry as well as the inspection of meat for residues prior to marketing.

Key words: Broiler chicken, antimicrobial residues, Zanzibar

INTRODUCTION

According to National Sample Census of Agriculture (2003), the chickens population in Zanzibar was 1 063 796 kept by 66 736 households. The population of broiler chicken in Zanzibar island was 23 851 in 2003 which is 20% of all improved chickens (NSCA, 2003). Poultry keeping in developing countries generally follows the traditional lines whereby mostly involves local chickens. The traditional or extensive poultry production, which depends on scavenging poultry in the rural areas constitute up to 89% of the total population of 56 million chickens in Tanzania (NSCA, 2003). The intensive (commercial) systems of productions deals with improved breeds (layers and broilers) and constitutes 11% of chicken population and it is mostly found in urban areas (NSCA, 2003).

The development of commercial chicken production in Tanzania is hindered by

many factors which include poor availability of good quality feeds and medicines, diseases, inadequate technical support services, low genetic potential, labour, markets and capital, extension services, equipment and inadequate knowledge in keeping of the chickens (Msoffe, 2003; Njombe and Msanga, 2009). Chicken farmers strive in many ways to overcome some of the problems. For example, there have been excessive indiscriminate uses of various types of chemotherapeutic agents in chicken production so as to boost growth rate, to treat and control of diseases, and to abate the risk of losses (Nonga *et al.*, 2010). Inadequate extension services and animal health delivery systems in the country have necessitated farmers to buy antimicrobials from veterinary shops and administer to chicken by themselves. Under such kind of practices correct dosages are unlikely to be observed and antibiotics/antimicrobials may be found in tissues, particularly when the birds are slaughtered without the observance of withdrawal period (Nonga *et al.*, 2009).

Antimicrobial residues in animal tissues above maximum residue limits (MRLs) clearly have an impact on human health. Concerns have been expressed about possible harmful effects on humans through the indiscriminate use of antimicrobials including increased production of antibiotic resistant strains of bacteria, allergic or anaphylactic reactions to antimicrobials in susceptible individuals, direct drug toxicity and cancer problems (Simonsen *et al.*, 1998; Sunpetch *et al.*, 2005). The public health risk to antimicrobial residues seems particularly high in developing countries, where there may be no local legislations regulating maximum tolerance limits for marketed products and where even recommended withdrawal times are readily violated. Therefore studies on antimicrobial status in foods for human consumption is of paramount important for public health information and to take right measures to prevent health problems. There is limited information on status of antimicrobial uses and residues in commercial chicken meat in Zanzibar. The current study aimed to assess veterinary drug usage and determine antimicrobial residues in broiler chicken meat in Urban district, Zanzibar, Tanzania. This baseline data is of great use to stakeholders in poultry industry, public health officials and the public at large in Zanzibar.

MATERIALS AND METHODS

Study area and sources of broiler meat samples

The study was conducted in Urban district, which is in Urban West region Zanzibar, United Republic of Tanzania. Geographically, Zanzibar is located between $6^0$10' S latitude and 39^0 20' E longitudes (LLWC, 2007) and is 64.36 km away from Tanzania mainland. Urban district has 44 Wards and 15 of them were involved in the study namely Amani, Chumbuni, Karakana, Kidatu, Kilimahewa bondeni, Kwamtipura, Mtopepo, Mkele and Mikunguni. Others were Muungano, Mpendae, Mingombani, Mwembe makumbi, Shaurimoyo and Sebleni. These wards were involved in this study because had higher number of poultry keepers. Key informants (livestock officers, medical personnel and veterinary drug shop owners/sellers) were selected from Urban district livestock office, district hospital and selected veterinary drug shop owners/sellers. Some selected hotels, chicken meat shops and kiosks, chicken slaughter canters (Zanzibar central market and New Mwanakwerekwe market) were used as sources of broiler meat samples. In addition, secondary data on type and amount of antimicrobials commonly sold

were obtained from five shops, which were main sellers of veterinary drugs to farmers in the Urban district, namely, Kalamao Farmers, Hash Medics, Mifugo Care and two PADEP shops. All the laboratory work was conducted in the laboratories of the Faculty of Veterinary Medicine, Sokoine University of Agriculture, Morogoro, Tanzania.

