German Journal of Veterinary Research

eISSN:2703-1322

Research article

Prevalence and antimicrobial susceptibility profiles of *Campylobacter coli* isolated from broilers and layers cloacal swabs in Mwanza and Arusha, Tanzania

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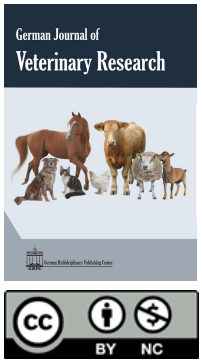

Article History:
Received: 21-Jul-2022
Accepted: 18-Sep-2022
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Abstract

Campylobacteriosis is an emerging zoonotic enteric disease that poses a threat to both human health and animal productivity. Poultry is known as the primary reservoir of *Campylobacter*, and 90% of human Campylobacteriosis is caused by *Campylobacter jejuni* and *Campylobacter coli*. This is complicated by the worldwide emergence of *Campylobacter* strains that are resistant to commonly used antimicrobial compounds. In this study, we determined the prevalence and antimicrobial susceptibility profiles of *Campylobacter coli* isolated from cloacal swabs collected from broilers and layers in Mwanza and Arusha, Tanzania. We collected 402 cloacal swabs from broilers and layers. Then, samples were enriched into Bolton Broth supplemented with 5% laked horse blood. *Campylobacter* was isolated and confirmed by PCR. Antibiogram was done by disk diffusion method using six antibiotics i.e., ampicillin, nalidixic acid, gentamycin, erythromycin, tetracycline, and ciprofloxacin. Of the 402 samples, 31 (7.71%) were confirmed to be *Campylobacter coli* by PCR. In Mwanza, the overall prevalence was 6.5% (6% and 7% in broilers and layers, respectively), while in Arusha, the overall prevalence was 8.9% (10.8% and 7% in broilers and layers, respectively). Antimicrobial susceptibility testing showed that 80.6%, 16.1%, 9.7%, 9.7%, 6.5%, and 3.2% were resistant to ampicillin, nalidixic acid, erythromycin, tetracycline, ciprofloxacin, and gentamycin, respectively. The rate of antimicrobial resistance (AMR) to at least one antimicrobial was 100%. Three out of thirty-one (9.7%) isolates were multi-drug-resistant to four different antimicrobial compounds, each with different patterns. Wise use of existing antimicrobials is necessary to curb the increasing trend of AMR strains.

Keywords: Chicken, *Campylobacter coli*, Prevalence, Antibiotic resistance, Tanzania

Citation: Nshama, R. P., Katakweba, A. S., Kashoma, I. P., Gahamanyi, N. and Komba, E.V. 2022. Prevalence and antimicrobial susceptibility profiles of *Campylobacter coli* isolated from broilers and layers cloacal swabs in Mwanza and Arusha, Tanzania. Ger. J. Vet. Res. 2 (4): 16-24. https://doi.org/10.51585/gjvr.2022.4.0045

Introduction

Antimicrobial resistance (AMR) is a global public health threat (WHO, 2014). It is projected that by the year 2050, the overall costs related to AMR could reduce global gross domestic product (GDP) by 2-3%, and the expected mortality reach ten million people each year (Sprenger and Fukuda, 2016; Burki, 2018). A recent study estimated that in 2019, 1.27 million deaths were directly attributable to AMR, which is higher than deaths due to HIV and Malaria (Murray et al., 2022). Evidence shows that the misuse of antimicrobial compounds in livestock production contributes to the overall burden of AMR in humans (Nhung et al., 2017). In some countries, antimicrobials are still used as growth promotors (Marshall and Levy, 2011), and livestock owners are easily getting access to antimicrobials over-the-counter without a veterinarian prescription leading to over-use and misuse of antimicrobials (Katakweba et al., 2012).

