

# Knowledge, attitude and practice in relation to Antimicrobial residues in beef among residents in Dodoma Region

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## SUMMARY

The safety of food of animal origin is of concern in the developing countries. Some of the antimicrobial agents that are used for the treatment of animal diseases seem to occur in the animal products. The knowledge, attitude and practice in relation to oxytetracycline (OTC) residues in beef among residents in Dodoma Region, Tanzania were evaluated. A cross sectional study included interviewing 254 randomly chosen respondents was conducted. Fifty two percent of the respondents were not aware of drug residues, 57% never heard about drug residues in food of animal origin such as milk and meat, 35% know residues can be harmful to human and 61% did not know if animals are treated with antimicrobial drugs when they were sick. Only 27% of the respondents knew common antimicrobial agents that cause residues in animal meat and milk and were able to mention. Majority of respondents (74%) did not know any method for the prevention of antimicrobial residues. Fifty six percent of the age group of 20-35 years purchased meat from butcheries. Secondary school (68.4%) and College (52.9%) respondents purchased meat from butcheries compared to informal (23.8%) and primary (49.2%) respectively that purchased meat locally within the villages. Majority of informal (66.7%) and primary (47.6%) respondents purchased meat locally within the villages. The differences were strongly significant  $p < 0.0001$ . Women (57.1%) used one hour to prepare meat. Age group 20-35 years (88.1%) prepared meat by cooking. Age group of 36-45 years prepared meat for 1 hour and 2 hours. College respondents (68.8%) barbecuing meat compared to smoking and freezing. The results in this study indicate that respondents had low knowledge and awareness on antimicrobial use and drug residues. This might be due to low level of education of respondents as majority of them had informal and primary education. Many of the drug respondents were not aware of the drug residues and did not know antibiotic residues can have effects in human health. Community based health education and promotion on antimicrobial use and preventing drug residues is highly recommended to this population.

**Key words:** knowledge, attitude, practice, residues in beef, residents, Dodoma Region, Tanzania

## INTRODUCTION

Tanzania has one of the largest ruminant livestock populations in Africa. It is ranked as a second country with largest herd in Sub Saharan Africa: United Republic of Tanzania (URT, 1994). It has 21.3 million cattle of which about 680 000 are dairy cattle, which are mainly crosses of Friesian, Jersey, and Ayrshire breeds with the Tanzania Shorthorn Zebu (NSCA 2007/2008). Of the meat producing animals, cattle are the most important as they produce most of the red meat and contribute 53% of total meat production, whereas sheep and goats contribute about 22% while the remaining percentage is contributed by pigs, poultry and non-conventional animals (URT, 1994).

Control of diseases in the livestock industry in sub-saharan Africa including Tanzania remains to be a challenge. The treatment of animals due to the infectious diseases has become a problem due to indiscriminate and frequent use of antibiotics (Nisha, 2008). Antimicrobial agents are among the

drugs for the treatment of diseases in livestock in developing countries (Karimuribo *et al.*, 2005; Nonga *et al.*, 2009). Oxytetracycline (OTC) is the most commonly used antibiotic in livestock production in Tanzania and other African countries (Olufemi and Agboola, 2009; Katakweba *et al.*, 2012).

According to Aryal (2001) the practice of using antimicrobials in animals is a worldwide problem owed to antimicrobial resistance; nearly all the antimicrobials used in animals are also used in human medicine. Some of drugs such as OTC, are used commonly to treat and protect cattle against several infections (Katakweba *et al.*, 2012). OTC is used in livestock for prophylactic, therapeutic treatment, and as a growth promoter due to its broad spectrum activity (Karimuribo *et al.*, 2005). The ingestion of unacceptable levels of OTC deposits in meat causes adverse health effects including bone and teeth problems in children and

development of bacterial resistance (Larkin *et al.*, 2004). Although the extent of antibiotic use in animals in developing countries is unknown, a study from Kenya reported that tetracyclines, sulfonamides and trimethoprim, nitrofurans aminoglycosides, beta-lactams and the quinolones are the most commonly used drugs in food-producing animals in Kenya (Mitema *et al.*, 2001). This study also revealed that the Tetracyclines contributed approximately 55% of the total consumption.

