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ORIGINAL RESEARCH

Antibiotic Use, Awareness of Antimicrobial Resistance and Residue in Veterinary Professionals and Farmers in Selected Districts of Kellem Wollega Zone, Ethiopia

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Background: Antimicrobials have a crucial role in reducing mortality and morbidity in animals, but misuse of them may cause antimicrobial resistance and residues which are challenging in animal production and public health. These problems are mostly aggravated in developing countries including Ethiopia.

Objective: Assessment of antibiotic use, awareness of antimicrobial resistance and antimicrobial residue in veterinary professionals and farmers.

Methods: A cross-sectional study was conducted from September 2021 to August 2022 in three districts (Seyo, Hawa Gelan, and Dale Sadi) of the Kellem Wollega zone, selected by purposive sampling. The study population was farmers and veterinary professionals. Data was collected from a total of 312 respondents; 230 farmers and 82 veterinary professionals using interviews and questionnaires, respectively.

Results: Out of 312 total respondents, 230 (73.71%) were farmers and 82 (26.28%) were veterinary professionals. From the farmer respondents, 127 (55.22%), 153 (66.52%), and 142 (61.74%) had an awareness of antibiotics and their usage, antimicrobial resistance, and withdrawal period, respectively. Out of 82 veterinary professional respondents, 92.68% practice dose calculation during animal treatment, 79.27% diagnose systemic infections by tentative diagnosis, 85.37% have no laboratory facility for bacterial disease, and 81.71% give broad-spectrum antibiotics for undifferentiated cases. The income type of respondents looks to have a strong association ($P < 0.05$) with awareness of antibiotics (OR: 3.427, SE: 1.404, CI: 1.535–7.654), antimicrobial resistance (OR: 3.536, SE: 1.339, CI: 1.683–7.430) and withdrawal periods (OR: 3.297, SE: 1.267, CI: 1.552–7.004).

Conclusion: This study shows most farmers have awareness about antibiotics and their use, antimicrobial resistance, and residue but inappropriate use of antimicrobials in farmers and lack of laboratory facilities in most veterinary professionals observed.

Keywords: antibiotic, antimicrobial, resistance, residue, Kellem Wollega, Ethiopia

Introduction

Although medicines have had an extraordinarily positive effect on health, leading to reduced mortality and disease burden, there is plenty of evidence of missed potential because of the way medicines are used.[1] The right medicine does not always reach the right patient, and approximately 50% of all patients fail to take their medicine correctly and misuse of antimicrobials causes the emergence of antimicrobial resistance.[1,2] In the absence of the development of new generations of antibiotic drugs, proper use of existing antibiotics is needed to ensure the long-term availability of effective treatments for bacterial infections.[3]

The misuse of antimicrobials in developing countries such as Ethiopia is maintained by their over-the-counter availability, lack of prescription, and unregulated supply chains.[4] Noncompliance with the use of antimicrobials has many consequences for resistance, and poverty is a major root factor of antimicrobial misuse in developing countries.[5]

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These actions result in the exposure of surviving pathogens to subtherapeutic concentrations of antimicrobials, thereby increasing the chances of acquiring resistance. Livestock owners' treatment of their animals is a common practice in developing countries, where they receive antimicrobials without prescription and through unregulated supply chains which may result in antimicrobial resistance (AMR).[6,7]

The threat of AMR is growing at an alarming rate, and the situation is perhaps aggravated in developing countries owing to the gross abuse of antimicrobials.[4,8] It is well known that the use of antimicrobials, however appropriate and justified, contributes to the development of resistance, but widespread, unnecessary, and excessive use worsens the situation.[9] When present in animal feedstuff, antibiotic residues can have negative implications for animal production and public health, including the transmission of carcinogenic compounds and the selection of antibiotic-resistant bacteria.[10–12] The residues of veterinary drugs or their metabolites in meat and other foods of animal origin may cause adverse toxic effects on consumer's health.[13] Different researchers have suggested that AMR is associated with human-animal contact, high levels of antibiotic use in small production systems, lack of withdrawal for human consumption of meat and milk products from recently treated animals, and frequent or less prudent antimicrobial use.[14]

In Ethiopia, regulations on antimicrobial use in livestock are poorly enforced, as in many developing countries, and farmers have easy access to veterinary drugs.[15] This issue in public health and veterinary medicine requires worldwide action. To solve this problem, understanding antibiotic use, management, the supply chain in human and veterinary medicine, and withdrawal periods for food animals is very important. Furthermore, understanding the epidemiology of AMR is key to developing effective strategies to reduce its emergence and spread. The absence of a prevention strategy that may rely on this problem may contribute to the maintenance of zoonotic bacteria and AMR in a complex environment; thus, conducting such research is timely and very important in Ethiopia to safeguard the public and livestock. The objective of this study was to assess antibiotic use and awareness of antimicrobial resistance and antimicrobial residue or withdrawal periods among veterinary professionals and farmers in selected districts of the Kellem Wollega Zone.