Globally, *Campylobacter* is among the major etiologies of foodborne illness, mainly gastroenteritis (Kouglenou et al., 2020). In addition, 90% of human enteric illness is caused by two common *Campylobacter* species, namely *C. jejuni* and *C. coli* (García-Sánchez et al., 2018). The main symptoms of human Campylobacteriosis include diarrhea, abdominal pain, fever, malaise, and headache (Whiley et al., 2013). Food-producing animals are the major reservoirs of *Campy-*

lobacter with the potential to transfer resistance to humans (WHO, 2014). Human exposure to *Campylobacter* can occur through direct contact with animal feces, during handling and petting or consumption of contaminated and improperly cooked food items, and drinking of unpasteurized milk and contaminated water (Kaakoush et al., 2015; Kashoma et al., 2015; Varga et al., 2019; Gahamanyi et al., 2020).

Chickens are the most commonly farmed species worldwide (Nhung et al., 2017). The population of chickens in Tanzania is estimated to be 87.7 million, of which 40.4 million are indigenous, and the remaining are exotic poultry (broiler and layers) which are 47.34 million (The United Republic of Tanzania, 2021). Apparently, due to their short time from hatching to maturity and easy accessibility, broiler meat is more consumed than other poultry species (FAO, 2019). Also, layers enter the food chain at the end of their egg production cycle with the possibility of spreading infections if they are colonized with zoonotic pathogens carrying AMR genes (Marshall and Levy, 2011).

In low- and middle-income countries (LMICs), most factors that accelerate AMR in *Campylobacter* include weak surveillance of antimicrobial use and resistance levels and extensive use of antimicrobials as growth promoters in livestock were reported (Komba et al., 2015). In LMICs, infections are reported to be commonly acquired through poor hygiene and sanitation. Also, living close to animals can result in humans acquiring Campylobacteriosis (Rukambile et al., 2021).

In Tanzania, there are limited reports of the prevalence and *Campylobacter* resistance to antimicrobials in livestock (Kashoma et al., 2015). The available literature highlights the increase of *Campylobacter*-associated infections in rural extensively raised local chickens (76%) than in urban broilers (60%), and a higher prevalence in local rural chickens than in those raised in urban areas (Komba et al., 2015; Chuma et al., 2016). No previous work has been conducted in Mwanza and Arusha regions on the prevalence and antimicrobial susceptibility profiles of *Campylobacter* species from livestock despite the high consumption of broilers and layers in these two cities. Therefore, we hypothesized that *Campylobacter* isolates from Mwanza and Arusha are resistant to commonly used antimicrobials in human and veterinary medicine. This study aims to determine the prevalence and antimicrobial susceptibility profiles of *C. coli* isolated from broilers and layers allocated in Mwanza and Arusha, Tanzania.

Material and methods

The current study was conducted in selected districts of the Mwanza and Arusha regions (Figure 1). The selection of the area of study was based on the high number of chickens in the reports that were provided by the District Veterinary Officers. Selected districts were Ilemela, Nyamagana, and Magu in the Mwanza region and Arusha Urban, Arusha Rural, Meru, and Monduli in Arusha region. Cloacal swabs were collected from broilers aged 4-6 weeks and layers (aged 1.5-2 years) that had reached the end of their laying period and were sold/being sold for human consumption. Samples were sent to Sokoine University of Agriculture (SUA) Microbiology and SACIDS laboratories in Morogoro for further analysis.

Study design and sample size determination

A cross-sectional study was conducted in Mwanza and Arusha regions (Figure 1) on farms having above 100 apparently healthy broilers (aged 4-6 weeks) and/or layers (aged 1.5 years and above). Farms with sick chicken or with chicken being treated with antimicrobial agents within the past seven days were excluded from the study. The sample size was calculated using the following formula: $(n) = (Z^2Pq)/d^2$, whereby; N= the total number of samples for the study, p= estimated prevalence of *Campylobacter* in Tanzania, d= allowable error (precision), and Z= confidence interval (Pourhoseingholi et al., 2013). The prevalence of 50.0% and 22.7% for broilers and layers, respectively, from a study conducted by Chuma et al. (2016) was used to determine the sample size at a 95% confidence interval and a precision of 0.05. A total of 402 samples (202 broilers and 200 layers) were collected from both regions.

