Original research article UDK 579.842.1/2:615.281.9:[636.2.053(65)
https://doi.org/10.46784/e-avm.v17i2.389

SEROTYPING AND ANTIMICROBIAL RESISTANCE OF *ESCHERICHIA COLI* ISOLATED FROM DIARRHEIC CALVES IN THE PROVINCE OF TIZI-OUZOU, ALGERIA

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Abstract

Calf diarrhea is still a problematic disease in the dairy industry worldwide. Several enterpathogens are associated with diarrhea in calves including *Escherichia coli.* This latter is one of the most common causes of diarrhea and septicemia in calves. The primary goal of antimicrobial therapy in calves with diarrhea is to prevent bacteremia and decrease the number of coliform bacteria in the small intestine. The excessive use of antibiotics reduced their effectiveness, which eventually led to the risk of emergence of antibiotic resistance. This study aimed to determine the carriage rate, antimicrobial resistance patterns and serotypes of *E. coli* isolates involved in calf diarrhea in farms from Tizi-Ouzou. A total of 154 fecal samples were collected from diarrheic calves belonging to 22 farms between 2019 and 2021. All the samples were inoculated into MacConkey agar plates (MC) and MacConkey agar supplemented with 2 µg/L of cefotaxime (MC+CTX) for cefotaxime-resistant (CTX^R) *E. coli*. *Escherichia coli* isolates were identified using API20E commercial kits. Antimicrobial susceptibility was determined by a disk diffusion test. The serogrouping of the isolates was realized

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with a rapid slide agglutination test. Overall, 128 isolates of *E. coli* (one isolate per sample) were obtained in MC, including three strains in MC+CTX. Furthermore, 47.6 % of *E. coli* strains recovered from MC agar were resistant to at least one antimicrobial. The three *E. coli* isolates recovered from MC+CTX media showed an *ESBL*-producing profile. The serological identification revealed that 67 (52.3%) of the isolated strains were typable with O antisera. The most common serogroup was O55 (13.3%), followed by O128 (10.1%) and O111 (7.8%), O119 (7%), O126 (6.2%), O26 (5.5%), and O114 (2.3%). Antibiotic susceptibility testing revealed that 37.5% (48/128) and 22.7% (29/128) of the isolates were resistant to tetracycline and streptomycin respectively. Furthermore, multidrug resistance was observed in 17.96% (23/128) of the *E. coli* isolates. Our study provides valuable information about *E. coli*-associated calf diarrhea in farms of Tizi-Ouzou. Regular antibiotic resistance monitoring is required to limit the spread of multidrug-resistant *E. coli* in the barn environment.

Key words: Calves, diarrhea, antimicrobial resistance, serotype, *Escherichia coli*

SEROTIPIZACIJA I ANTIMIKROBNA REZISTENCIJA *ESCHERICHIA COLI* IZOLOVANIH OD TELADI SA DIJAREJOM U PROVINCIJI TIZI-OUZOU, ALŽIR

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Kratak sadržaj

Dijareja teladi još uvek predstavlja problematično oboljenje u industriji mleka i mlečnih proizvoda širom sveta. Više enteropatogena se povezuju sa dijarejom teladi uključujući i vrstu *Escherichia coli.* Ovaj organizam je

jedan od najčešćih uzročnika dijareje i septikemije kod teladi. Primarni cilj antimikrobne terapije kod teladi sa dijarejom je sprečavanje bakteremija i smanjenje broja koliformnih bakterija u tankom crevu. Prekomerna upotreba antibiotika smanjila je njihovu efikasnost, što je na kraju dovelo do rizika od razvoja i širenja antimikrobne rezistencije. Cilj ovog rada je da odredi stopu prenosa, modele antimikrobne rezistencije i serotipove izolata *E. coli* povezane sa dijarejom teladi na farmama u oblasti Tizi-Ouzou. U periodu od 2019. do 2021.godine prikupljeno je ukupno 154 uzorka fecesa teladi sa dijarejom sa 22 farme. Svi uzorci su inokulisani na ploče sa MacConkey (MC) agarom i MacConkey agarom sa dodatkom 2 μg/L cefotaksima (MC+CTX) za ceftaksim-rezistentne (CTX^R) *E. coli*. Izolati *Escherichia coli* identifikovani su pomoću komercijalnih kitova API20E. Antimikrobna osetljivost određena je pomoću disk difuzione metode. Seološko grupisanje izolata vršeno je pomoću brzog testa aglutinacije na mikroskopskim pločicama. Ukupno je utvrđeno 128 izolata *E. coli* (po jedan izolat po uzorku) sa MC uključujući tri soja na MC+CTX. Osim toga, 47.6% sojeva *E. coli* dobijenih na MC agaru bilo je rezistentno na barem jedan antimikrobni preparat. Tri izolata *E. coli* dobijena sa MC+CTX podloga manifestovali su *ESBL*–produkujući profil. Serološka identifikacija pokazala je da je tipizacija pomoću O antiseruma bila moguća kod ukupno 67 (52.3%) izolovanih sojeva. Najčešća serogrupa bila je O55 (13.3%), a zatim O128 (10.1%), O111 (7.8%), O119 (7%), O126 (6.2%), O26 (5.5%), i O114 (2.3%). Testovi osetljivosti na antibiotike pokazali su rezistenciju na tetraciklin i streptomycin kod 37.5% (48/128) odnosno 22.7% (29/128) izolata. Višestruka (multi) rezistencija je ustanovljena kod 17.96% (23/128) izolata *E. coli*. Naše istraživanje pružilo je korisne informacije o dijareji teladi izazvanih organizmima *E. coli* na farmama u oblasti Tizi-Ouzou. Neophodno je sprovoditi redovan monitoring antimikrobne rezistencija kako bi se ograničilo širenje multirezistentnih *E. coli* u štalama teladi.

