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Review on Antimicrobial Resistance Pattern of Similar Antibiotics Used for *Escherichia coli* and *Salmonella* spp. in Bangladesh with Public Health Significance

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MJH, RARS and MMR finalized the study conception. Authors MJH, RARS and ZF collected literature and executed data curation. Authors MJH and RARS wrote original draft and performed data analysis. Authors MJH, MTR and MSAM reviewed and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

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Review Article

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ABSTRACT

Antimicrobial resistance (AMR) is a major health issue for humans and animals around the world. Different classes of antibiotics are frequently used to treat human, poultry, and livestock diseases in Bangladesh. *Escherichia coli* and *Salmonella* spp. cause gastrointestinal illness in humans and

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animals. Since they have zoonotic potential, their antibiotic resistance genes may transfer both horizontally and vertically. Human, poultry, and livestock excreta and their environment are excellent sources of pathogenic bacteria. Therefore, *E. coli* and *Salmonella* infections in humans and animals are frequently found here, causing huge economic losses. To control these infections, similar categories of antibiotics are aimlessly used here. In this study, different types of antibiotics like ampicillin, ceftriaxone, ciprofloxacin, gentamicin, erythromycin, azithromycin, tetracycline, sulphamethoxazole-trimethoprim, and colistin were found to have higher levels of resistance against *E. coli* and *Salmonella* spp. Due to a higher level of resistance, two or three types of antibiotic combinations are used today to check bacterial infections that increase the medicinal burden. It is high time to combat AMR infections by raising public awareness, and the government should implement a national action policy to combat illegal antibiotic use.

Keywords: AMR; E. coli; Salmonella; zoonotic; humans; poultry; livestock.

1. INTRODUCTION

The issue of antimicrobial resistance (AMR) affects public health worldwide [1,2]. AMR increases the number of deaths and hospitalizations while also increasing medical costs [1]. It also affects the poultry and livestock sectors simultaneously [3,4]. Each year, AMR is responsible for hundreds of thousands of fatalities [5]. According to the GRAM Burden Report 2022, AMR is responsible for 4.95 million fatalities in 2019 [1]. AMR is expected to kill approximately 10 million people per year by 2050 [6]. According to the WHO, AMR is among the top 10 worldwide public health hazards to humanity [7,8]. According to World Bank estimations, with modest AMR impacts, the world's annual gross domestic product (GDP) will probably decline by 1.1% by 2050, while in a high AMR adverse situation, the global GDP would fall by 3.8% by 2050, with an annual shortfall of 3.4 trillion US dollar by 2030 [9]. AMR would also cause less-developed countries to experience greater economic growth declines than developed countries, increasing economic disparities between nations [10]. The highest AMR effect scenario projects a probable 11% reduction in livestock productivity in low-income nations by 2050 [9].

E. coli is often found in the gastrointestinal tracts of humans and animals. *E. coli* strains are not commonly detrimental. But some strains such as Shiga toxin-producing *E. coli* (STEC), can cause severe foodborne diseases. Around the world, 20% of cases of foodborne diseases are caused by *E. coli* O157:H7 [11]. Salmonellosis is an ordinary bacterial disease condition that is responsible for gastrointestinal illness. *Salmonella* spp. generally lives in the intestines of humans and animals and is shed in feces. CDC reported that *Salmonella* generates 1.35 million illnesses, 26,500 hospital admissions, and 420 human deaths annually in the US [12]. Both *E. coli* and *Salmonella* spp. have zoonotic significance and cause severe production losses in dairy and poultry [3,4].

Different classes of antibiotics have been widely used for the treatment of *E. coli* and *Salmonella* infections for decades. Antibiotics are becoming less effective due to their widespread indiscriminate use. That’s why several studies have been carried out on AMR for various bacterial species in humans, poultry, and livestock from time to time in Bangladesh. This study is designed to look into the use of similar kinds of antibiotics and their resistance patterns in humans, poultry, and livestock.

2. MATERIALS AND METHODS

We utilized the databases Google, Google Scholar, Pubmed, and ReseachGate for a search of pertinent literature on similar antibiotics used in humans, poultry, and livestock in Bangladesh. The keywords used to search databases were "AMR of *E. coli* and *Salmonella* in humans, poultry, and livestock from 2010 to 2022 in Bangladesh" and "AMR of *E. coli* and *Salmonella* in different divisions of Bangladesh;" "AMR of *E. coli* and *Salmonella* in Bangladesh for livestock production;" "Antibiotic-resistant" or "antimicrobial-resistant" in poultry farming in Bangladesh. We also searched for AMR situations in hospital patients, chickens, and ruminants in Bangladesh. AMR of *E. coli* and *Salmonella* spp. in humans, poultry, and livestock around the world is also observed for the global burden and situation of AMR. We used Microsoft Word and Excel (MS-2013) for data curation and analysis.

3. SOURCE AND TRANSMISSION

3.1 *E. coli*

The main reservoir for *E. coli* transmission is cattle [4]. Similarly, other livestock like sheep and goats are considered to be significant hosts, and some vertebrates, including poultry, pigs, and horses, have also been detected as transport hosts [2,11]. Humans become infected with *E. coli* O157:H7 after consuming contaminated foods such as raw meat or unpasteurized milk [11]. Cross-contamination with beef and other animal foods during cooking, diseased surfaces, and dirty kitchen tools are some ways that infection can happen. Another risk factor is fecal contamination of food, drink, and other sources [4].

3.2 *Salmonella* spp.

Salmonella spp. can be transmitted by food animals like chickens, pigs, and cattle [2,4,13]. It is also found in birds, reptiles, and turtles, as well as in pets like cats and dogs [13]. *Salmonella* may go up the food web from feedstuffs through primary production to homes, catering, and other locations where food is served [2]. Salmonellosis is most commonly transmitted to humans by consuming untreated water and contaminated foods of livestock origin [13]. It is also feasible for humans to transmit salmonellosis indirectly [14]. Pet owners who come into contact with diseased animals may also get sick [13].