Sample collection and transportation to the laboratory

Samples were collected from the birds' cloaca using sterile swabs (Oxoid Ltd., Basingstoke, UK). Farms with more than 100 chickens were identified for sample collection, and 10-20 chickens were purposively picked on the farm for sampling. Cloacal swabs were collected and placed into tubes containing Bolton Broth (Oxoid Ltd, Basingstoke, UK) supplemented with 5% lysed horse blood (Oxoid Ltd., Basingstoke, UK), and the tubes were labeled with sample identification, location, and date. Collected samples were stored in a cool box with ice packs and transported to the Sokoine University laboratory within eight hours for further processing.

Laboratory analysis of fecal samples

Isolation of Campylobacter species

Samples in Bolton broth were incubated at 42°C for 24 hours in microaerophilic conditions generated by a lit candle and subcultured onto blood agar (BA) plates (Oxoid Ltd., Basingstoke, UK) by membrane filtration method. Briefly, a 0.45 μm-pore size nitrocellulose filter membrane (Fisher Scientific, Leicestershire, UK) was placed on top of the BA, and 200 μL of the sample from Bolton Broth were dispensed onto the filter using a pipette and allowed to sink for 45 minutes (Tilmanne et al., 2019). The filter paper was carefully removed from the medium. As previously mentioned, the filtered samples were streaked on the whole BA plate and incubated at 42°C under micro-aerophilic conditions for 48 hours. Presumptive *Campylobacter* colonies were sub-cultured onto new sterile BA plates, and preliminary identification of *Campylobacter* spp. was done

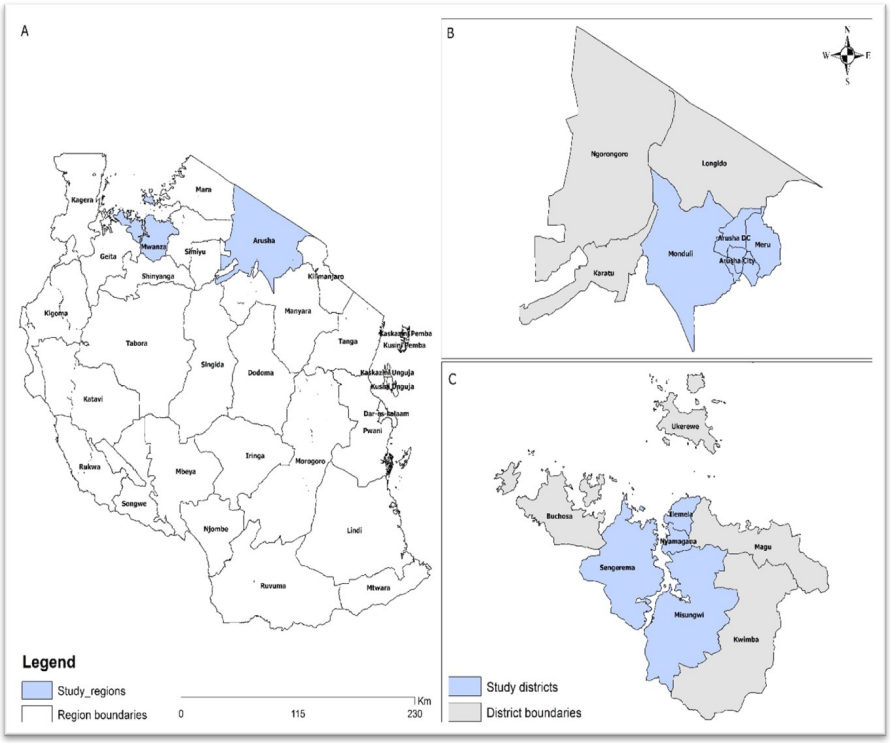

Figure 1: A map showing study regions and districts, A) Mwanza and Arusha regions, B) Arusha Rural, Meru, and Monduli (Arusha region), and C) Ilemela, Nyamagana, and Magu (Mwanza regions). The map was created by using ArcGIS software (licensed access).

based on their morphological appearance on solid media (BA), i.e., non-hemolytic, greyish, smooth, glistening, and convex with entire edges and Gram staining features including small, curved or spiral, Gram-negative bacteria. Pure colonies were preserved at -80°C in Mueller Hinton broth containing 15% glycerol before multiplex polymerase chain reaction (PCR) for species confirmation.