Questionnaire survey and broiler meat sampling

The populations from which the respondents were drawn involved heads of households with chicken in the selected wards. Simple random sampling technique was used to select 3 - 4 households with chicken from each ward. The process involved listing of all names of households which kept chickens in each ward, recorded and fold each on a small pieces of paper, shuffled and picked the folded papers at random. However, farmers who were not willing to participate in the study were excluded and being replaced by others who were also obtained through random sampling. Questionnaires were administered to selected chicken farmers to collect information on drug use, type of antibiotics/antimicrobials, purpose of drug use and observance of withdrawal period. In addition, key informants were interviewed on types and amount of veterinary drug used, availability of professional advice on the uses of antibiotics/antimicrobials, diagnosis and treatment of chicken diseases and if there was health effects noted due to veterinary drug toxicity in Urban district.

Broiler chicken carcasses were purposively selected based on willingness and cooperation of chicken owners. Specifically, sources of broiler meat samples were farmers with chicken at slaughter age (7 – 8 weeks), chicken slaughter centres, hotels, chicken meat shops and kiosks. Freshly dressed carcasses were purchased from each participating household or centres and 50 g of breast muscles was cut and packed in separate clean plastic bag, labeled accordingly and stored in cool box with ice pack during field sampling. All the samples were subsequently transported to the laboratory at the Faculty of Veterinary Medicine, Sokoine University of Agriculture, and stored at -20°C until analysis.

Broiler meat sample processing and antimicrobial residues detection

Five gram of thawed meat were minced in 5 ml of sterile distilled water and homogenized using a blender for 5 min and then centrifuged for 5 min at 5000 rpm. The supernatant was decanted into a sterile test tube as muscle tissue extract and used in antimicrobial residues analysis. The same procedures were done for local chicken meats (two samples) which were prepared from the antibiotic free flock to be used as a negative control. The local chicken meat sample tissue extracts collected from the antibiotic free chicken were subjected to the Delvo test SP assay and agar well diffusion test before used as the control samples.

Assessment of antimicrobial residues in broiler muscle tissue extract samples was carried out in duplicate using two bacterial growth inhibition tests namely Delvo SP® kit (SP mini kit; Delft, the Netherlands) that used *Bacillus stearothermophilus* var. *calidolactis* and agar well diffusion test that used *Bacillus subtilis* as the test organism. Gentamycin 5% (Laprovet®, Indre Et Loire, France) was used in validation of agar well method for the zone of bacterial growth inhibition and used as a positive control.

For the Delvo SP® kit, 100 µl of muscle tissue extract was pipetted into the ampoule

with nutrient tablet. Each time the test was run together with positive and negative controls. The ampoules were incubated in a water bath with a controlled temperature of 64.0 ± 0.5°C for 3 hr. For comparisons with the colour of the ampoule containing the control tissue extract sample, a complete purple (blue-violet) colour throughout the whole gel indicated a positive result to antimicrobial residues as they inhibit the growth of the tested strain, *Bacillus stearothermophilus* var. *colidolactis*. For the negative results, the tested strain grew, leading to a colour change of the pH indicator from blue-violet to yellow.

In agar well diffusion method, antibiotic residues was tested on Muller Hinton (MH) Agar (Oxoid Ltd, Basingstoke, UK) by disc diffusion method as described by Luangtongkum *et al.* (2007). Uniform streaking of *Bacillus subtilis* was done followed by creating wells on the media using sterile boring glass rods. A 100 µl of the test muscle tissue extract was pipetted in the wells and the plates were incubated at 37ºC for 24 hours. The tests were performed in duplicate. Positive and negative control wells were also included in each culture plate as stated above. The cultures were examined for bacteria growth inhibition zone after 24 hrs of incubation and the diameters of inhibition zones were measured with slipping calipers.The iterpretation of diameter measurements as sensitive and resistant was as per the general guidelines according to National Committee for Clinical Laboratory Standards (NCCLS), (2002).