Methods

Study Area

This study was conducted in three districts (Seyo, Hawa Gelan, and Dale Sadi) of Kellem Wollega zone, Western Ethiopia. The map of the study districts is indicated in Figure 1. Seyo woreda is located at an altitude range of 1100–2300 m above sea level. It has suitable topography for agricultural activities and Dega, Weinadega, and Kola are classified at 27%, 43%, and 30%, respectively. The annual rainfall varies from 600 to 1500 mL. The temperature varies from 10°C to 28°C. The woreda consists of 26 rural kebeles and four urban kebeles. According to the basic data report, there are 68,835 cattle, 48,930 sheep, 46,065 goats, 3415 horses, 3520 donkeys, 825 mules, and 398,120 poultry in the woreda. There are 23,539 farmers (livestock owners) and 55 veterinary professionals in the woreda.[16]

Hawa Gelan is one of the districts of the Kellem Wollega Zone, with 32 kebeles (two urban and 30 rural). Hawa Gelan is bordered to the south and southwest by Sayo, to the north by Yemalogi Well, to the northeast by Dale Wabera, and the south and southeast by Illubabor Zone. Hawa Gelan district is classified as highland and lowland, covering approximately 32% and 68% of the total area of the district, respectively. The annual rainfall varies from 800 to 1200 mL. The altitude and temperature of the woreda range from 1600 to 2200 m above sea level and 24–30°C, respectively. The livestock population in Hawa Gelan district is estimated to be 83,737 cattle, 39,628 sheep, 24,623 goats, 1147 horses, 8925 donkeys, 1440 mules, and 155,144 poultry. There are 29,082 farmers (livestock owners) and 49 veterinary professionals in the woreda.[17]

The Dale Sedi District is located in western Ethiopia in the Oromia region, 550 km from the capital city of the country to the west. Dale Sedi is one of the districts in the Kellem Wollega Zone. The capital of the Dale Sedi District is Haro Sabu. It is bordered to the south by the Illubabor Zone, west by Dale Wabera, north by the West Wollega Zone, and east by Lalo Kile. The mean annual rainfall ranges from 1000 to 1200 mL and the mean temperature is 23°C. The livestock population in the Dale Sedi district is estimated to be 128,500 cattle, 43,100 sheep, 20,100 goats, 210 horses, 450 mules, 4150 donkeys, and 142,820 poultry. There are 13,139 farmers (livestock owners) and 45 veterinary professionals in the woreda, respectively.[18]

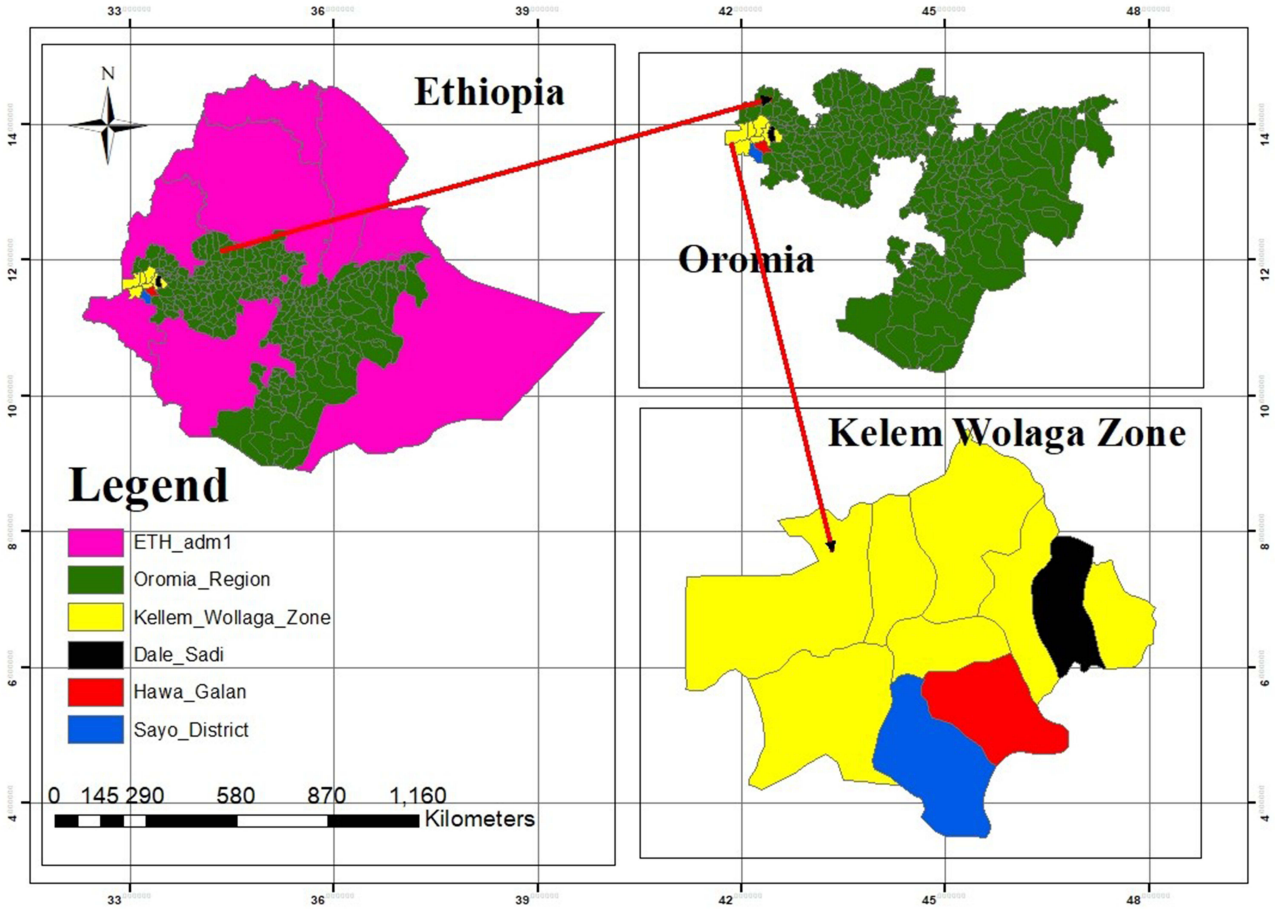

Figure 1 Map of the study area.