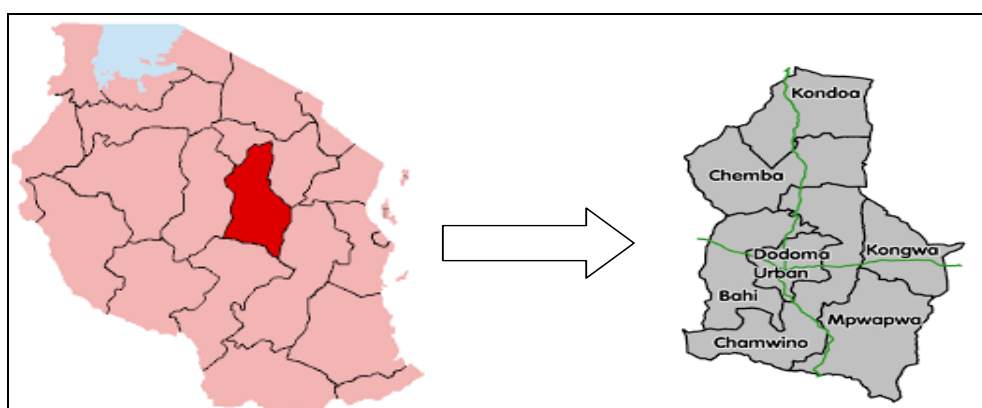
Informal access to antimicrobial and absence of awareness may lead to mismanagement and overuse of the antimicrobial which result in the

failure of observing withdrawal periods (Nisha 2008). Cinquina *et al.* (2003), reported withdrawal period of 5–20 days before animals are slaughtered.

Therefore, the aim of this study was to assess the knowledge, attitude and practice in relation to antimicrobial residues among beef consumers in Dodoma, Tanzania.

## MATERIALS AND METHODS

This study was carried out in Kongwa, Kondoa, Chamwino, Dodoma Rural and Dodoma Urban Districts in Dodoma region, Tanzania (Figure 1)



**Figure 1:** Map of Tanzania showing Dodoma region districts

### Data collections

Data collection included individual interviews using questionnaires targeting 254 residents living in Dodoma Region. Both closed and open-ended questions were included in the questionnaires. The information included demographic characteristics (age, education, occupation and marital status), where they buy meat, how often they consume meat in their family, amount consumed per meal, how they prepare beef before consuming and how much time it takes to prepare, knowledge about antimicrobial residues in meat, effects of antimicrobial residues in human health, common antimicrobial agents which can cause residues and methods used to prevent antimicrobial residues. Data obtained from questionnaires were captured in Excel and imported into SPSS version 20 software, descriptive and inferential statistics (t-test) were used to data analysis

## RESULTS

### Respondent's demographic information

Demographic information on the 254 respondents regarding sex, age, education, marital status and occupation was summarized in Table 1. The majority of the respondents (87%) were females and 13% were males (Table 1.1).

### Respondents' practice about beef

Most of the respondents purchased meat from butcheries 58%, followed by 36% who purchased it locally within the village (Table 1.2). Fifty three percent of the respondents bought beef while 26% bought liver. Respondents were consuming beef  $3.5 \pm 1.3$  times per month and majority of respondents (69%) were consuming meat three to five times per month. Cooking was the most common method (80%) of beef preparation and majority (51%) of respondents took an hour to prepare beef before consuming.