RESULTS

Broiler chicken management and common diseases reported by farmers

A total of 55 smallholder broiler chicken farmers were interviewed in the selected households from 15 wards in Urban district. The median flock size was 350 (ranged 100 – 1600). The chickens were managed under deep litter intensive system and chicken house floor was normally covered with wood shavings or rice husks as litter materials. Feeding and watering was through common feeders and water troughs. Broilers were fed on commercial feeds preferably broiler mash. Most farmers preferred supplementing their chicken with multivitamins.Vaccination and other veterinary interventions were routinely done. Several problems associated with poultry keeping in Urban district were mentioned by the farmers as shown in Table 1. Chicken diseases and poor availability of good quality feed were the most common problems. The common diseases that were reported in study flocks are summarized in Figure 1.

Table 1. Common problems to poultry farming in Urban district, Zanzibar

Problem mentioned by the respondents (n=55)	No. of respondents mentioned	Percentage
Diseases	55	100.0
Poor availability of good quality feed	24	43.6
Limited veterinary services	18	32.7
Shortage of market for poultry product	11	20.0
Pests	6	10.9
Theft	4	7.3
Shortage of land for expansion	3	5.5

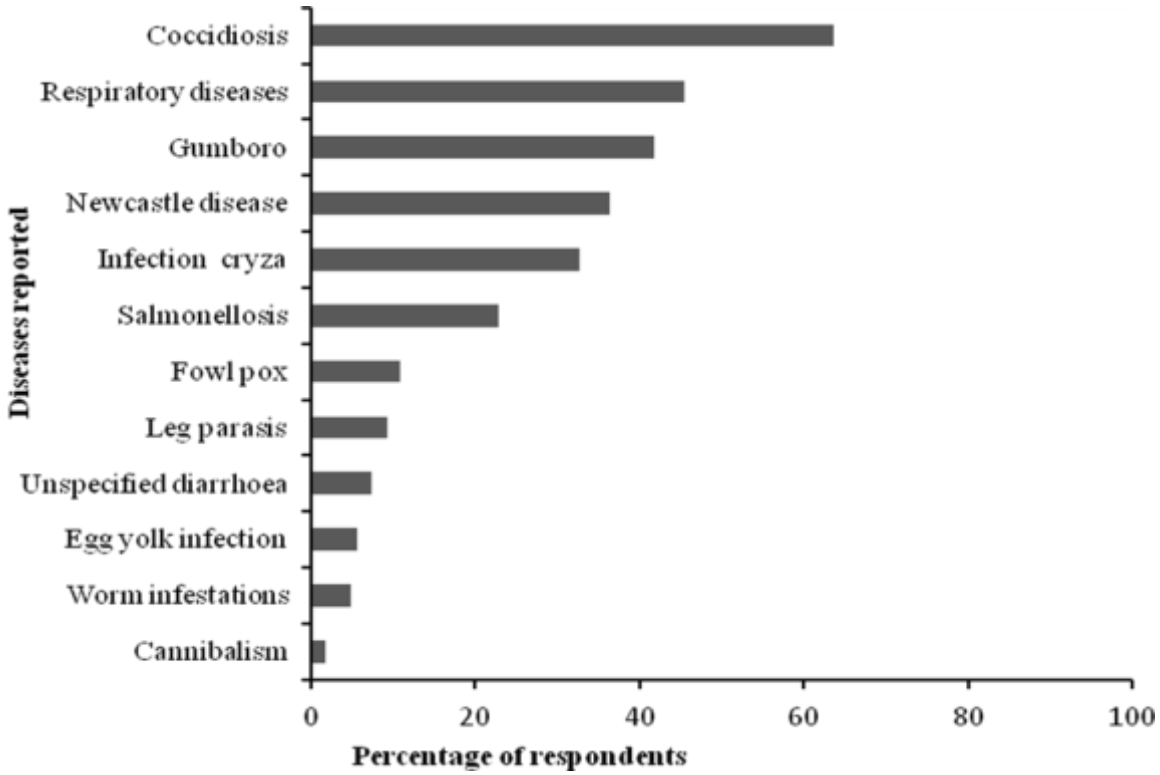

Figure 1. Common chicken diseases reported by farmers in Urban district, Zanzibar