Study Design and Study Population

This cross-sectional study was conducted from September 2021 to August 2022 in selected districts of the Kellem Wollega Zone. The study population included farmers and veterinary professionals, such as veterinary clinicians, animal health experts, drug vendors, and meat inspectors in abattoirs found in the study area, who were used to assess how they use antibiotics, their awareness of AMR, and antimicrobial residues.

Sampling Technique and Sample Size

Before starting the survey, discussions were held with zonal and district animal health professionals and representative farmers in the study area about the objective of the study and the need for their participation in the success of the study. Subsequently, a rapid single-stage field observation was conducted by the researchers and the respective district's animal health professionals in each of the study areas to establish a sampling frame from which representative kebeles were sampled. Based on the outcomes of the rapid field survey, two kebeles were selected from each district using a purposive sampling technique based on the relative availability of veterinary clinics, abattoirs, and drug vendors; easy accessibility of information; and farmers' willingness to participate in the study. The respondents were then randomly selected for sampling questionnaire-based interviews with the selected representative kebeles. The sample size to collect data for this study was determined by using,[19] with a maximum variability or margin of error of 6%. The sample size was calculated using the following equation.

$$n = \frac{N}{1 + N(e)2}$$

where n is the sample size the research uses, N is the total number of the study population, e is the maximum variability or margin of error, and 1 is the probability of the event occurring.

Based on the above formula, the total sample size of the study was computed from 65,909 farmers and veterinary professionals, to be 277, using a 6% maximum variability or margin of error. However, by increasing the sample size by 10% a total of 312 respondents, 230 farmers, and 82 veterinary professionals were included in this study.

Data Collection Tools

Data were collected through questionnaires and questionnaire-based interviews from veterinary clinics, drug vendors, and abattoirs in the study area to complement the antibiotic usage in veterinary clinics and the treatment history of slaughtered and other food animals. For this study, a mixed approach combining qualitative and quantitative interviews was used. The questionnaire was developed by the researchers and translated into Afan Oromo. Then, it was administered to randomly selected farmers and veterinary professionals by a team of data collectors recruited and trained for this purpose, with close supervision and participation of the researchers. Veterinary drug shops, veterinary clinics, and abattoirs in all districts of the study area were visited, and data was collected on antimicrobial sources, sales, usage and all its management aspects, awareness of AMR, drug residue, and withdrawal period in food animals.

Reliability and Validity of Data

For reliability and validity of data used for the study, the questionnaire developed by the researchers was reviewed by researchers, other experts, and the research committee of Dambi Dollo University. Data collectors were well-trained on how to collect relevant information. The questionnaire was also pre-tested after being collected from a few respondents before fully administered, and some re-arrangement, reframing, and corrections were made.

Data Management and Analysis

Data obtained from the questionnaire survey and interviews were entered into a Microsoft Excel spreadsheet and coded. All statistical analyses were performed using STATA 14 (StataCorp, College Station, TX, USA). Descriptive statistics were computed for all variables, and the results were presented as percentages (%) of each variable. The chi-squared test was used to determine the level of significance, and the p-value was set at 0.05 to determine the significance level. The logistic regression analysis model was used to demonstrate the association between the demography of farmer respondents and awareness of antibiotic use and AMR and residue.

Result

Demographic Characteristics of Farmer Respondents

A total of 312 respondents participated in this study; 230 (73.71%) were farmers and 82 (26.28%) were veterinary professionals. From a total of 230 farmers, 90 (39.13%) were from Hawa Gelan, 75 (32.61%) were from Seyo, and 65 (28.26%) were from Dale Sedi districts. From all respondents, 185 (80.43%) were male, 137 (59.57%) were aged 31–45 years, 60 (26.09%) were 46–60 years, 26 (11.30%) were 15–30 years, and seven (3.04%) were above 60 years. Regarding the level of education, 124 (53.91%) of the respondents had attended up to grade 8, 32.61% attended grades 9–12, 10.87% attended college and above, 1.74% had no formal education, and 0.87% attended adult education. The income type of the respondents was, 87.83% from both land cultivation and animal rearing, 10.43% just from land cultivation, and 1.74% from animal rearing (Table 1).

Antibiotic Usage in Farmer Respondents

From total farmer respondents, 55.22% had awareness about antibiotics, and 44.78% did not. The most commonly known antibiotics in the study area were oxytetracycline and penicillin. Most (approximately 53.48%) of the respondents in the study area used antibiotics for diseased animals. Some of the respondents used antibiotics for diseased animals, for prevention in healthy animals, and also for fattening in general (24.35%). More than half of the respondents (58.26%) had taken their animals to veterinary clinics, 30.43% to veterinary clinics or purchased antibiotics from drug vendors, and

Table 1 Socio-Economic Demography of Farmer Respondents

Variable	Category	Number	Frequency (%)
District	Hawa Gelan	90	39.13
	Seyo	75	32.61
	Dale Sedi	65	28.26
Kebele	Machara	50	21.74
	Gaba Robi	40	17.39
	Alaku Gambi	50	21.74
	Dambi Dollo 03	25	10.87
	Gonsi Daraba	46	20.00
	Haro Sabu 02	19	8.26
Sex	Male	185	80.43
	Female	45	19.57
Age	31–45 years	137	59.57
	46–60 years	60	26.09
	15–30 years	26	11.30
	>60 years	7	3.04
Educational Level	<8	124	53.91
	9–12	75	32.61
	College and above	25	10.87
	No formal education	4	1.74
	Adult education	2	0.87
Income type	Both land cultivation and animal rearing	202	87.83
	Land cultivation	24	10.43
	Animal rearing	4	1.74
Job Duration	Above 10 years	177	76.96
	Less than 10 years	53	23.04

approximately 7.83% had taken their animals to veterinary clinics or treated them in traditional ways. In total, 59.13% of the respondents obtained antibiotics from both government and private veterinary clinics, followed by 32.17% from government veterinary clinics alone. When they bought antibiotics in their homes, most (67.83%) of the respondents used veterinary professionals to inject their animals as 14.35% injected animals themselves, and 10.43% of them used both methods (Table 2).