**Table 1.1:** Demographic characteristics of respondents (n=254)

Parameter	Category	Frequency (n)	Percent (%)
Sex	Male	33	13.0
	Female	221	87
Age group in years	20-35	168	66.1
	36-45	66	26
	46-55	16	7.1
	56-65	2	0.8
Education level	Informal	21	8.3
	Primary	63	24.8
	Secondary	136	53.5
	College	34	13.4
Marital status	Single	86	33.9
	Married	162	63.8
	Widow	3	1.2
	Divorced	3	1.2
Occupation	Peasant farmers	67	26.4
	Business Student	138	54.3
		49	19.3

**Table 1.2:** Respondents' practice about beef (n=254)

Parameter	Category	Frequency (n)	Percent
Source of meat	Supermaket	15	5.9
	Butcheries	147	57.9
	Locally	92	36.2
Meat intake per month	1 -2 times	60	23.6
	3 -5 times	174	68.5
	6 -8 times	20	7.9
Meat part	Liver	66	26.0
	Kidney	22	8.7
	Neck	32	12.6
	Muscle	134	52.8
Meat preparation	Eating raw	0	0
	Cooking	202	79.5
	Barbeque	27	10.7
	Smoking	25	9.9
	Freezing	0	0
Cooking time	15 mins	1	.4
	30 mins	69	27.2
	1 hour	120	51.2
	2 hours	54	21.3

### Respondents' knowledge on antimicrobial use and drug residues.

Fifty two percent of respondents did not know drug residues and 57 % never heard about drug residues in food of animal origin such as milk and meat (Table 1.3). Majority of respondents 65% knew

about the effects of residues in human, but only 39.% were aware that animals are treated with antimicrobials when they got sick. Only 31% of respondents mentioned same antimicrobials they knew while only 26% were able to mentioned the methods for prevention of drug residues in animal meat and milk.

**Table 1.3:** Respondents' knowledge on antimicrobial use and drug residues

Characteristic	Category	Frequency (n)	Percent
Awareness on drug residues	Yes	122	48
	No	132	52
Drug residues in food	Yes	110	43.3
	No	144	56.7
Effects of residues in human	Yes	89	35
	No	164	64.6
Animals treated with antimicrobial drugs	Yes	100	39.4
	No	154	60.6
Common antimicrobial drugs	Yes	68	26.8
	No	186	73.2
Mentioned any antimicrobial drug	Yes	78	30.7
	No	176	69.3
Prevent antimicrobial drug	Yes	67	26.4
	No	187	73.6

The study indicates that majority of respondents' purchases meat from butcheries. While 75.8% of the men purchased meat from the butcheries than from meat market and locally within the village, majority of women 53.4% purchased muscle tissue while 30.3% of men purchased liver. Fifty six percent of the age group 20-35 purchased the meat tissues. Secondary (68.4%) and College (52.9%) respondents purchased meat from butcheries compared to informal (23.8%) and primary (49.2%) respectively. Majority of informal (66.7%) and primary (47.6%) respondents purchases meat locally within the villages. The differences were strongly significant  $p < 0.0001$ .

Majority of the respondents (Table 1.5) prepare meat by cooking. Women (57.1%) took one hour to prepare meat. Age group 20-35 (88.1%) prepared meat by cooking. Age group 36-45 prepared meat for 1 hour and 2 hours respectively. College

(68.8%) respondents' preferred barbequing meat compared to smoking and freezing.

The age group (35-45) seemed to be more aware of drug residues compared to the other group (56.1%). The same age group had heard about drug residues in animal-origin (54.5%) and knew that residues are harmful to human (65.2%), Table 1.6.

Awareness on the drug residues seemed to be better based on the education levels. Knowledge on antimicrobial drugs increased as the education increased, informal < primary < secondary < college. The differences were strongly significant  $p < 0.0001$ . The female participants seemed to be unaware of the knowledge on antimicrobial drugs (62%) compared to men. Students had more knowledge on antimicrobial use (55%) compared to peasant and businesspersons. The differences between them were strongly significant  $p < 0.0001$ .