4. SIMILAR ANTIBIOTICS USED IN HUMAN, POULTRY AND LIVESTOCK

Antibiotics are drugs used to treat bacterial infections in both humans and animals [15]. Globally, different classes of antibiotics are used for the treatment of *E. coli* and *Salmonella* infections in humans, poultry, and livestock [16, 17]. Several studies have been reported that penicillins, cephalosporins, quinolones, aminoglycosides, macrolides, tetracyclines, sulfonamides, and other classes of similar antibiotics are frequently used to treat *E. coli* infections in humans, poultry, and livestock in Bangladesh [Table 1].

5. RESISTANT PATTERN OF *E. coli* AND *Salmonella* SPP.

Antimicrobial resistance of *E. coli* and *Salmonella* spp. has become an alarming issue that is being encountered more frequently worldwide in both veterinary and human medicine. *Salmonella* and *E. coli* species have a strong potential to acquire resistance genes, despite the fact that all therapeutically significant antimicrobial medicines are fundamentally sensitive to them. In the case of *E. coli*, horizontal gene transfer is predominant [43], whereas salmonellosis involves both horizontal and vertical transmission [2]. The resistance pattern of similar antibiotics for *E. coli* and *Salmonella* spp. infection in humans, poultry, and livestock in Bangladesh is shown in Table 2.

Table 1. List of similar antibiotics used in humans, poultry, and livestock in Bangladesh

Class of antibiotics	Name of antibiotics	References
Penicillins	i) Ampicillin ii) Amoxicillin	[18-26]
Cephalosporins	i) Cephalexin ii) Ceftriaxone	[17, 18, 23, 27-29]
Quinolones	i) Ciprofloxacin ii) Levofloxacin iii) Norfloxacin iv) Nalidixic Acid	[16, 18, 20, 24, 26, 28, 30-35]
Aminoglycosides	i) Gentamicin	[18, 23, 36]
Macrolides	i) Erythromycin ii) Azithromycin	[4, 22, 23, 28, 33, 37, 38]
Tetracyclines	i) Tetracycline ii) Doxycycline	[4, 16, 18, 19, 32, 38-40]
Phenicols	i) Chloramphenicol	[4, 24, 33]
Sulphonamides	i) Sulphamethoxazole	[17, 20, 36, 41]
Polymyxins	i) Colistin	[3, 27, 42]

Table 2. Resistance pattern of similar antibiotics used for *E. coli* and *Salmonella* spp. in Bangladesh

Antibiotic class	Name of antibiotics	Resistant percentage for *E. coli*			References	Resistant percentage for *Salmonella* spp.			References
		Human	**Poultry**	**Livestock**		**Human**	**Poultry**	**Livestock**	
Penicillins	Ampicillin	90	100	87	[18-22, 24-26]	100	100	100	[44-47]
	Amoxicillin	74	100	90	[18, 21, 23, 26]	16	100	100	[18, 48-50]
Cephalosporins	Cephalexin	84.1	100	53.8	[17, 23, 27]	06	65	71.4	[17, 18, 51]
	Ceftriaxone	63	69.24	21.79	[18, 28, 29]	03	96.42	33	[18, 52, 53]
Quinolones	Ciprofloxacin	61	100	22.1	[18, 28, 30, 31]	94	100	31.57	[18, 54, 55]
	Levofloxacin	54.3	81.6	14.8	[18, 31, 32]	25	50	9.1	[53, 56, 57]
	Norfloxacin	39	50	16.32	[24, 33, 34]	23	20	21.42	[18, 51, 58]
	Nalidixic Acid	85.9	100	86	[16, 20, 26, 35]	100	100	100	[44, 45, 59-62]
Aminoglycosides	Gentamicin	30	100	100	[18, 23, 36]	02	86.70	6.62	[4, 18, 54]
Macrolides	Erythromycin	98	100	88.89	[4, 22, 23, 37, 38]	87	100	100	[39, 45, 50, 55, 59, 63-65]
	Azithromycin	49	76.93	100	[4, 28, 33]	100	81.25	100	[4, 45, 60]
Tetracyclines	Tetracycline	56	100	89.44	[4, 18, 19, 37, 38]	15	100	86.76	[4, 18, 39, 48, 51, 59, 64, 66]
	Doxycycline	61.1	78.1	28.57	[16, 32, 39]	7	79.31	26.66	[18, 61, 65]
Phenicols	Chloramphenicol	40	97.2	33.89	[4, 24, 33]	20.8	94.28	76	[16, 47, 67]
Sulphonamides and Trimethoprim	Sulphamethoxazole-trimethoprim	78.1	100	100	[17, 20, 37, 41]	29.4	76.83	81.48	[3, 16, 19, 68]
Polymyxins	Colistin	2.9	48.84	15.9	[3, 27, 42]	19.54	60	89.47	[46, 55, 69]

5.1 Resistance to Penicillins

Antibiotics from various classes are frequently used to treat *E. coli* and *Salmonella* infection. Ampicillin and amoxicillin are β-lactam antibiotics that kill a wide variety of bacterial pathogens [2]. In Bangladesh, ampicillin showed 87% to 100% resistance to *E. coli* and *Salmonella* spp. from hospital patients, poultry, and cattle samples, respectively. Manhique-Coutinho et al. [70] reported 97.8% ampicillin resistance to *E. coli* from diarrheal children in Mozambique and 91% ampicillin resistance to *Salmonella* Typhimurium in China [71]. Racewicz et al. [72] detected 100% ampicillin resistance to *E. coli* in poultry in Poland, whereas 95.4% resistance was found in livestock in the UAE [73]. On the other hand, Elmadiena et al. [74] reported 90.60% ampicillin resistance in *Salmonella* from humans and animals in Sudan. Fig. 1 shows the resistance of ampicillin to *E. coli* and *Salmonella,* where 100% resistance was observed in the case of *Salmonella* among humans, poultry, and livestock in Bangladesh.