Awareness of Farmer Respondents on Antimicrobial Resistance

Based on the awareness assessment of the respondents on AMR, 153 (66.52%) of them had awareness about AMR and 77 (33.48%) of them did not. Among those who asked what AMR meant, 132 said animals treated but not cured, and 21 said adaptation of animal disease to drug. When they asked for factors responsible for AMR, 33.04% had no answer, followed by

Table 2 Antibiotic Usage in Farmer Respondents

Variable	Category	Number	Frequency (%)
Do you know about antibiotics?	Yes	127	55.22
	No	103	44.78
Which antibiotics have you used frequently?	Oxytetracycline and Penstrep	74	32.17
	Oxytetracycline	46	20.00
	Penstrep	6	2.61
	Do not know	104	45.22
What are the uses of antibiotics in your area?	For diseased animals	123	53.48
	For diseased animals, for prevention in healthy animals, and for fattening	56	24.35
	For diseased and for prevention in healthy animals	21	9.13
	For prevention in healthy animals	18	7.83
	For diseased animals and for fattening	12	5.22
What measures do you take if your animal is diseased?	Taken animal to veterinary clinic	134	58.26
	Taken animal to veterinary clinic and purchased antibiotic from drug vendor	70	30.43
	Taken animal to veterinary clinic or treat animal in traditional ways	18	7.83
	Taken animal to veterinary clinic or purchased antibiotic from drug vendor or buy in village	8	3.48
From where do you get antibiotics?	Government and private veterinary clinic	136	59.13
	Government veterinary clinic	74	32.17
	Drug vendor	11	4.78
	Private veterinary clinic	9	3.91
Who will inject your animal if you bring antibiotics to your home?	Veterinary professional	156	67.83
	Myself	33	14.35
	Myself or veterinary professional	24	10.43
	No purchase to home	17	7.39

underdose of the drug (29.13%), insufficient treatment (16.65%), over/under dose of the drug (8.07%), inappropriate drug, delayed treatment, treatment without a prescription, drug–disease mismatch, or no drug change. Based on an assessment of the consequences of inappropriate antimicrobials, about 51.30% of them responded that drug resistance would develop and the animal would not be cured; 40.87% said that the animal would not be cured. When asked about the problems of underdose treatment, 55.22% responded that drug resistance would develop and the animal would not be cured, 26.96% said the animal would not be cured, and 16.09% answered that drug resistance would develop (Table 3).

Awareness of Farmer Respondents on Drug Residue

Based on an assessment of the awareness of farmer participants on drug residue, 38.26% had no awareness about the drug withdrawal period, whereas 61.74% of them had. From respondents who had awareness of the withdrawal period, 92 described it as not using animal products after treatment for an amount of permitted day, 29 described it as not lactating animals after

Table 3 Awareness of Farmer Respondents on Antimicrobial Resistance

Variable	Category	Number	Frequency (%)
Do you know what antimicrobial resistance means?	Yes	153	66.52
	No	77	33.48
If "Yes" *describe*	Animal treated but no cure	132	57.39
	Adaptation of disease to drug	21	9.13
	Not considered	77	33.48
What are the factors for antimicrobial resistance?	Under dose injection of drug	67	29.13
	Insufficient treatment	36	15.65
	Under/over dose injection of drug	20	8.70
	Inappropriate drug	9	3.91
	Delayed treatment	8	3.48
	Treatment without prescription	6	2.61
	Drug disease mismatch	5	2.17
	No drug change	3	1.30
	Not considered	76	33.04
What are the problems if animals are treated with inappropriate antimicrobials?	Drug resistance will develop and animal will not be cured	118	51.30
	Animal will not be cured	94	40.87
	Drug resistance will develop	16	6.96
	No problem	2	0.87
What are the problems of under dose treatment?	Drug resistance will develop and animal will not be cured	127	55.22
	Animal will not be cured	62	26.96
	Drug resistance will develop	37	16.09
	Not considered	4	1.74

treatment for days, and some answered that the drug remained in the body or giving rest to animals after they were treated. Of the total respondents, 178 (77.39%) answered that they employed withdrawal periods in treated animals and 52 (22.61%) of them did not employ withdrawal periods in treated animals. When asked about the potential problems if withdrawal periods were not adhered to properly, 91.30% of them answered that it causes disease in consumers (humans), 5.22% of them answered that it had no problem, and 3.48% did not know the problem. When the respondents were asked about the challenges of maintaining withdrawal periods, 25.22% said that the priority given to benefit from animal products than the effect it poses, 23.04% said both benefit left from animals and priority given to benefit from animal products than the effect it poses, 13.48% had lack of knowledge of the effect, and some of them answered as no challenge, carelessness, or did not know of any problem (Table 4).