**Table 1.4:** Relationship between source of meat and demographic characteristics of respondents (n=254)

Characteristic	Category	Total n = 254	Source of meat n (%)				Part of meat n (%)				
			Meat market	Butcher	Buying locally	P value	Liver	Kidney	Neck	Muscle	P value
Sex	Male	33	1 (3.0)	25 (75.8)	7 (21.2)	> 0.05	10 (30.3)	4 (12.1)	3 (9.1)	16 (48.5)	> 0.05
	Female	221	14 (6.3)	122 (55.2)	85 (38.5)		56 (25.3)	18 (8.1)	29 (13.1)	118 (53.4)	
Mean age in years	32±15.56										
Age group in years	20-35	168	10 (6.0)	100 (59.5)	58 (34.5)	> 0.05	38 (22.6)	14 (8.3)	22 (13.1)	94 (56.0)	> 0.05
	36-45	66	3 (4.5)	33 (50)	30 (45.5)		19 (28.8)	8 (12.1)	8 (12.1)	31 (47.0)	
	46-55	18	2 (11.1)	12 (66.7)	4 (22.2)		9 (50.0)	0 (0)	1 (5.6)	8 (44.4)	
	56-65	2	0 (0)	2 (100)	0 (0)		0 (0)	0 (0)	1 (50.0)	1 (50.0)	
Education level	Informal	21	2 (9.5)	5 (23.8)	14 (66.7)	< 0.0001	3 (14.3)	1 (4.8)	2 (9.5)	15 (71.4)	> 0.05
	Primary	63	2 (3.2)	31 (49.2)	30 (47.6)		14 (22.2)	8 (12.7)	10 (15.9)	31 (49.2)	
	Secondary	136	5 (3.7)	92 (68.4)	38 (27.9)		33 (24.3)	13 (9.6)	17 (12.5)	73 (53.7)	
	College	34	6 (17.6)	18 (52.9)	10 (29.4)		16 (47.1)	0 (0)	3 (8.8)	15 (44.1)	
Marital status	Single	86	7 (8.1)	61 (70.9)	18 (20.9)	< 0.0001	24 (27.9)	5 (5.8)	14 (16.3)	43 (50.0)	> 0.05
	Married	162	6 (3.7)	85 (52.5)	71 (43.8)		42 (25.9)	17 (10.5)	16 (9.9)	87 (53.7)	
	Widow	3	2 (66.7)	0 (0)	1 (33.3)		0 (0)	0 (0)	1 (33.3)	2 (66.7)	
	Divorced	3	0 (0)	1 (33.3)	2 (66.7)		0 (0)	0 (0)	1 (33.3)	2 (66.7)	
Occupation	Peasant	67	6 (9.0)	31 (46.3)	30 (44.8)	< 0.01	16 (23.9)	8 (11.9)	10 (14.9)	33 (49.3)	> 0.05
	Business	138	4 (2.9)	80 (58.0)	54 (39.1)		33 (23.9)	10 (7.2)	19 (13.8)	76 (55.1)	
	Student	49	5 (10.2)	36 (73.5)	8 (16.3)		17 (34.7)	4 (8.2)	3 (6.1)	25 (51.0)	