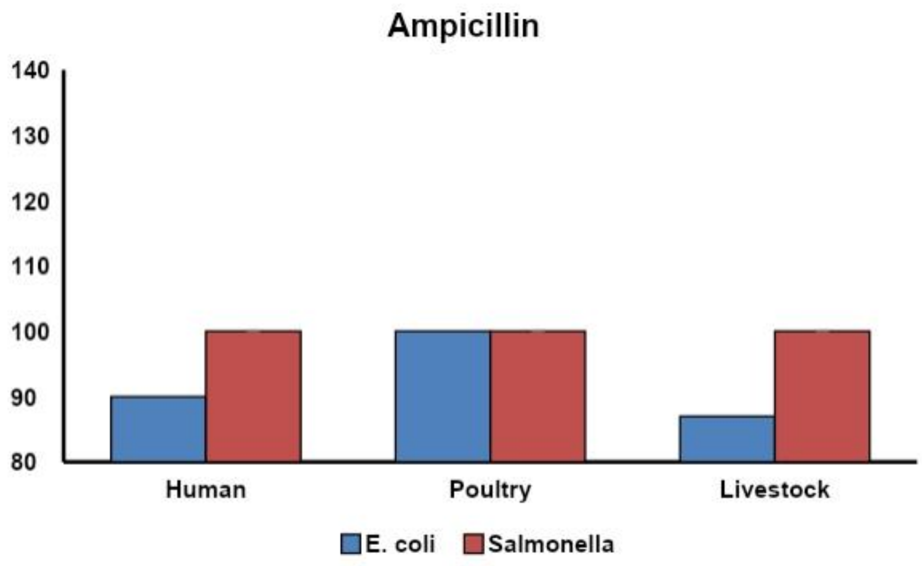

Fig. 1. Pattern of ampicillin resistance in Bangladesh

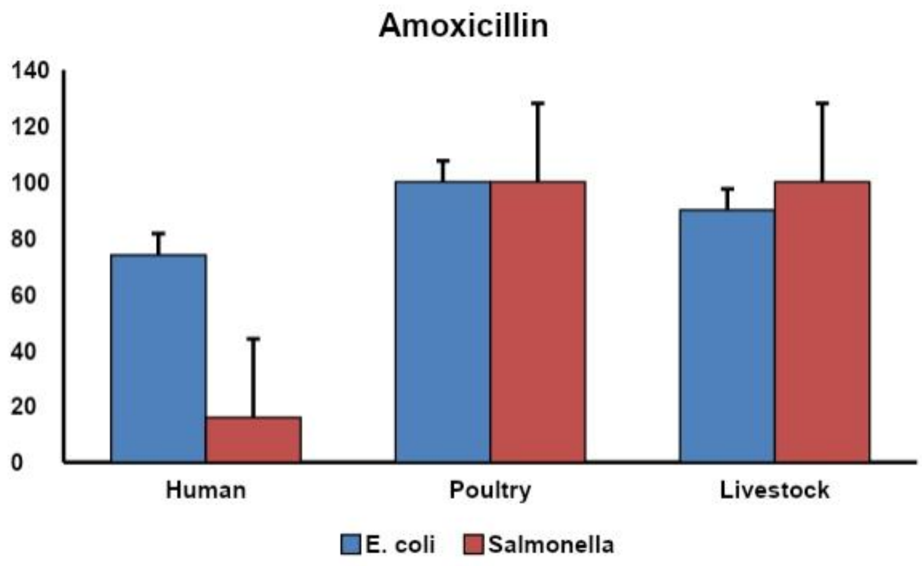

Fig. 2. Pattern of amoxicillin resistance in Bangladesh

Amoxicillin found 74% to 100% resistance to *E. coli* and 16% to 100% resistance to *Salmonella* in human, poultry, and dairy samples in Bangladesh. Wu et al. [75] reported 85% amoxicillin resistance to *E. coli* in neonates in China. Abbassi et al. [76] showed 57% amoxicillin resistance to *E. coli* in livestock in Tunisia, whereas 95% was found in diarrheal calves in Chile [77]. On the other hand, Garbaj et al. [78] found 100% *Salmonella*-resistant amoxicillin in dairy products in Libya. Fig. 2 represents the resistance of amoxicillin to *E. coli* and *Salmonella*, whereas 100% resistance was noticed in both *E. coli* and *Salmonella* in poultry in Bangladesh. Similarly, amoxicillin resistance in livestock was also significantly high. Long-term use of penicillin drugs in humans and animals may result in higher detection of resistance against *E. coli* and *Salmonella* spp.

5.2 Resistance to Cephalosporins

Cephalexin is the first generation and ceftriaxone is the third generation cephalosporin, which are widely used to treat numerous diseases in humans, poultry, and livestock [16,17]. In this review, we found 53.8% to 100% cephalexin-resistant and 21.79% to 69.24% ceftriaxone-resistant *E. coli* samples from humans, poultry, and ruminants. Recently, Eezzeldin et al. [79] reported 90.6% cephalexin and 72% ceftriaxone resistance to *E. coli* from Soba hospital samples in Sudan. On the other hand, Manishimwe et al. [80] found 56.8% ceftriaxone resistance in *E. coli* samples from dairy cattle in the USA. Fig. 3 represents the resistance of cephalexin to *E. coli* and *Salmonella*, where 100% resistance was observed in salmonellosis in poultry in Bangladesh. In humans, 84.1% of cephalexin-resistant *E. coli* was also alarming.