Socio-Economic Demography of Veterinary Professional Respondents

A total of 82 veterinary professional respondents participated in this study and 37 were from Hawa Gelan, 29 from Seyo, and 16 from Dale Sedi. Of the professional respondents, 73 were male, 52 were aged 31–45 years, 21 were younger than 30 years, and nine were 46–60 years. From an educational perspective, 48 of the respondents had a diploma, 33 had

Table 4 Awareness of Farmer Respondents on Drug Residue

Variable	Category	Number	Frequency (%)
Do you know what withdrawal period means?	Yes	142	61.74
	No	88	38.26
If "yes" *describe*	Not using animal product after being treated for a number of permitted days	92	40.00
	Not lactating animal after being treated for a number of days	29	12.61
	The time that the drug stays in the body	11	4.78
	Giving rest for animals after treatment	10	4.35
	Not considered	88	38.26
Do you keep to withdrawal periods?	Yes	178	77.39
	No	52	22.61
What are the problems if withdrawal periods are not kept properly?	Causes disease in consumer (Humans)	210	91.30
	No problem	12	5.22
	Do not know the problem	8	3.48
What are the challenges to keep withdrawal periods?	Priority given to benefit than effect	58	25.22
	Benefit left from animals and priority given to benefit than effect	53	23.04
	Benefit left from animal	41	17.83
	Lack of knowledge of the effect and priority given to benefit than effect	33	14.35
	Lack of knowledge of the effect	31	13.48
	No challenge	6	2.61
	Carelessness	5	2.17
	Do not know	3	1.30

a degree, and one had a master's degree. The responsibilities of the respondents at their work were: clinic workers (69.51%), office workers (29.27%), and meat inspectors at abattoirs (1.22%) (Table 5).

Antibiotic Usage in Veterinary Professional Respondents

Most veterinary professionals (92.68%) practiced dose calculation during animal treatment and used body weight estimation (62.20%), as prescribed on the leaflet (28.05%), or by the recommended dose. Regarding the diagnosis of systemic infections, 79.27% of them were diagnosed by tentative diagnosis, 14.63% by laboratory, and 6.1% of them by treatment response. Among the veterinarian respondents, 85.37% of them have no laboratory facility for bacterial disease, and 14.63% of them have. For undifferentiated cases, 81.71% of them were administered broad-spectrum antibiotics, and 18.29% of them were administered antibiotics for gram-negative and gram-positive bacterial infections, at the same time. About 41.46% of professional respondents obtained veterinary antibiotics from both government and private suppliers and 39.02% from government suppliers alone (Table 6).

Table 5 Socio-Economic Demography of Veterinary Professional Respondents

Variable	Category	Number	Frequency (%)
District	Hawa Gelan	37	45.12
	Seyo	29	35.37
	Dale Sedi	16	19.51
Sex	Male	73	89.02
	Female	9	10.98
Age	31–45 years	52	63.41
	Less than 30 years	21	25.61
	46–60 years	9	10.98
Educational Level	Diploma/Level	48	58.54
	Degree	33	40.24
	Masters	1	1.22
Responsibility	Clinic	57	69.51
	Office Work	24	29.27
	Meat Inspector	1	1.22
Jobs Duration	5–10 years	37	45.12
	Above 10 years	30	36.59
	Less than 5 years	15	18.29

Table 6 Antibiotic Usage in Veterinary Professional Respondents

Variable	Category	Number	Frequency (%)
Do you practice dose calculation?	Yes	76	92.68
	No	6	7.32
If yes, how?	Body weight estimation	51	62.20
	As prescribed on the leaflet	23	28.05
	Body weight estimation and Recommended dose	8	9.76
How do you diagnose systemic infection?	Tentatively	65	79.27
	Laboratory	12	14.63
	By treatment response	5	6.10
Do you have a laboratory facility for bacterial disease?	No	70	85.37
	Yes	12	14.63
Which antibiotics do you give for undifferentiated cases?	Broad Spectrum	67	81.71
	Gram negative and Gram positive, simultaneously	15	18.29

(*Continued*)

Table 6 (Continued).

Variable	Category	Number	Frequency (%)
From where you get veterinary antibiotics?	From both government and private suppliers	34	41.46
	From government suppliers	32	39.02
	From private suppliers	16	19.51

Actions on AMR and Drug Residue by Veterinarian Respondents

Among the veterinary professional respondents who were asked whether they treat animals underdose/overdose or not, 87.80% of them responded that they have not treated animals under dose or overdose. When asked for evidence of not treating animals under dose or overdose, 42.68% of them stated that it was because overdose treatment would affect animals and under dose would be ineffective, 24.39% were due they were professionals, 17.07% of them, said under dose causes resistance and overdose affects the animal, and 12.20% of them gave overdose sometimes for aggressive cases. Approximately 98.78% of the respondents had given an awareness of the unprofessional use of antimicrobials for farmers. All respondents answered that they told the animal owners to maintain the withdrawal periods. About 85.37% of respondents would consider the treatment history of animals to be slaughtered at abattoirs if they were meat inspectors. Among the professional respondents who participated in this study, 65.85% of them sold veterinary drugs only to licensed veterinarians, 30.49% sold to any animal owner, and 3.66% sold it to any person who could resale the drug in the village (Table 7).