**Table 1.5:** Relationship between meat preparation and demographic characteristics of respondents (n=254)

Characteristics	Category	Total n =254	Meat preparation n (%)					P value	Duration of meat preparation n (%)				P value
			Eating raw	Cooking	Barbequing	Smooking	Freezing		¼ hour	½ hour	1 hour	2 hour	
Sex	Male	33	0 (0)	32 (97.0)	0 (0)	1 (3.0)	0 (0)	> 0.05	0 (0)	7 (21.2)	18 (54.5)	8 (24.2)	> 0.05
	Female	221	2 (0.9)	17 (76.9)	25 (11.3)	22 (10.0)	2 (0.9)		1 (0.5)	62 (28.1)	112 (57.7)	46 (20.8)	
Mean age in years	32±15.56												
Age group in years	20-35	168	2 (1.2)	148 (88.1)	5 (3.0)	13 (7.7)	0 (0)		1 (0.6)	51 (30.4)	83 (49.4)	33 (19.6)	
	36-45	66	0 (0)	42 (63.6)	14 (21.2)	8 (12.1)	2 (3.0)	< 0.01	0 (0)	12 (18.2)	38 (57.6)	16 (24.2)	> 0.05
	46-55	18	0 (0)	10 (55.6)	6 (33.3)	2 (11.1)	0 (0)		0 (0)	6 (33.3)	8 (44.4)	4 (22.2)	
	56-65	2	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	1 (50.0)	1 (50.0)	
Education level	Informal	21	2 (9.8)	15 (71.4)	0 (0)	4 (19)	0 (0)		0 (0)	5 (23.8)	10 (47.6)	6 (28.6)	
	Primary	63	0 (0)	60 (95.2)	3 (4.8)	0 (0)	0 (0)	<	0 (0)	25 (39.7)	34 (54.0)	4 (6.3)	< 0.05
	Secondary	136	0 (0)	102 (75.0)	19 (14.0)	13 (9.6)	2 (1.5)	0.0001	1 (0.7)	31 (22.8)	71 (52.2)	33 (24.3)	
Marital status	College	34	0 (0)	25 (73.5)	3 (68.8)	6 (17.6)	0 (0)		0 (0)	8 (23.5)	15 (41.1)	11 (32.4)	
	Single	86	2 (2.3)	78 (90.7)	3 (3.5)	3 (3.5)	0 (0)		0 (0)	30 (34.9)	34 (39.5)	22 (25.6)	
	Married	162	0 (0)	120 (74.1)	22 (13.6)	18 (11.1)	2 (1.2)	< 0.01	1 (0.6)	38 (25.3)	94 (58.0)	29 (17.5)	> 0.05
	Widow	3	0 (0)	1 (33.3)	0 (0)	2 (66.7)	0 (0)		0 (0)	1 (33.3)	0 (0)	2 (66.7)	
Occupation	Divorced	3	0 (0)	3 (100)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	2 (66.7)	1 (33.3)	
	Peasant	67	2 (3.0)	59 (88.1)	1 (1.5)	3 (4.5)	2 (3.0)		0 (0)	23 (34.3)	35 (52.2)	9 (13.4)	
	Business	138	0 (0)	106 (76.8)	19 (13.8)	13 (9.4)	0 (0)	< 0.01	1 (0.7)	33 (23.9)	70 (50.7)	34 (24.6)	> 0.05
	Student	49	0 (0)	37 (75.5)	5 (10.2)	7 (14.3)	0 (0)		0 (0)	13 (26.5)	25 (51.0)	11 (22.4)	