About 6% to 71.4% cephalexin resistance and 3% to 96.42% ceftriaxone resistance were found against salmonellosis in humans and animals in Bangladesh. Elmadiena et al. [74] discovered that 50% of Sudanese humans and animals were cephalexin-resistant to *Salmonella*. On the other hand, Oneko et al. [81] reported 56.5% resistance to ceftriaxone against *Salmonella* in Keneya. Fig. 4 represents the resistance of ceftriaxone to *E. coli* and *Salmonella*, where the highest resistance was noticed in salmonellosis in poultry in Bangladesh. These results highlight the urgent requirement for an improved drug monitoring system in Bangladesh.

5.3 Resistance to Quinolones

Quinolone is a class of antibiotics that is widely used for the treatment of bacterial infections. Fluoroquinolone antimicrobials like ciprofloxacin, levofloxacin, norfloxacin, and nalidixic acid are often used to treat a variety of illnesses in people, poultry, and animals [2]. In this study, we observed 22.1% to 100% ciprofloxacin resistance to *E. coli* and 31.57% to 100% ciprofloxacin resistance to *Salmonella* in humans, poultry, and livestock in Bangladesh. Recently, Eezzeldin et al. [79], Koju et al. [82], and Samy et al. [83] found 68%, 66%, and 50.8% resistance to ciprofloxacin against *E. coli* in human, poultry, and livestock samples from Sudan, Nepal, and Egypt, respectively. *Salmonella* found 75% ciprofloxacin resistance in human and broiler isolates in Colombia [84]. Qamar et al. [85] reported 31% ciprofloxacin resistance from raw milk samples in Pakistan. Fig. 5 shows the resistance of ciprofloxacin to *E. coli* and *Salmonella*, where 100% resistance was noticed in both *E. coli* and *Salmonella* in poultry in Bangladesh. In humans, 94% of ciprofloxacin-resistant *Salmonella* detections were also significant.

Levofloxacin found 54.3%, 81.6%, and 14.8% resistance to *E. coli*, whereas norfloxacin observed 39%, 50%, and 16.32% resistance to *E. coli* in human, poultry, and livestock samples in Bangladesh. In Colombia, Herrera-Sánchez et al. [84] found 57.1% levofloxacin-resistant *Salmonella* in human and broiler isolates. Nalidixic acid (NA) is another kind of quinolone antibiotic that is generally used to treat infections. In this study, we found 86%–100% NA resistance to *E. coli* and *Salmonella* from various isolates from humans, poultry, and animals. Vuthy et al. [86] reported 91% *E. coli* resistance and 92% *Salmonella* spp. resistance in NA from chicken samples in Cambodia. On the other hand, 77.3% of NA-resistant *E. coli* were detected in fecal isolates of dairy cattle in Texas [80]. Fig. 6 shows the resistance of NA to *E. coli* and *Salmonella*, where 100% resistance was observed in the case of *Salmonella* among humans, poultry, and livestock in Bangladesh. These findings warn regarding the rigorous application of fluoroquinolones in humans, birds, and animals.

5.4 Resistance to Aminoglycosides

Aminoglycoside antibiotics inhibit the production of bacterial proteins [87]. One of the most common aminoglycoside antibiotics used in human and animal medicine is gentamicin. In this study, we observed 30% to 100% gentamicin resistance to *E. coli* and 2% to 86.70% resistance to *Salmonella* from human, poultry, and livestock samples in Bangladesh. Recently, Garca-Béjar et al. [88] observed 79% resistance to gentamicin in *E. coli* samples from chickens in Spain. Abdelwahab et al. [73] also reported 85% resistance to gentamicin from *E. coli* isolates from ruminants in the UAE. In Pakistan, Wajid et al. [89] reported 64.70% gentamicin-resistant *S. typhimurium* in poultry. The detection of higher resistance to gentamicin in animal samples is quite alarming. Gentamicin should therefore be used with caution in poultry production. Fig. 7 represents the resistance of gentamicin to *E. coli* and *Salmonella*, where higher resistance was noticed in *E. coli* in poultry and livestock in Bangladesh.