Table 7 Actions on AMR and Drug Residue by Veterinarian Respondents

Variable	Category	Number	Frequency (%)
Have you treated animals under dose or overdose?	No	72	87.80
	Yes	10	12.20
If you treated, Why?	Overdose affects animals and under dose is ineffective	35	42.68
	I am a professional	20	24.39
	Under dose causes resistance, overdose affects animal	14	17.07
	Some times for aggressive cases	10	12.20
	The animal will not be cured	3	3.66
Do you give awareness about unprofessional use of antimicrobials for farmers?	Yes	81	98.78
	No	1	1.22
Do you tell owners to keep withdrawal periods?	Yes	82	100.00
	No	0	0.00
Do you consider treatment history of animals to be slaughtered, if you work in an abattoir?	Yes	70	85.37
	No	12	14.63
To whom do you sell veterinary antibiotics, if you have a drug vendor?	Only to licensed veterinarian	54	65.85
	To any animal owner	25	30.49
	To any person who can resell the drug in the village	3	3.66

Association of Awareness About Antibiotics, AMR, and Withdrawal Periods with Demography of Farmer Respondents

The results showed a statistically significant relationship ($P < 0.05$) of districts, kebele, and income type with awareness of antibiotics, however educational level, age, sex, or job duration did not. Based on districts, high awareness about antibiotics was recorded in Hawa Gelan (75.5%) and lowest in Seyo (22.6%) with OR: 1.385; 95% CI: [1.003–1.913]. From kebeles, the highest awareness was noted in Machara (90%) and lowest in Dambi Dollo 03 (12%) with OR: 1.262; 95% CI: [1.071–1.486]. Farmers with income type of both land cultivation and animal rearing also had the highest awareness about antibiotics (60.5%) with OR: 3.427; 95% CI: [1.535–7.654] (Table 8).

Table 8 Logistic Regression Analysis on Association of Awareness on Antibiotics, AMR, and Withdrawal Periods with Demography of Farmer Respondents

Awareness of Antibiotic		Yes (%)	No	Odds ratio	Std. Err	95% CI	Chi-square	P-value
Educational Level	<8	66 (53.22)	58	0.875	0.145	[0.632–1.211]	0.65	0.418
	9–12	45 (57.69)	33					
	College and above	12 (54.54)	10					
	No formal education	3 (75)	1					
	Adult education	1 (50)	1					
Age	31–45	78 (56.93)	59	1.188	0.195	[0.861–1.639]	1.11	0.291
	46–60	33 (55)	27					
	15–30	14 (53.84)	12					
	>60	2 (28.57)	5					
Sex	Male	97 (52.43)	88	0.551	0.192	[0.278–1.091]	3.03	0.081
	Female	30 (66.66)	15					
District	Hawa Gelan	68 (75.55)	22	1.385	0.228	[1.003–1.913]	3.96	0.046
	Seyo	17 (22.66)	58					
	Dale Sedi	42 (64.61)	23					
Kebele	Machara	45 (90)	5	1.262	0.105	[1.071–1.486]	8.02	0.004
	Gaba Robi	23 (57.5)	17					
	Alaku Gambi	14 (28)	36					
	Dambi Dollo 03	3 (12)	22					
	Gonsi Daraba	32 (69.56)	14					
	Haro Sabu 02	10 (52.63)	9					
Income type	Both land cultivation and animal rearing	123 (60.89)	79	3.427	1.404	[1.535–7.654]	11.12	0.0009
	Land cultivation	0 (0)	24					
	Animal rearing	4 (100)	0					

(*Continued*)

Table 8 (Continued).

Awareness of Antibiotic		Yes (%)	No	Odds ratio	Std. Err	95% CI	Chi-square	P-value
Job duration	Above 10 years	101 (57.06)	76	1.380	0.433	[0.745–2.553]	1.05	0.304
	Less than 10 years	26 (49.05)	27					
Awareness of AMR								
Educational Level	<8	89 (71.77)	35	1.429	0.242	[1.025–1.993]	4.47	0.034
	9–12	49 (65.33)	26					
	College and above	12 (48)	13					
	No formal education	1 (25)	3					
	Adult education	2 (100)	0					
Age	31–45	92 (67.15)	45	1.243	0.210	[0.892–1.731]	1.64	0.200
	46–60	43 (71.66)	17					
	15–30	16 (61.53)	10					
	>60	2 (28.57)	5					
Sex	Male	120 (64.86)	65	0.671	0.248	[0.324–1.388]	1.20	0.273
	Female	33 (73.33)	12					
District	Hawa Gelan	70 (77.77)	20	0.749	0.131	[0.531–1.056]	2.76	0.096
	Seyo	20 (26.66)	55					
	Dale Sedi	63 (96.92)	2					
Kebele	Machara	49 (98)	1	0.912	0.078	[0.770–1.081]	1.12	0.288
	Gaba Robi	21 (52.5)	19					
	Alaku Gambi	11 (22)	39					
	Dambi Dollo 03	9 (36)	16					
	Gonsi Daraba	44 (95.65)	2					
	Haro Sabu 02	19 (100)	0					
Income type	Both land cultivation and animal rearing	145 (71.78)	57	3.536	1.339	[1.683–7.430]	12.69	0.0004
	Land cultivation	5 (20.83)	19					
	Animal rearing	3 (75)	1					
Job duration	Above 10 years	127 (71.75)	50	2.637	0.848	[1.404–4.953]	9.07	0.002
	Less than 10 years	26 (49.05)	27					

(*Continued*)

Table 8 (Continued).