All respondents reported different disease conditions that affected broiler chickens in Urban district. The most common diseases as were reported by the respondents include coccidiosis followed by respiratory diseases, Gumboro, Newcastle disease and Infectious coryza (Figure 1). Majority of the respondents (70.9%) reported to diagnose the chicken diseases themselves with the minimal help from veterinary drug sellers. Chicken antimicrobials were dispensed over the counter from agrovet shops without any prescriptions from the veterinarians. Drug administration to sick chickens was done by the farmers themselves.

Drug use pattern in broiler chicken farms in Urban district, Zanzibar

All the farmers interviewed reported to use different drugs to either treat or prevent occurrence of diseases in their birds as summarized in Table 2. Of the drugs reported by respondents, 90% were classical antimicrobial agents being predominated by amprolium and oxytetracycline. All the drugs used by the farmers were administered either in drinking water or mixed with feed. Up to 66% of the respondents were aware of drug withdrawal period which they reported to be informed by livestock extension officers (40%), drug sellers (14.5%) and through reading on drug labels and or leaflets (10.9%). A total of 54.5% of respondents admitted to slaughter chickens even before the withdrawal period because were afraid of financial losses. Nevertheless, 71% of the respondents were unaware of possible effects to broiler consumers caused by drug residues in broiler meat. Interestingly, the highest proportion (92.7%) of the respondents admitted to keep different types of records which included chick purchase date, feeds, diseases, treatments, slaughter and mortalities. Majority of chicken farmers (80%) admitted to get different kinds of advice and on farm training on different issues including general commercial chicken husbandry and management, poultry diseases and their control; and types and uses of different drugs for chickens.

Table 2. Types of drugs commonly used in Urban district, Zanzibar

Drug used	Number of farms used (%)	95% CI	Purpose of use
Amprolium	54 (98.2)	90.3 - 100	Treatment & prophylaxis
Different types of vaccines	52 (94.5)	84.9 – 98.9	Prophylaxis
Tetracyclines	50 (90.9)	80.0 – 97.0	Treatment & prophylaxis
Sulphonamides	45 (81.8)	69.1 – 90.9	Treatment & prophylaxis
Penicillines	27 (49.1)	35.4 – 62.9	Treatment
Vitamins	10 (18.2)	9.1 – 30.9	Enhance growth
Herbs	1 (1.8)	0.0 – 9.7	Treatment & prophylaxis

Interviews with key informants

Livestock extension officers

A total of seven livestock extension officers (LEOs), two males and five females were interviewed in five wards namely Kiembe Samaki, Mfenesini, Mtoni kidatu, Mwembemakumbi and Mwera. The LEOs mentioned diseases as among the chicken production constraints in Urban district. The mostly encountered chicken diseases reported were coccidiosis, Newcastle disease, infectious coryza and Gumboro. Other diseases mentioned were helminthosis, stress of different kinds, mycoplasmosis and nutritional deficiency that lead to leg paralysis. Other limitations listed included poor availability of good quality chicken feed, scarcity of chicks and theft. The LEOs confessed to receive many cases of health problems of chicken flocks but they were not been able to attend all of them since were few compared to number of farms. The common veterinary services they provided include disease diagnosis based on clinical signs and pathological lesions, prescribing treatment, vaccination, advice on feeding, general advice on management and biosecurity measures. They listed a number of commonly used drugs in chickens which include oxytetraclines, amprolium, flumequine, fluquin®, trimazine, tylosin, piperazine citrate, neoxyvital and different types of vaccines. LEO further reported to rarely advice the farmers on drug withdrawal periods in chicken meant for slaughter and the follow up on their compliance. The LEO further admitted that there could be some health effects to humans who consumed meat with antimicrobial residues. However they said that they had never heard or experienced any case of poisoning due to eating broiler meat with antimicrobial residues. The LEOs informed that there was liberalization of veterinary drug trade and that almost all the dealers were under private sector.