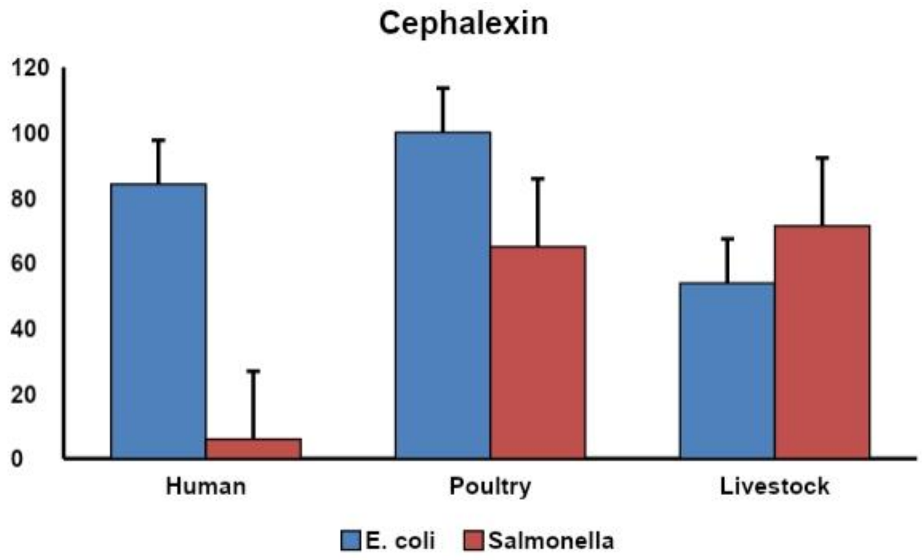

Fig. 3. Pattern of cephalexin resistance in Bangladesh

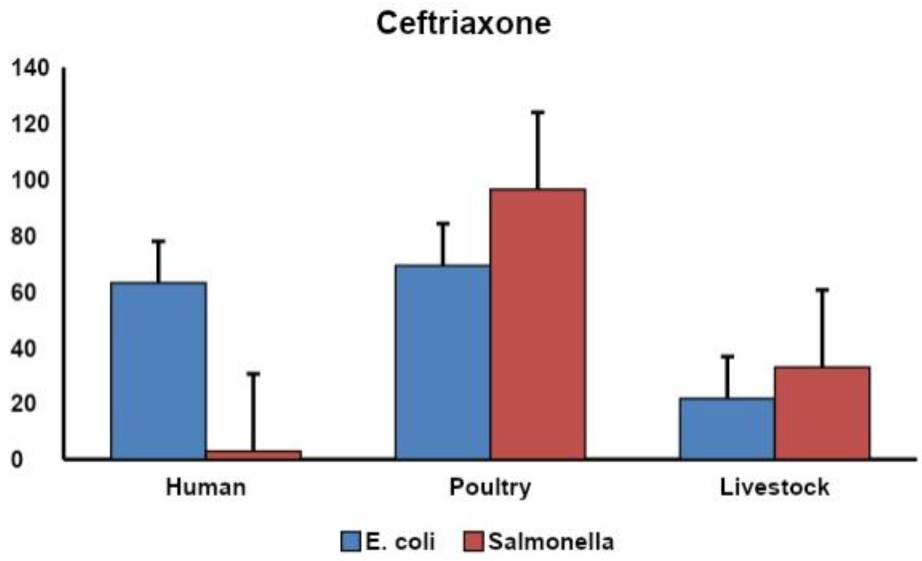

Fig. 4. Pattern of ceftriaxone resistance in Bangladesh

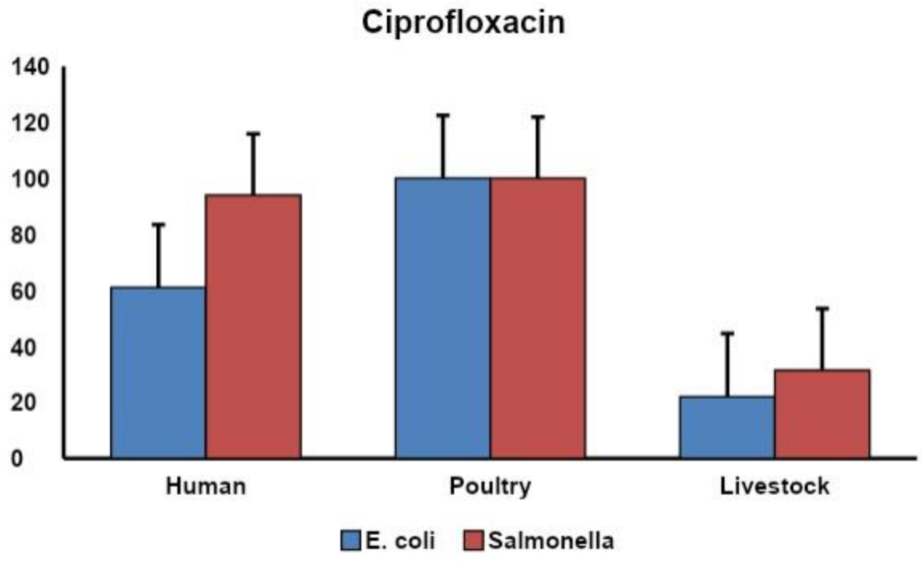

Fig. 5. Pattern of ciprofloxacin resistance in Bangladesh

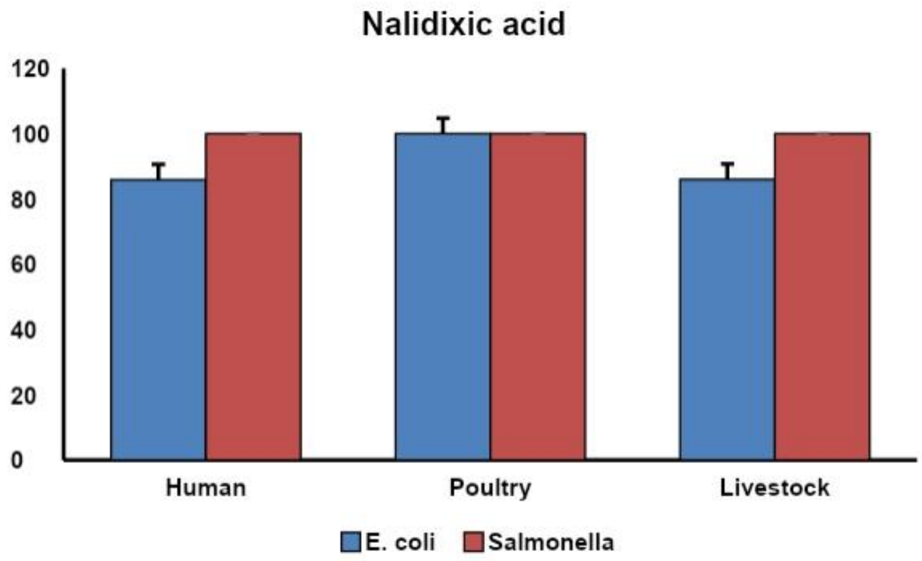

Fig. 6. Pattern of nalidixic acid resistance in Bangladesh

5.5 Resistance to Macrolides

Erythromycin and azithromycin are grouped into macrolides, where their main function is to restrict or inhibit bacterial growth rather than destroy it [90]. In Bangladesh, 88.89% to 100% erythromycin-resistant *E. coli* and 87% to 100% erythromycin-resistant *Salmonella* were observed in human, poultry, and livestock isolates. Kibret et al. [91] found 89.4% resistance to erythromycin against *E. coli* from human isolates in Ethiopia. Recently, Ranasinghe et al. [92] also reported 80.84% resistance of *E. coli* to erythromycin from poultry samples in Sri Lanka. Ramatla et al. [93] observed 89.3% erythromycin-resistant *Salmonella* in human and livestock isolates in South Africa. Sharma et al. [94] and Cardoso et al. [95] also noticed 100% resistance to *Salmonella* against erythromycin in India and Brazil, respectively. Adzitey et al. [96] found 86% erythromycin-resistant *Salmonella* in dairy cattle in Ghana. Fig. 8 represents the resistance of erythromycin to *E. coli* and *Salmonella*, where higher resistance was observed in all cases in humans, poultry, and livestock.