Molecular confirmation of Campylobacter by PCR

DNA extraction

The preserved isolates were subcultured onto BA for 48 hours at 42°C before DNA extraction. Colonies were subcultured onto BA to obtain colonies free from glycerol. DNA extraction was performed by the boiling method in which a single loopful of isolated colonies was added into an Eppendorf tube containing 500 μL DNase/RNase-free water and boiled at 95^{o}C for 10 minutes in the water bath, then centrifuged at a speed of 20,000 rounds per minute (rpm) for 5 minutes (Pavlova et al., 2016). The supernatant was transferred into a new Eppendorf tube without touching the pellet, the centrifugation was repeated twice, and the extracted DNA was stored at 4°C.

Confirmation of *Campylobacter* by PCR

The confirmation of *Campylobacter* genus and species was done using forward and reverse primers of *Campylobacter* genus, *C. jejuni*, *C. coli*, and *C. lari* at the base pair size of 816, 161, 502, and 251, respectively (Integrated DNA Technologies, Belgium) (Pavlova et al., 2016). *C. jejuni* ATCC® 33560 and *C. coli* ATCC® 33559 were used as positive controls. Deionized water (Thermo Fisher Scientific, USA) was used as a negative control. Template DNA was added to the PCR mixture containing 12.5 μL of 2× Master Mix (Thermo Fisher Scientific, USA), 1 μL (10 μM) of each primer, and 9.5 μL of sterile deionized water (Integrated DNA Technologies, Inc., Singapore). The DNA amplification was performed using the MiniAmpTM Plus Thermal Cycler (Applied Biosystems, Massachusetts, USA). The cycling conditions used were one cycle of 95°C for 5 min, 35 cycles each of 94°C for 30 seconds, 55°C for 45 seconds, 72°C for 45 seconds, and a final extension at 72°C for 7 minutes. The PCR products were analyzed on 1.5% gel electrophoresis, and bands were visualized under ultraviolet light and photographed with Bio-Rad ChemiDoc Imaging System (Bio-Rad Laboratories, USA).

Antibiogram

The antibiogram was carried out according to the guidelines provided by the Clinical and Laboratory Standards Institute (CLSI), adopting the disc diffusion method on Muller Hinton Agar (MHA) (Oxoid Ltd, Basingstoke, UK) (CLSI, 2021). *Campylobacter* colonies from previously isolated and preserved at -80°C were suspended in sterile normal saline and adjusted to a turbidity equivalent to a 0.5 McFarland standard. Using sterile cotton-tipped swabs, the suspension was streaked onto MHA containing 5% lysed horse blood (Azrad et al., 2018). The plates were left to dry for 15 minutes. Antimicrobials tested are representatives of the drugs used for humans and

livestock in Tanzania. The same antimicrobials are on the list of commonly used drugs as recommended by WHO (Aidara-Kane et al., 2018). Antimicrobial discs used include quinolones (ciprofloxacin 5 μg and nalidixic acid 30 μg), aminoglycoside (gentamycin 10 μg), macrolides (erythromycin 15 μg), penicillin (ampicillin 10 μg) and tetracycline (30 μg) (Oxoid Ltd, London, UK). The antibiotic discs were distributed over the plates using a q1BB disc dispenser (Fisher Scientific, USA) and incubated at 37°C for 48 hours under microaerophilic conditions. After incubation, the diameters (mm) of inhibition zones were measured using a ruler. Interpretation of results was recorded as susceptible (S), Intermediate (I), or resistant (R) based on the breakpoint recommended by CLSI (CLSI, 2021). Isolates that are resistant to three or more antimicrobial classes are considered multidrug-resistant (MDR) (Hakanen et al., 2003; WHO, 2014).