Medical personnel report

Five medical practitioners/doctors (4 male and 1 female) from four different health facilities (Miembeni, Hassan Clinic, Magogoni and Mnazi Mmoja) were interviewed. When were asked on their experience in attending human cases suspected of poisoning due to veterinary drugs, two of them said that they had never attended such cases. One doctor from Hassan clinic said that he used to get an average of 10 cases per year suspected of poisoning due to drugs while another doctor from Miembeni clinic said he got at least two cases per year. They both reported that the common presenting signs were diarrhoea, headache, weakness, skin irritation and sometimes vomiting. The medical personnel further reported that high doses of drug poisoning may cause interferences with blood circulation due to thrombosis, increased blood viscosity, liver and renal damage. The long term effects associated with antimicrobial residues in animal products mentioned by the doctors included gynecomastia, cancer, bacterial resistance to antibiotic and interference with embryogenesis in pregnant women. The doctors further said that the diagnosis of such cases was mostly based on history of veterinary drug exposure and clinical signs. Confirmation was not done because of shortage of diagnostic facilities in their health centers. The common method of exposure mentioned by the doctors was through accidental ingestion. They had no any opinion on the control methods rather than insisting that individuals handling veterinary drugs needed to be careful.

Veterinary shop sellers responses

Five veterinary shop sellers/owners (four males and one female) with their shops

located in five different wards (Mwembe makumbi, Fuoni, Machui, Amani and Magomeni) were interviewed. A number of antibiotics/antimicrobials and other drugs were recorded in the shops (Table 3). Four of the shop owners reported that highest sells of chicken drugs was between August and November each year. They said that this was the period in which the weather in Zanzibar is too warm and humid and is normally associated with high chicken diseases in particular respiratory diseases and diarrhoea.

However, they also listed a number of commonly reported chicken diseases which included Newcastle disease, coccidiosis, helminthosis, infectious coryza, Gumboro and nutritional deficiencies. The chicken drug sells could range from 10 packets (200-500 gm/packet) per month in small shops like PADEP shop – Machui to 200 packets in large shops like PADEP shop – Fuoni Kibondeni. In March to May, the sells drop down probably due to low incidences of diseases in chickens reattributed to cool weather. Sales of vaccines were almost constant throughout the year. All shop owners/sellers reported that normally farmers obtained advice from the shop keepers on which drug to use for their chicken. Thereafter, farmers bought the drugs and treated their chicken. Rarely, livestock extension officers were involved. All sellers/owners of veterinary drugs knew about drug withdrawal periods and said that it was written on most chicken drug packets but only three reported to advice farmers whenever requested. The three of the sellers/owners further said that they are aware of drug residues health effects associated with drug residue in humans. The common signs mentioned were diarrhoea. However, they had not heard any case of drug residue poisoning in humans.

Table 3. Chicken drugs recorded in different veterinary shops in Urban district between in November to December 2009

Veterinary shop	Common antibiotics/antimicrobials in veterinary shops	Other chicken drugs
Mifugo care- Maruhubi	Oxytetracycline, sulphonamides, pennicillines, neoxyvital, chlortetracycline, amprolium , flumequine, trimazine, tylosin, neoxyvital	Piperazine citrate, vitality, suvitylayer, suvitybroiler, vaccines, minerals and vitamins supplements
PADEP shop - Fuoni Kibondeni	Oxytetracycline, sulphonamides, amprolium, penicillines, neoxyvital, chlortetracycline, amprolium , flumequine, Fluquin®, trimazine, tylosin, neoxyvital	Piperazine citrate, minerals, vitamins supplements, vaccine
PADEP shop -Machui	Oxytetracycline, amprolium, penicilline.	Piperazine citrate, vitamins supplements
Kalanamo farmer- Amani	Oxytetracycline, sulphonamides, pennicillines, amprolium, flumequine, trimazine, neoxyvital	Piperazine citrate, vitamins supplements, vaccine
Hash Medics- Magomeni	Oxytetracycline, sulphonamides, amprolium, penicilline, flumequine, fluquin®, tylosin, neoxyvital	Piperazine citrate, vitamins supplements, vaccines,