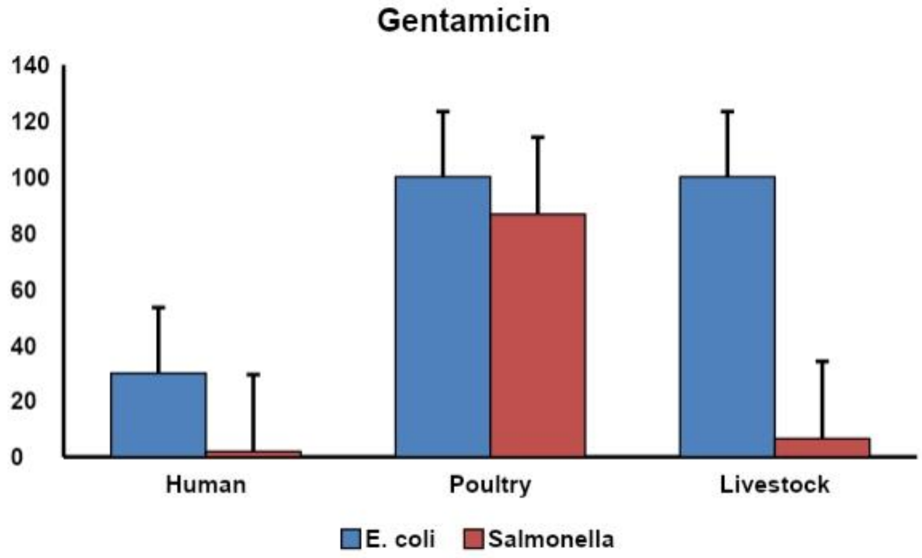

Fig. 7. Pattern of gentamicin resistance in Bangladesh

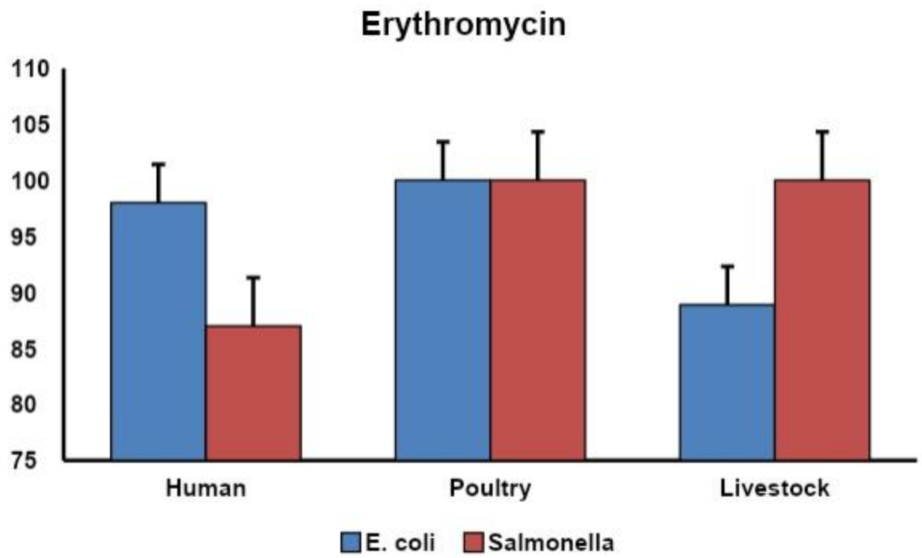

Fig. 8. Pattern of erythromycin resistance in Bangladesh

In this study, we found 49% to 100% azithromycin-resistant *E. coli* and 81.25% to 100% azithromycin-resistant *Salmonella* isolates from human and animal samples. Xiang et al. [97] reported 86.7% azithromycin-resistant *E. coli* from hospital patients' samples in China. On the other hand, Gupta et al. [98] also found 73.3% azithromycin-resistant. *Salmonella* from human isolates in India. Fig. 9 represents the resistance of azithromycin to *E. coli* and *Salmonella* where 100% resistance was noticed in both *E. coli* and *Salmonella* in livestock.

5.6 Resistance to Tetracyclines

Tetracyclines, which include doxycycline and tetracycline, are commonly used in human and animal medicine. In Bangladesh, 56% to 100% tetracycline-resistant *E. coli* and 15% to 100% tetracycline-resistant *Salmonella* were observed in humans, poultry, and ruminants. Wilkerson et al. [99] reported 52% and 98% tetracycline-resistant *E. coli* from human and bovine isolates, respectively. Koju et al. [82] also found 87.7% tetracycline-resistant *E. coli* in chicken samples in Nepal. On the other hand, Pavelquesi et al.

[100] reported 70% tetracycline-resistant *Salmonella* of human and animal origin. Sharma et al. [94] also detected 100% resistance to tetracycline-resistant *Salmonella* from chicken meat samples in India. Fig. 10 shows the resistance of tetracycline *to E. coli* and *Salmonella*, where 100% resistance was noticed in both *E. coli* and *Salmonella* in poultry. Livestock also remained in the upper position.

In this study, we found that more than 75% of the *E. coli* and *Salmonella* spp. isolated from poultry in Bangladesh were resistant to doxycycline. Racewicz [72] and Waghamare et al. [101] also reported *E. coli* and *Salmonella* as being 100% resistant to doxycycline in China and India.