Awareness of Antibiotic		Yes (%)	No	Odds ratio	Std. Err	95% CI	Chi-square	P-value
Awareness of Withdrawal Periods								
Educational Level	<8	83 (66.93)	41	1.494	0.252	[1.072–2.082]	5.81	0.015
	9–12	47 (62.66)	28					
	College and above	9 (36)	16					
	No formal education	2 (50)	2					
	Adult education	1 (50)	1					
Age	31–45	86 (62.77)	51	1.252	0.207	[0.904–1.734]	1.83	0.175
	46–60	40 (66.66)	20					
	15–30	14 (53.84)	12					
	>60	2 (28.57)	5					
Sex	Male	110 (59.45)	75	0.595	0.215	[0.293–1.209]	2.14	0.143
	Female	32 (71.11)	13					
District	Hawa Gelan	61 (67.77)	29	0.624	0.108	[0.445–0.877]	7.63	0.005
	Seyo	19 (25.33)	56					
	Dale Sedi	62 (95.38)	3					
Kebele	Machara	46 (92)	4	0.857	0.072	[0.726–1.012]	3.36	0.066
	Gaba Robi	15 (37.5)	25					
	Alaku Gambi	11 (22)	39					
	Dambi Dollo 03	8 (32)	17					
	Gonsi Daraba	44 (96.65)	2					
	Haro Sabu 02	18 (94.73)	1					
Income type	Both land cultivation and animal rearing	136 (67.32)	66	3.297	1.267	[1.552–7.004]	11.20	0.0008
	Land cultivation	2 (8.33)	22					
	Animal rearing	4 (100)	0					
Job duration	Above 10 years	123 (69.49)	54	4.076	1.343	[2.136–7.777]	19.13	0.000
	Less than 10 years	19 (35.84)	34					

Abbreviations: CI, confidence interval; Std. Err, standard error; AMR, antimicrobial resistance.

This study also showed a significant association ($P < 0.05$) between educational level (OR: 1.429; 95% CI: [1.025–1.993]), income type (OR: 3.536; 95% CI: [1.683–7.430]), and job duration (OR: 2.637; 95% CI: [1.404–4.953]) with awareness of AMR but age, sex, district, and kebele did not. Significant relationship ($P < 0.05$) between awareness about withdrawal periods and educational level (OR: 1.494; 95% CI: [1.072–2.082]), district (OR: 0.624; 95% CI: [0.445–0.877]), income type (OR: 3.297; 95% CI: [1.552–7.004]), and job duration (OR: 4.076; 95% CI: [2.136–7.777]) (Table 8).

Discussion

Antibiotics and antimicrobials are used in livestock production worldwide.[20] They are used in livestock farming mostly for purposes such as therapeutics (treating sick animals), metaphylaxis (control treatment of whole herds in case of disease outbreak), prophylaxis (preventive treatment), and growth promotion.[21] However inappropriate use of these drugs has a serious effect on animals, the economy, public health, and the environment.[22,23]

In the current study, more than half of the respondents had an awareness of the common antibiotics oxytetracycline and penicillin. This was consistent with the studies conducted by,[24,25] which indicated the most commonly used class of antibiotics was Tetracyclines and Penicillins in pastoral production systems in the Amhara and Oromia regions of Ethiopia and Mymensingh Division of Bangladesh, respectively. In this study, most of the respondents in the study area used antibiotics for diseased animals, although some of them used antibiotics for prevention in healthy animals and fattening or growth promotion. According to,[15] the majority of respondents (96.7%) gave antibiotics to treat their livestock from different sources in the Amhara region, northwestern Ethiopia. However, as stated in,[24] the use of antimicrobials for prophylactic purposes is common.

In this study, most of the respondents took their animals to veterinary clinics, some of them either took them to veterinary clinics or purchased antibiotics from drug vendors, and a very small number of owners treated their animals in traditional ways. Most of the respondents (59.13%) received antibiotics from both government and private veterinary clinics, followed by 32.17% of them from government veterinary clinics alone. This finding was almost in line with that of,[24] which stated that the main source of veterinary drugs for livestock owners in both highland and lowland mixed crop-livestock systems was the government or official veterinarian, whereas pastoralists most commonly accessed drugs from private suppliers. However,[15] stated that most respondents bought antibiotics from private pharmacies without a prescription; some of them were provided by clinical veterinary services, and others used antibiotics previously stored in their houses in northwestern Ethiopia.

This study showed that most (67.83%) of the respondents used veterinary professionals to inject their animals; some injected by themselves and others used either of them if they bought antibiotics at home. According to,[26] approximately half of the respondents stated that they used antibiotics before they contacted the veterinarian when their animals became ill in eastern Turkey, which is in line with our findings. This result indicates that inappropriate and unprofessional use of antibiotics may lead to AMR and residue formation which have a great effect on animals and also the consumer.

Based on the awareness of farmer respondents on AMR and responsible factors, 66.52% of them had awareness about AMR from which 29.13% of them responded as under dose injection of drugs; 16.65% of them said insufficient treatment (over/under dose injection) and 8.07% of them thought inappropriate drug as factors for AMR. The left respondents thought of delayed treatment, treatment without a prescription, and drug–disease mismatch as responsible factors for AMR. According to,[26] approximately 17% of the respondents stated that they had information about the importance of AMR, and 72% of them stated that inappropriate use of antibiotics caused the development of resistance in eastern Turkey. The respondents also have the development of drug resistance and animals unable to cure as problems with inappropriate antimicrobials and under-dose treatment. According to a study conducted by,[15] poor awareness of AMR, lack of rapid and effective diagnostic techniques, sub-standard quality of antibiotics, and use of antimicrobials for animal growth promotion were the most important factors that contribute to the increase of AMR. This result showed that there is a gap in the awareness of society on AMR which needs serious attention from the concerned bodies for awareness creation.