**Table 1.6:** Relationship between respondents awareness on drug residues and demographic characteristics of (n=254)

Characteristic	Category	Total n = 254	Awareness on drug residues			Ever heard about drug residues in animal-origin food			Drug residues can be harmful human		
			Aware	Unaware	P value	YES	NO	P value	Aware	Unaware	P value
Sex	Male	33	20 (60.6)	13 (39.4)	> 0.05	15 (45.5)	18 (54.5)	> 0.05	24 (72.7)	9 (27.3)	> 0.05
	Female	221	102 (46.2)	119 (53.8)		95 (43.0)	128 (57.0)		141 (63.8)	80 (36.2)	
Mean age in years	32±15.56										
Age group in years	20-35	168	74 (44.0)	94 (56.0)	> 0.05	65 (38.7)	103 (61.3)	< 0.05	108 (64.3)	60 (35.7)	> 0.05
	36-45	66	37 (56.1)	29 (43.9)		36 (54.5)	30 (45.5)		43 (65.2)	23 (34.8)	
	46-55	18	9 (50.0)	9 (50.0)		7 (38.9)	11 (61.1)		12 (66.7)	6 (33.3)	
	56-65	2	2 (100)	0 (0)		2 (100)	0 (0)		2 (100)	0 (0)	
Education level	Informal	21	3 (14.3)	18 (85.7)	< 0.001	4 (19.0)	17 (81.0)	< 0.05	12 (57.1)	9 (42.9)	< 0.01
	Primary	63	24 (38.1)	39 (61.9)		23 (36.5)	40 (63.5)		31 (49.2)	32 (50.8)	
	Secondary	136	77 (56.6)	59 (43.4)		67 (49.3)	69 (50.7)		3 (68.4)	43 (31.6)	
Marital status	College	34	18 (52.9)	16 (47.1)	> 0.05	16 (47.1)	18 (52.9)	> 0.05	29 (85.3)	5 (14.7)	< 0.05
	Single	86	43 (50.0)	43 (50.0)		35 (40.7)	51 (59.3)		53 (61.6)	33 (38.4)	
	Married	162	77 (47.5)	85 (52.5)		72 (44.4)	90 (55.6)		108 (66.7)	54 (33.3)	
	Widow	3	1 (33.3)	2 (66.7)		1 (33.3)	2 (66.7)		3 (100)	0 (0)	
Occupation	Divorced	3	1 (33.3)	2 (66.7)	> 0.05	2 (66.7)	1 (33.3)	> 0.05	1 (33.3)	2 (66.7)	< 0.01
	Peasant	67	28 (41.8)	39 (58.2)		22 (32.8)	45 (67.2)		33 (49.3)	34 (50.7)	
	Business	138	72 (52.2)	66 (47.8)		68 (49.3)	70 (50.7)		98 (71.0)	40 (29.0)	
	Student	49	22 (44.9)	27 (55.1)		20 (40.8)	29 (59.2)		34 (69.4)	15 (30.6)	

**Table 1.7: Relationship between respondents 'awareness on antimicrobials and demographic characteristics (n=254)**

Characteristic	Category	Total n = 254	Animals are treated with antimicrobial drugs			Common antimicrobial agents causing drug residues			Method to prevent drug residues		
			Aware	Unaware	P value	YES	NO	P value	Aware	Unaware	P value
Sex	Male	33	16 (48.5)	17 (51.5)	> 0.05	13 (39.4)	20 (60.6)	> 0.05	6 (18.2)	27(81.6)	> 0.05
	Female	221	84 (38.0)	137 (62.0)		55 (24.9)	166 (75.1)		61 (27.6)	61 (72.4)	
Mean age in years	32±15.56										
Age group in years	20-35	168	60 (35.7)	108 (64.3)	> 0.05	39(23.2)	129 (76.8)	< 0.05	130 (77.4)	38 (22.6)	> 0.05
	36-45	66	31 (47.0)	35 (53.0)		21 (31.8)	45 (68.2)		42 (63.6)	24 (36.4)	
	46-55	18	8 (44.4)	10 (55.6)		7 (38.9)	11 (61.1)		14 (77.8)	4 (22.2)	
	56-65	2	1 (50.0)	1 (50.0)		1 (50)	1 (50)		1 (50)	1 (50)	
Education level	Informal	21	3 (14.3)	18 (85.7)	< 0.0001	6 (28.6)	15 (71.4)	< 0.05	13 (61.9)	8 (38.1)	< 0.0001
	Primary	63	14 (22.2)	49 (77.8)		12 (19)	51 (81)		51 (81.0)	12 (19.0)	
	Secondary	136	62 (45.6)	74 (54.4)		38 (27.9)	98 (72.1)		108 (79.4)	28 (20.6)	
	College	34	21 (61.8)	13 (38.2)		12 (35.3)	22 (64.7)		15 (44.1)	19 (55.9)	
Marital status	Single	86	27 (31.4)	59 (68.6)	> 0.05	18 (20.9)	68 (79.1)	> 0.05	68 (79.1)	18 (20.9)	< 0.05
	Married	162	71 (43.8)	91 (56.2)		47 (29.0)	115 (71.0)		116 (71.6)	46 (28.4)	
	Widow	3	1 (33.3)	2 (66.7)		2 (66.7)	1 (33.3)		1 (33.3)	2 (66.7)	
	Divorced	3	1 (33.3)	2 (66.7)		1 (33.3)	2 (66.7)		2 (66.7)	1 (33.3)	
Occupation	Peasant	67	13 (19.4)	54 (80.6)	< 0.0001	18 (26.9)	49 (73.1)	> 0.05	51 (76.1)	16 (23.9)	> 0.05
	Business	138	60 (43.5)	78 56.5)		31 (22.5)	107 (77.5)		102 (73.9)	36 (26.1)	
	Student	49	27 (55.1)	22 (44.9)		19 (38.8)	30 (61.2)		34 (69.4)	15 (30.6)	