5.7 Resistance to Phenicols

Chloramphenicol is not presently used widely but is sometimes used in a lower dose, which may be harmful to the hosts [102]. But it has long been used to treat a variety of bacterial illnesses in people and animals [2]. In this review, we found 33.89% to 97.2% chloramphenicol-resistant *E. coli* and 20.8% to 94.28% chloramphenicol-resistant *Salmonella* from human, chicken, and livestock samples in Bangladesh. Abbasi et al. [76] reported 53.4% chloramphenicol-resistant *E. coli* from livestock samples in Tunisia. Okoli et al. [103] also found 100% chloramphenicol-resistant *E. coli* in poultry isolates in Nigeria. Busani et al. [104] found 84%, and El-Sharkawy et al. [105] reported 100% resistance to chloramphenicol against *Salmonella* from cattle and poultry isolates in Italy and Egypt, respectively. Fig. 11 shows the resistance of tetracycline to *E. coli* and *Salmonella*, where 100% resistance was noticed in both *E. coli* and *Salmonella* in poultry.

5.8 Resistance to Sulphonamides

The sulfamethoxazole component is a member of the sulfonamide drug class that acts as a bacteriostatic [2]. In this study, we observed 78.1% to 100% sulphamethoxazole-trimethoprim resistance in *E. coli* and 29.4% to 81.48% sulphamethoxazole-trimethoprim resistance in *Salmonella* from human, poultry, and livestock samples in Bangladesh. Bailey et al. [106] reported 71% sulphamethoxazole-trimethoprim-resistant *E. coli* from hospital patient samples in the USA. Racewicz et al. [72] also reported 84% resistance of *E. coli* to sulfamethoxazole-trimethoprim in poultry samples from China. On the other hand, Nguyen et al. [107] detected 53.04% sulfamethoxazole- trimethoprim-resistant *Salmonella* from poultry isolates in Vietnam. Dahshan et al. [108] also reported 100% sulphamethoxazole-trimethoprim-resistant *Salmonella* from pigs in Japan. Fig. 12 shows the resistance of sulphamethoxazole-trimethoprim to *E. coli* and *Salmonella*, where higher resistance was noticed in both *E. coli* and *Salmonella* in poultry and livestock.