From the respondents, 61.74% have an awareness about a withdrawal period from which most (40%) of them described it as not using animal products after treatment for an amount of unpermitted days and the remaining respondents said it was not lactating animals after treatment for an amount of day, and the time that drug remained in an animal's body after treatment. According to a study conducted by[25] in Bangladesh, approximately 63.7% of farmers have heard about antibiotic residues, and more than half of them described antibiotic residues as an accumulation of antibiotics in the human body through the ingestion of meat and milk during antibiotic treatment or accumulation of antibiotics in the animal body. Based on this result the awareness of farmer respondents on the withdrawal period was not

sufficient and the issue is a serious public health problem. It is obvious that not keeping the withdrawal period in food animals may lead to the consumption of the drug residue found in animal products.

From the total respondents, 77.39% answered that they kept to withdrawal periods in treated animals, and when asked about the problems of not keeping to withdrawal period, 91.3% of them answered that it causes diseases in consumers (Humans). In contrast, in a study conducted by[25] in Bangladesh, only 25.5% of the farmers followed a withdrawal period after the use of antibiotics, and approximately 68.9% of the total population reported that they consumed or sold animal products and slaughtered animals during antimicrobial treatment. According to,[27] failure to observe the withdrawal periods, extra-label dosages for animals, the use of unlicensed antibiotics, and incorrect route of administration may result in residue formation.

Most (92.68%) of the veterinary professionals in this study practiced dose calculation during animal treatment and used the estimation of body weight method, as prescribed on the leaflet and diagnosed systemic infection by tentative diagnosis. A lack of laboratory facilities for bacterial diseases was found in the responses of most respondents, and most of them used broad-spectrum antibiotics in undifferentiated cases. According to Von Boeckel et al,[2] the misuse of antimicrobials in food animals can potentially cause the emergence of antimicrobial-resistant bacterial strains by increasing the selection pressure on bacteria to become resistant. Therefore, inappropriate use of antimicrobials and the treatment of animals with broad-spectrum antibiotics in undifferentiated cases may contribute to the development of resistant microbes in both animals and consumers.

Almost all the veterinary professionals who participated in this study responded that they had not treated animals with an overdose or under dose, although some of them treated animals with overdose for aggressive cases. Almost all veterinary professional respondents were aware of the unprofessional use of antimicrobials and to keep to withdrawal periods for farmers and consider the treatment history of animals to be slaughtered at abattoirs. More than half of the professional respondents who participated in this study sold veterinary drugs only to licensed veterinarians, but some sold them to any animal owner or to any person who could resell the drug in the village. According to Bedada et al,[28] misuse of drugs is common among various sectors, including veterinary and public health, in Ethiopia, and there is a lack of preparedness among the controlling authorities and producers in dealing with the risk of indiscriminate use of antibiotics to livestock and consumers. Therefore, even if in a minute number, giving animals an overdose or under dose, selling drugs to unprofessional persons or to any person who resells drugs in the village may contribute to the resistance to antimicrobials and the effect of drug residue on both animals and consumers.

In this study districts, kebele, and income type of farmer respondents showed a significant relationship with awareness of antibiotics. Educational level, income type, and job duration also showed a significant relationship with awareness of AMR, as well as educational level, district, income type, and job duration, showed a significant relationship with withdrawal periods. The study done by[26] in Turkey also indicated high level of education involved in the livestock sector increased the perception and awareness of AMR. This difference may probably be from linkage with animal ownership, the length of period they experienced in rearing animals, and the knowledge level of respondents because high awareness was observed in respondents with both land cultivation and animal rearing or only animal rearing as an income generation, those having more than 10 years experience in their job as well as having a formal education.

Conclusion

The current study showed more than half of the farmers in this study had an awareness of antibiotics and their usage, and almost all had used antibiotics for different purposes. The majority of the farmers also had an awareness of antimicrobial resistance and its causes, such as under-dose, insufficient treatment, inappropriate drugs, or treatment without a prescription. About half of the farmers were aware of drug residues and maintained the withdrawal period after animals were treated, as they considered it could cause diseases in the consumers (humans). Priority was given to benefit over effect, lack of knowledge of the effect, and carelessness were challenges for maintaining withdrawal periods in treated animals. Most veterinary professionals in this study practiced dose calculation during animal treatment by estimating body weight, tentatively diagnosing diseases, and treating animals with broad-spectrum antibiotics. Most professional respondents did not treat animals with under-dose or overdose and considered the

treatment history of animals slaughtered at abattoirs. Generally, the current study revealed that animals were administered under doses, and treatment by unprofessional, and broad-spectrum antibiotics, which may contribute to resistance to antimicrobials.

Abbreviations

AMR, antimicrobial resistance; CI, confidence interval; DSWAO, Dale Sedi Woreda Agricultural Office; FAO, Food and Agricultural Organization; HGWAO, Hawa Gelan Woreda Agricultural Office; OR, odd ratio; SE, standard error; SWAO, Seyo Woreda Agricultural Office; WHO, World Health Organization.

Data Sharing Statement

The data and materials used in this study are available from the corresponding author and can be shared upon reasonable request.

Ethics Approval and Consent to Participate

Before starting the research Dambi Dollo University Institutional Review Committee has seen the proposal and approved by minute reference number DaDUIRC/022/21 as the study has no ethical or moral problem on the respondents. Written consent was prepared but due possibility of farmers being unable to read it, it was applied verbally. The procedure was approved by the Dambi Dollo University Institutional Review Committee. The respondents agreed with the purpose of the study as it was so clear and important.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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Disclosure

All authors declare no competing interests in this work.

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