Results

Isolation and Molecular confirmation of *Campylobacter*

Out of 402 cloacal swabs collected from broilers and layers chickens allocated in Mwanza (n=200) and Arusha (n=202) farms, 39 samples were suspected to be *Campylobacter* positive by Cape Town protocol. Out of 39 isolates, 31 (7.71%) were confirmed using multiplex PCR to be *Campylobacter* spp. After gel electrophoresis, bands were observed at 816bp and 502bp, which corresponded to the known standard bands of Genus *Campylobacter* and *C. coli*, respectively. There were no bands observed for C. lari (251bp) and *C. jejuni* (161bp) (Figure 2).

Prevalence of *Campylobacter* species in Mwanza and Arusha

The overall prevalence of *C. coli* in broilers and layers was 8.4% (17/202) and 7% (14/200), respectively. In Mwanza, the overall prevalence of *C. coli* was 6.5% (13/200), 6% (6/100) in broilers, and 7% (7/100) in layers. In Arusha, the overall prevalence of *C. coli* was 8.9% (18/202), 10.8% (11/102) in broilers, and 7% (7/100) in layers.

Antimicrobial susceptibility profiles

The highest frequency of resistance was observed for ampicillin (80.6%), whereas the lowest resistance was recorded for gentamycin (3.2%), as shown in Table 1.

Antimicrobial susceptibility profiles of *Campylobacter coli* by region

Isolates from the Arusha region showed the highest resistance to all the antimicrobials tested in this study, with the highest resistance for AMP (45.2%), followed by NAL (12.9%), and the lowest resistance was observed for GEN (3.2%). In Mwanza, the highest resistance was observed for AMP (35.5%), followed by NAL and TET (3.2%). No resistance was observed for CIP, GEN, and ERY (Table 2).

Antimicrobial susceptibility profiles of *Campylobacter coli* by chicken breeds

C. coli isolates obtained from layers in this study showed a higher proportion of resistance to AMP (58.1%) than broilers (22.6%). No resistance was recorded for CIP. The antimicrobial susceptibility of *C. coli* isolated from broiler and layer chickens in the Arusha and Mwanza regions is shown in Table 3.

Antimicrobial resistance of *Campylobacter coli* isolates by district

Campylobacter coli isolates from Arusha urban, Monduli, Magu, and Ilemela districts were 100% susceptible to TET compared to Meru and Nyamagana with a resistance of 6.5% and 3.2%, respectively. There was a significant difference between the percentage of TET resistance recorded in the two districts (p-value= 0.036). No resistance to CIP, NAL, GEN, TET, and ERY was observed among the *C. coli* isolated from Magu and Ilemela districts. The highest resistance to AMP was observed in Arusha urban.

Multi-drug resistance profiles of *Campylobacter coli* isolates

Twenty-three out of 31 (74.3%) isolates were resistant to AMP only, whereas four out of 31 (12.5%) were resistant to NAL only. One isolate was resistant to two antimicrobial classes, while four isolates were resistant to three antimicrobial classes (Figure 3). Two out of 31 (6.5%) of the *C. coli* isolates were susceptible to all antimicrobial agents evaluated in this study (Table 4).

Discussion

Human-animal interactions and poor hygienic practices are associated with the worldwide distribution of foodborne illnesses, particularly Campylobacteriosis. In this study, the overall prevalence of *C. coli*, the only isolated species, was 7.71% (31/402). *Campylobacter* spp. are frequently isolated from broiler chickens worldwide. According to the systemic review that evaluated the prevalence of *Campylobacter* species in humans and animals in sub-Saharan Africa (SSA), the overall prevalence of *Campylobacter* ranged from 1.7% to 62.7% in humans and from 1.2% to 80% in animals, and the most reported species were *C. jejuni* and *C. coli* (Gahamanyi et al., 2020).

However, the recorded prevalence differs from other recently reported findings. For example, in a study from Southern Benin, a lower prevalence of *C. coli* (7.8%) than *C. jejuni* (23.4%) was reported (Kouglenou et al., 2020). In Kenya, the prevalence of *C. coli* was 44% in broiler chickens (Carron et al., 2018), whereas in Egypt, it was 15% in layers (Ghoneim et al., 2021). Contrary, a lower prevalence of 4.44% was reported in a study conducted in Burkina Faso (Coulidiaty et al., 2021), which indicates that the prevalence of *C. coli* varies from country to country, which could be attributed to the differences in study design, geographic location, husbandry practices, differences in transportation media used, environment, and interactions by humans and animals of different species.