## DISCUSSION

In the present study we assessed the knowledge, attitude and practice in relation to antimicrobial residues among beef consumers in Dodoma, Tanzania. The results obtained in this study indicate that the respondents interviewed had low knowledge and awareness on antimicrobial use and antimicrobial residues. Some of the respondents were aware that animals are treated with antimicrobials but (65%) they could not realise that the same antimicrobials can cause antimicrobial residues in animal meat and milk. The other reason which could be considered is lack of awareness to respondents on the possible side effects of antimicrobials and other drugs to humans. Furthermore, the study has demonstrated a relationship between education and beef purchasing. Most of secondary and college residents purchased beef from burcheries while infomal and primary residents purchases locally within village. Majority of female (76.9%) preferred cooking beef for one hour.

The current results confirm previous reporting from a rural District in China on lack of knowledge and practice on cautious use of antimicrobial and antimicrobial resistance in developing countries (Chenggang *et al.*, 2011; Katakweba *et al.*, 2012). This might be due to low levels of education of the respondents as majority of them had informal and primary education only.

This study showed that age also plays a role regarding knowledge of antimicrobials. The study is also in line with a socio-demographic analysis conducted by SPECIAL EUROBAROMETER 338 in 2010 within European countries (European Commission 2010) which revealed that women seem to be better informed than men on this topic and age also plays a role and as regards to knowledge of antimicrobials. Respondents with higher education are also more likely to have a more clear knowledge on the antimicrobials effects. However, the respondents need to be educated on the possible effects associated with use of beef with antimicrobial residues

### Competing interests

The authors declare no conflict of interests

This study is also in line with the study described by Bilashoboka *et al.* (2016) who accessed the level of knowledge, concerns and practices of animal keepers, consumers and extension agents in relation to antimicrobials withdrawal requirements and observed that most of animal keepers interviewed were ignorant of antimicrobial residues and withdrawal periods. The majority of respondents were not aware of the antimicrobial residues in beef whereas the businessmen and law enforcers were aware.

The factors that may contribute to antimicrobials and antimicrobial residues in food in developing countries, such as Tanzania include 1) lack of sufficient knowledge in use of antimicrobial for human and animal, 2) failure to observe withdrawal periods when antimicrobials are administered to animals, 3) lack of updated antimicrobial use and treatment guidelines and 4) Easy access to antimicrobials such as oxytetracycline (Nisha, 2008).

### Conclusion

It is concluded that this study suggested that many of the respondents were aware of the antimicrobial residues but did not know that antimicrobial residues can have effects in human health.

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### Ethical issues

Permission for this study was granted by the Executive Directors of the Dodoma Region Council and ethical approval for the study was obtained from the Ethical Committee of the Sokoine University of Agriculture. The university issued a research permit letter on behalf of the Tanzanian Commission for Science and Technology

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