Laboratory results of antimicrobial drug residues in broiler chicken meat

A total of 72 samples were collected and qualitatively analyzed for antimicrobial residues. The Delvo test results indicated that 76.4% of the broiler meat samples contained antimicrobial residues. However, 8 (11.1%) out of 72 broiler meat samples screened by agar well diffusion method showed positive results with the mean inhibition zone of 6.8 ± 0.9 mm (range 5.5–8 mm). All the 15 samples that were positive to agar well diffusion test were also positive to Delvo test.

DISCUSSION

There is a trend towards increased consumption of livestock products, especially poultry. It is estimated that the per capital consumption of livestock products in developing countries could rise to as much as 44% by 2030 (FAO, 2003). To meet this demand, it is predicted that commercial livestock production has to increase with a consequent of increased use of veterinary drugs such as antibiotics, coccidiostats, vaccines and growth promoters (FAO, 2003). Currently, antibiotics are widely used in developing countries, partly due to the high incidence of infectious diseases in many areas and sometimes as a means to overcome poor animal management practices. For example, in Kenya the mean consumption of antimicrobial per year was 1411 ± 246 kg in food producing animals between 1995 to 1999 (Mitema *et al.*, 2001), the amount which currently may have doubled. Such an increase in use of antimicrobials may be associated with increased health problems in humans and animals. The excessive use of antimicrobials to bacterial populations is a significant driving force for the selection of resistant forms of bacteria, and such forms of bacteria can spread from one organism to another. There is therefore an important question of whether or not the use of antimicrobials in livestock production poses a threat to human health. In particular, the worry is that resistant forms of bacteria spread from animals and/or the environment (ground-water/surface-water/soil) to humans and cause diseases in humans that are either troublesome or impossible to treat.

The findings from this study indicate that most of the broiler chickens were kept by small scale farmers whose majority had chicken flock size ranging from 100 to 500. As in many other poultry farming systems in Tanzania, many problems in particular diseases, poor availability of good quality poultry feeds and chicks were among the major drawbacks oberved during this study. Most of the chicken farmers interviewed reported to repeatedly use antimicrobial agents because of rampant and wide spread of diseases. The results of the current study are in line with what was reported in Morogoro, Tanzania by Nonga *et al.* (2009). In a report by Njombe and Msanga (2009), it was cited that unless diseases are controlled, poultry industry in Tanzania will remain stagnant while producing poor quality broiler meat and eggs.

Inadequate of livestock extension officers coupled with little motivation might have contributed to most of the farmers diagnose chicken diseases themselves. Possibilities of wrong diagnosis, inappropriate choice of medicines and treatment approach are high taking into account that farmers are ignorant on veterinary issues. These could be among the factors which may led to unnecessary higher uses of veterinary drugs with little or no improvements in the production, in additional to big implications to chicken product consumers.

Different veterinary drugs on use were reported by farmers, livestock extension

officers and registered veterinary shops in Urban district. The farmers reported to use the veterinary drugs in particular antimicrobial agents for treatment and control of diseases in their birds. Amprolium and oxytetracycline were the predominant drugs probably because of the wide spread of coccidiosis and bacteria-borne diseases in the district. Furthermore, veterinary drugs were easily obtained without any restriction over the counter in markets and veterinary shops. Such practices may lead to haphazard use of veterinary drugs which consequently increase incidences of veterinary drug residues in poultry products. Previous studies in Tanzania by Mmbando (2004) and Nonga *et al.* (2009; 2010) also reported higher uses of veterinary drugs such as oxytetracycline and amprolium in livestock production. Similarly, Muriuki *et al.* (2001) and Mitema *et al.* (2001) reported higher uses of oxytetracycline in livestock production in Kenya.