Table 1: Antimicrobial susceptibility profiles of *C. coli* from broiler and layer chickens in Arusha and Mwanza regions, Tanzania.

Antimicrobial agent	**Number of resistant isolates**	**Resistance %**
Ciprofloxacin (CIP)	2/31	6.5
Nalidixic acid (NAL)	5/31	16.1
Gentamycin (GEN)	1/31	3.2
Erythromycin (ERY)	3/31	9.7
Ampicillin (AMP)	25/31	80.6
Tetracycline (TET)	3/31	9.7

Table 2: Resistance of *Campylobacter coli* by region isolates obtained from broiler and layer chickens in Arusha and Mwanza regions, Tanzania.

Antimicrobial agent	**Arusha**		**Mwanza**		**P value**
	Number of resistant isolates	Resistance %	Number of resistant isolates	Resistance %	
Ciprofloxacin	2/18	6.5	0/13	0	0.245
Nalidixic acid	4/18	12.9	1/13	3.2	0.348
Gentamycin	1/18	3.2	0/13	0	0.419
Erythromycin	3/18	9.7	0/13	0	0.148
Ampicillin	14/18	45.2	11/13	35.5	0.217
Tetracycline	2/18	6.5	1/13	3.2	0.841

Table 3: Antimicrobial susceptibility of *Campylobacter coli* isolates obtained from broiler and layer chickens in Arusha and Mwanza regions in Tanzania by chicken type.

Antimicrobial agent	**Broilers**		**Layers**		**chi-square**	**P value**
	Number of resistant isolates	Resistance %	Number of resistant isolates	Resistance %		
Ciprofloxacin	2/17	6.5	0/14	0	3.887	0.049
Nalidixic acid	3/17	9.7	2/14	6.5	1.565	0.211
Gentamycin	0/17	0	1/14	3.2	0.568	0.451
Erythromycin	2/17	6.5	1/14	3.2	1.411	0.235
Ampicillin	7/17	22.6	10/17	58.1	3.16	0.075
Tetracycline	2/17	6.5	1/14	3.2	1.411	0.235

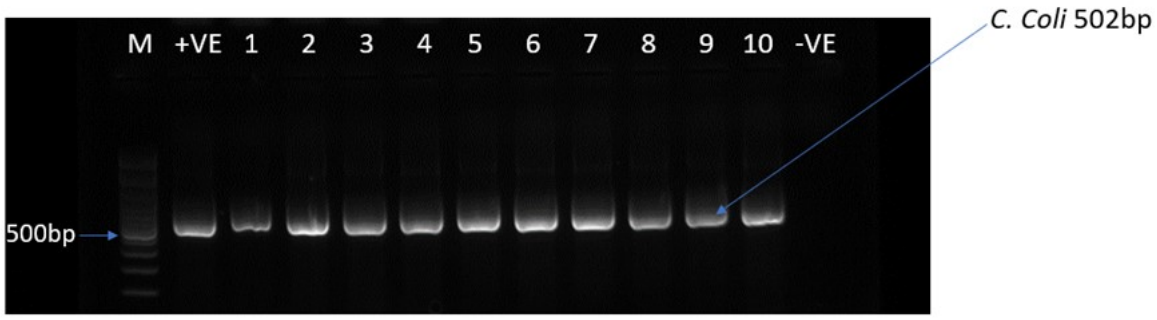

Figure 2: Agarose gel image showing bands of *C. coli* from chicken. M = Marker (100bp), +ve = Positive control (*C. coli ATCC® 33559*), 1-10 = Samples, -ve = Negative control, bp= base pair.

Table 4: Antimicrobial susceptibility profiles of the *Campylobacter coli* isolates obtained from broiler and layer chickens in Arusha and Mwanza regions, Tanzania.