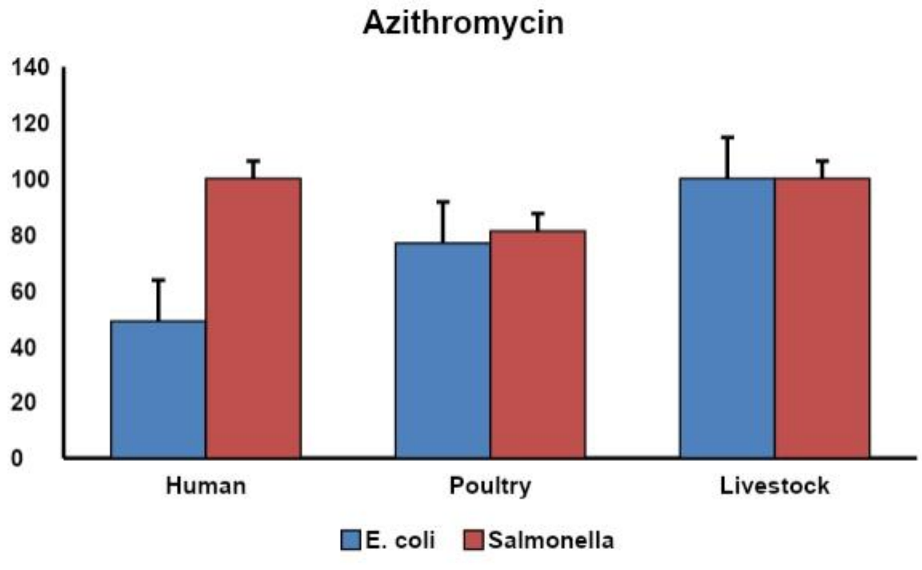

Fig. 9. Pattern of azithromycin resistance in Bangladesh

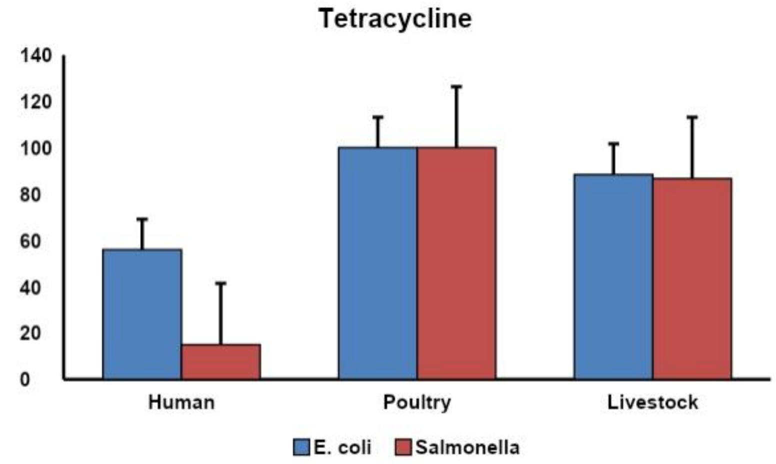

Fig. 10. Pattern of tetracycline resistance in Bangladesh

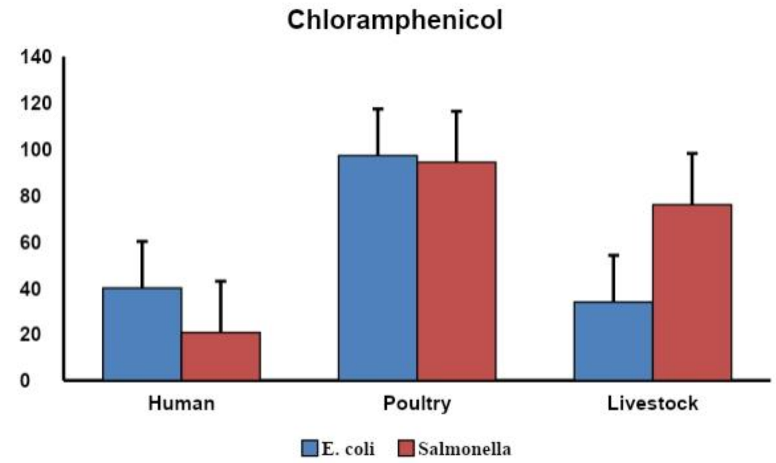

Fig. 11. Pattern of chloramphenicol resistance in Bangladesh

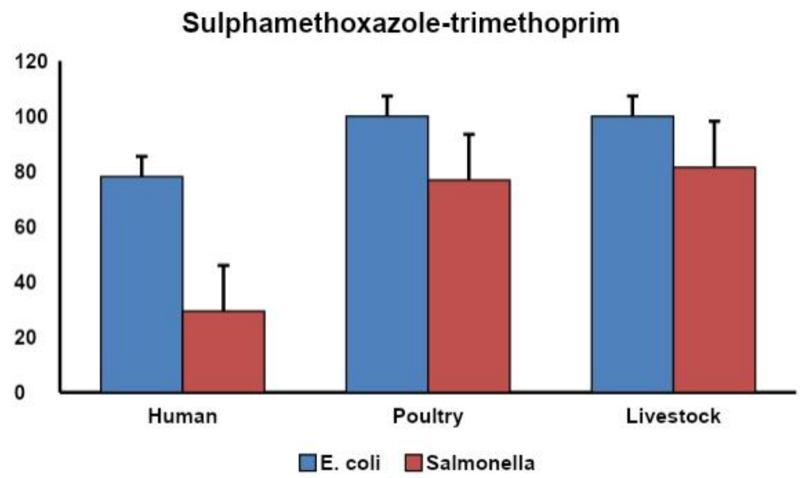

Fig. 12. Pattern of sulphamethoxazole-trimethoprim resistance in Bangladesh

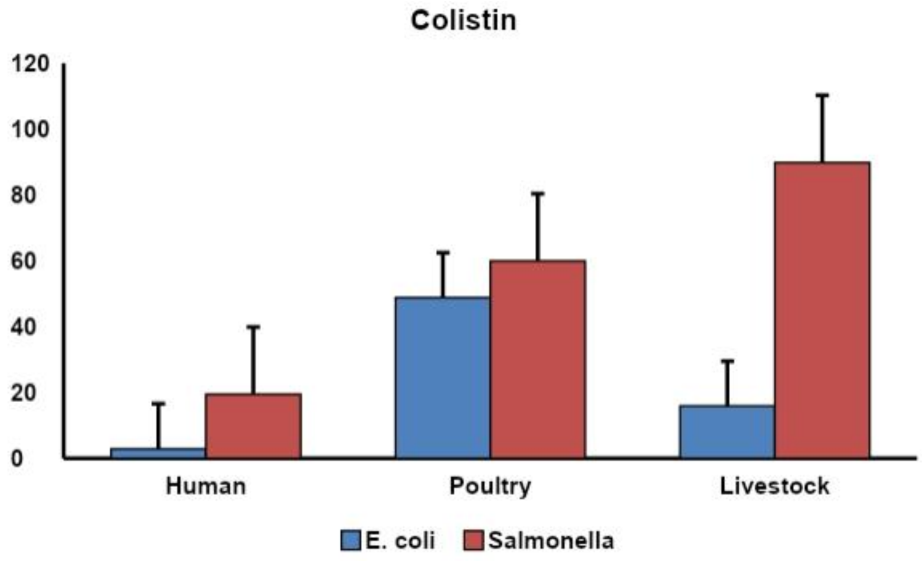

Fig. 13. Pattern of colistin resistance in Bangladesh

5.9 Resistance to Polymyxins

Colistin is a polymyxin antibiotic that is restricted in application for the cure of human illness, but it is still widely used in animal production [2,109]. In Bangladesh, 2.9% to 48.84% colistin-resistant *E. coli* and 19.54% 89.47% colistin-resistant *Salmonella* were observed in human and animal isolates. Similarly, Garca-Béjar et al. [88] and Hess et al. [110] also reported 73.68% and 87% resistance to colistin against *E. coli* from poultry isolates in Spain and Austria, respectively. Phiri et al. [111] also found 78.70% colistine-resistant *Salmonella* in Zambia. Fig. 13 shows the resistance of colistin to *E. coli* and *Salmonella*, where higher resistance was observed in *E. coli* in livestock.

6. PREVENTION AND CONTROL MEASURES FOR *E. Coli* AND *Salmonella* spp.

E. coli and *Salmonella* spp. antimicrobial resistance has a significant economic impact on every continent. It causes extra treatment expenses, loss of productivity, and death, all of which result in financial losses. Good personal hygiene, proper food handling, avoiding cross-contamination of foods, and a biosecurity system at the farm level may reduce the clinical manifestation of diseases. Good sanitation and an effective AMR surveillance system are essential to combat zoonotic infections and control *E. coli* and *Salmonella* infections. National action plans for AMR reduction should be followed, which might be helpful to reduce the chance of AMR transmission.

7. CONCLUSION

Antimicrobial resistance is a critical issue that is increasing day by day. *E. coli* and *Salmonella* spp. have zoonotic significance, and AMR resistance genes may transfer through human and animal interactions. Penicillins, cephalosporins, quinolones, aminoglycosides, macrolides, tetracyclines, phenicols, sulphonamides, and polymyxins are different classes of antibiotics that were found to have higher resistance in this study. Resistance to a similar class of antibiotics was discovered in humans, poultry, and livestock, which is extremely concerning for future AMR combat. Control and prevention with one health strategy may reduce the transmission of antimicrobial-resistant genes of *E. coli* and *Salmonella* in humans, poultry, and livestock.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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