Most of the commercial veterinary preparations are utilized extensively in chicken production in Urban district with no specific recommendations on withdrawal periods. Even though there is no report of severe adverse reaction following the consumption of chicken meat with residues, this may be attributed by poor health services with poor diagnostic facilities in the country as was also pointed out by medical personnel. Despite that most respondents were aware of drug withdrawal periods, there was a significantly low number of them reported to comply as also reported in Senegal by Alambedji *et al.* (2008). Among the reason given was fear of losses. Most of the poultry keepers were subsistence farmers and since there was frequent occurrence of diseases which needed regular use of drugs, observing withdrawal periods was difficult and significant losses would be realized. The other reason was lack of awareness among farmers on the possible side effects of antimicrobial residues and other drugs to humans. The veterinary drug misuse probably was further escalated by lack of food inspection for residues and poor legislation enforcement by the responsible organs like Tanzania Food and Drug Authority. However, livestock extension officers reported that uncontrolled use of veterinary drugs was partly contributed by trade liberalization whereby the government was no longer involved in the control.

Qualitative analysis for antimicrobial residues showed that there was a higher percentage (76.4%) of chicken meat with antimicrobial drug residues in the market in Urban district. These findings are in line with the findings elsewhere by Al- Ghamdi *et al*. (2000); Salehzadeh *et al.* (2006) and Nonga *et al.* (2009), but far exceed those in Nigeria where Kabir *et al.* (2004) reported incidence of 33.1% antimicrobial residues in broiler meat based on agar well diffusion test. The high incidence of antimicrobial residues recorded in the current study probably resulted from slaughter of chicken for sell which were under therapeutic or prophylactic regimens. This is verified by the higher rate of non-compliance to withdrawal periods as was mentioned by the farmers. Normally, broilers are grown actively often with drugs to attain maximum weight within a short period of time. This is of concern, because, backyard production provides a continuous supply of chicken meat to fast growing urban dwellers. Meanwhile, there is no official residue monitoring program and consumer response towards the dangers posed by residues is passive. Thus, there is a risk of sustained consumer exposure to antimicrobial residues.

The internationally recognized organizations such as World Health Organizations (WHO) and Food and

Agriculture Organizations of the United Nation (FAO) have set tolerance or maximum residue limits (MRLs), acceptable daily intakes (ADIs) for humans and withholding times for pharmacologically active substances including antimicrobial agents prior to marketing (WHO/FAO, 1988). For example, the maximum residue levels of oxytetracycline in meat is 100 µg/kg (WHO, 1996) while the sensitivity of *Baccillus stearothermophilus* to tetracycline ranges between 400 and 500 mg/kg (Pavlina *et al.*, 2003). The meat analysed in this study showed indications of violation of these recommendations. Therefore the higher number of positive samples in this study means that there is high exposure rate of the public to antimicrobial residues through consumption of chicken meat. This implies that the Urban district community of Zanzibar ingests small doses of antimicrobials from broiler meat and probably other food of animal origin. This practice may contribute significantly to the development of antimicrobial resistance and other health effects.

It was also found by previous studies that the Delvo test was superior to the agar well diffusion test with respect to detection of antimicrobial residues in eggs. In the present study, 11.1% of the 72 tested meat samples were positive to agar well diffusion test. These finding tallies with results obtained when the same tests were used to assess presence of antimicrobial residues in eggs, broiler meat and milk in the same laboratory (Karimuribo *et al.*, 2005; Nonga *et al.*, 2009; 2010). The difference in performance of the two tests may be explained by differential sensitivities of the test organisms, that is, *Bacillus stearothermophilus var calidolactis* for the Delvo test compared to *Bacillus subtilis* for the agar well diffusion test. Delvo test is more sensitive (approximately 7.5 to 40-folds) than the agar well diffusion method in estimating the detection limits of cephalosporin antibiotics (Kukurová and Hozová, 2003). Generally, agar well diffusion method for residue testing has low sensitivity and it detects only a higher level of residues as compared to Delvo test that has a detection limit of 0.002 IU/ml of penicillin where agar well diffusion method detect limit is 0.008- 0.2 IU/ml. However, the simplicity of agar well diffusion method makes it to be a suitable method for screening of antibiotic residues in food.

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