Antimicrobial agent	**Number of isolates**	**%**
Ampicillin	23/31	74.3
Nalidixic acid	4/31	12.5
Nalidixic acid-Gentamycin	1/31	3.2
Nalidixic acid-Erythromycin-Ampicillin	2/31	6.5
Nalidixic acid-Ampicillin-Tetracycline	2/31	6.5
Ciprofloxacin-Erythromycin-Tetracycline	2/31	6.5
Ciprofloxacin-Nalidixic acid-Erythromycin	2/31	6.5
NONE	2/31	6.5

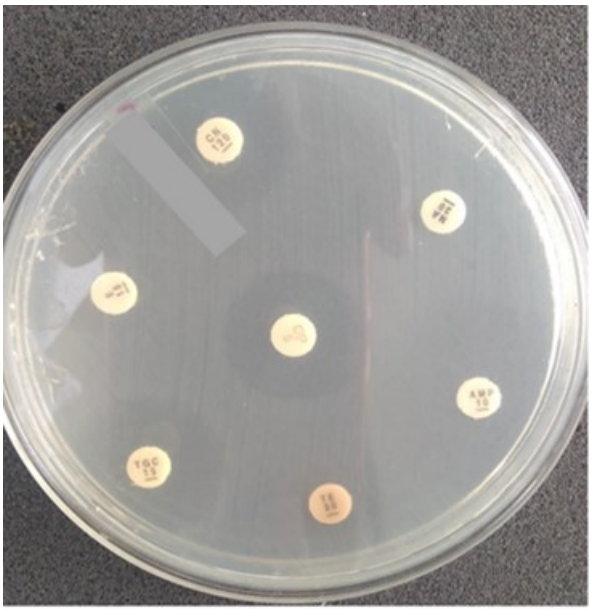

Figure 3: Muller Hinton Agar plate showing the one of MDR pattern. CN= gentamycin, NA= nalidixic acid, AMP= ampicillin, TE= tetracycline, E= Erythromycin, CIP= ciprofloxacin.

In Mwanza, the prevalence of *C. coli* was 6% and 7% in broilers and layers, respectively, while in Arusha, it was 11% and 7%, respectively. The results indicate a slightly higher *Campylobacter* prevalence in broilers from Arusha than in Mwanza. The similarities in *C. coli* prevalence suggest that both regions could be showing similar exposure to factors that cause *Campylobacter* spp. contamination during chicken produc-

tion. Different studies have shown that in the guts of poultry, *C. jejuni* is more prevalent than *C. coli*, the predominant species in pigs (Komba et al., 2015; Gahamanyi et al., 2020, 2021; Neogi et al., 2020). However, in this study, *C. coli* was the only species that could be isolated (100%). A stressful environment due to the prolonged exposure to non-optimal temperature during long transportation time (8 hours) of samples from Mwanza and Arusha to Morogoro might trigger *C. jejuni* to be changed to the dormant phase (viable-but-nonculturable) (Kassem et al., 2013).

The increased demand for livestock products in LMICs has been partly associated with the continuous use of antimicrobials as growth promoters leading to increased antimicrobial consumption and the rise of AMR pathogens (Subbiah et al., 2020). A recent study in Msimbazi River Basin, Tanzania, reported a very high usage (87.6%) of veterinary antimicrobials for prophylaxis in poultry and pig farming without a veterinarian prescription (Frumence et al., 2021). Also, a report from the northern part of Tanzania reported a high prevalence (over 50%) of AMR *Campylobacter* spp. in domestic animals, wildlife, and water sources (Subbiah et al., 2020). Furthermore, a recent report shows that *Campylobacter* is resistant to the mostly used antimicrobials, including AMP, TET, and ERY in SSA, which is partly associated with the extensive use of antimicrobials in human and veterinary medicine (Gahamanyi et al., 2020).

In this study, the rate of AMR to at least one antimicrobial was 88.24%. The highest and lowest resistance were observed for AMP (80.6%) and GEN (3.2%), respectively. The probable reason for the high resistance to AMP is that penicillin antimicrobial class is commonly used as a supplement in animal feeds and is also easily available over the counter for human use without a medical prescription (Varga et al., 2019). Additionally, *Campylobacter* is inherently resistant to beta-lactam antibiotics like ampicillin due to enzymatic inactivation by *bla*OXA-61, as previously reported (Kashoma et al., 2015). Resistance to GEN has been relatively low (3.2% in this study); this could be attributed that GEN is used for treating systemic infections and is not used as a feed additive (Lynch et al., 2020). Monitoring GEN resistance is crucial because its misuse might also cause nephrotoxicity and ototoxicity (Onyeanu et al., 2020).

Indeed, precaution is needed to prevent the spread of resistance of *C. coli* to CIP (6.5% in this study) because CIP is used in human medicine, and resistant strains can circulate among different reservoirs. Moreover, the resistance of *C. coli* isolates to NAL was 16.1% which is lower than those which was reported in Tunisia (46.2%) (Gharbi et al., 2018), Burkina Faso (50%) (Coulidiaty et al., 2021), Sri Lanka (84.44%) (Kottawatta et al., 2017), and South Korea (88%) (Kwon et al., 2021).

In this study, 9.7% of *C. coli* were resistant to TET which was low compared to other reports from different studies such as in Sri Lanka (24.4%) (Kottawatta et al., 2017), Bangladesh (42%) (Neogi et al., 2020), South Korea (56%) (Kwon et al., 2021), Southern Benin (71.4%) (Kouglenou et al., 2020) Burkina Faso (87.5%) (Coulidiaty et al., 2021), and Tunisia (100%) (Gharbi et al., 2018). The lower resistance observed suggests that tetracycline is not commonly used in livestock production in Mwanza and Arusha, Tanzania. The resistance to ERY was 9.7% which is closely related to 11.7% reported in Benin (Kouglenou et al., 2020), 8.8% in South Korea (Kwon et al., 2021), and 11.11% in Sri Lanka (Kottawatta et al., 2017). However, higher resistance rates were reported in Tunisia (100%) (Gharbi et al., 2018) and Bangladesh (46%) (Neogi et al., 2020). This could be associated with a slow development of resistance and low survival of resistant strains to erythromycin by *Campylobacter* species (Gahamanyi et al., 2021).

This study also indicates that there was no significant difference in AMR prevalence among breed types except for CIP, which was higher in broilers (6.5%) than in layers (0%) (Table 4). This result is in agreement with Bester and Essack, who reported a high prevalence in broilers (91%) than in layers (76%) in South Africa (Bester and Essack, 2012). Out of 31 *C. coli* isolates, four isolates (12.9%) were MDR with different patterns. However, higher rates of MDR were reported in Benin (Kouglenou et al., 2020), Tunisia (Gharbi et al., 2018), and South Korea (Kottawatta et al., 2017). The reasons for different MDR rates could be attributed to the differences in types and number of antimicrobials tested and extent of exposure to these antimicrobials by country in livestock and humans, different study designs, and the number of isolates obtained for testing.

Conclusion

In this study, the overall prevalence of *Campylobacter* isolated from 402 cloaca swabs in the Mwanza and Arusha regions of Tanzania was 7.71%. All isolates were confirmed to be *C. coli*. Additionally, 88.24% of the isolated *C. coli* were resistant to at least one of the tested antimicrobials. *C. coli* isolated from broilers were observed to have higher resistance to CIP, NAL, ERY, and TET than those isolated from layers. The highest resistance was reported for AMP in Mwanza and Arusha. GEN and AMP resistance was higher in *C. coli* isolated from layers than from broilers. Three isolates were MDR with different resistance patterns. The adoption of AMR surveillance using the One-Health approach is recommended to minimize *Campylobacter* contamination in humans and animals. Also, proper use of existing antimicrobials is urgently needed to ensure consumer safety.

Article Information

Ethical Approval. The research was approved by Sokoine University Institutional Ethical Review Board with a reference number DRTC/R/186udmIII/5.

Conflict of Interest. The authors have no conflict of interest to declare.

Acknowledgments. We extend our sincere gratitude to individuals and/or groups whose contributions made this study

possible: staff at the Microbiology and SACIDS laboratories at the Sokoine University of Agriculture for their assistance during my laboratory work, farmers in Mwanza and Arusha for their acceptance and readiness to provide support during data collection.

Funding. This research received no funds.

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