Ključne reči: telad, dijareja, antimikrobna rezistencija, serotip, *Escherichia coli*

INTRODUCTION

Cattle farming in Algeria is characterized by substantial heterogeneity in production methods and practices. Gastrointestinal disorders are one of the most prevalent diseases of pre-weaned dairy calves, which cause substantial economic losses due to high morbidity, mortality, growth retardation, and

treatment costs (Bernal-Córdoba et al., 2022).

Calf diarrhea is attributed to both infectious and non-infectious factors. Multiple enteric pathogens such as viruses (e.g., bovine *rotavirus*, bovine *coronavirus*, bovine viral diarrhea virus); bacteria (e.g., *Escherichia coli* K99, *Salmonella* spp., *Clostridium perfringens*) and protozoa (*e.g., Cryptosporidium parvum, Giardia duodenalis*, *Eimeria* spp.) are involved in the development of the disease. Co-infection is frequently observed in diarrheic calves. A single primary pathogen can be the cause in some cases (Brunauer *et al.,* 2021).

Affected calves experience dehydration, electrolyte imbalances, metabolic acidosis, and decreased appetite, which, if left untreated, can lead to death (Foster and Smith, 2009; Gomez et al., 2022). Long-term effects of calf diarrhea in dairy heifers include reduced weight gain and development, increased time to first calving, and reduced milk production in the first lactation (Caffarena et al., 2021). Moreover, diarrhea raises serious concerns about newborn calf welfare and remains the primary reason for antimicrobial treatment in beef calf ranches (Waldner et al., 2013). The primary goal of antimicrobial therapy in diarrheic calves is to prevent bacteremia and decrease the number of coliform bacteria in the small intestine. Overusing and misusing of antibiotics is a common practice in the dairy industry and on livestock farms. Careless use of antimicrobial agents and inadequate hygiene and biosecurity contribute to the emergence and spread of antibiotic resistance worldwide (Kaczorek et al., 2017). Furthermore, the intensification of cattle breeding and the intensive use of antibiotics make cattle important reservoirs of resistant bacteria that can be disseminated at the human-animal-environment interface (Rousham et al., 2018).

Escherichia coli is a leading cause of diarrhea and septicemia in calves; as a significant reservoir of human pathogenic *E. coli,* calves can transmit this pathogen to humans (Algammal et al., 2020). There are six major diarrheagenic *E. coli* pathotypes (Jafari et al., 2012). Enterotoxigenic *E. coli* (ETEC) is the confirmed primary causative agent of neonatal calf diarrhea. Enteropathogenic *E. coli* (EPEC), and Shiga toxin-producing *E. coli* (STEC including enterohemorrhagic *E. coli* /EHEC) are also often isolated from diarrheic and healthy calves; still, their role in calf disease remains controversial. EPEC, STEC, and EHEC are important human pathogens, and cattle constitute a major reservoir. Enteroaggregative *E. coli* (EAEC), diffusely adherent *E. coli* (DAEC), and enteroinvasive *E. coli* (EIEC including Shigella) are less frequently reported in cattle (Jafari et al., 2012).

To our knowledge, the carriage of pathogenic *E. coli* by calves suffering from diarrhea and the potential zoonotic reservoir represented by cattle are not well documented in Algeria. To address the deficit of epidemiological and

microbiological data concerning serotyping and antimicrobial resistance of *E. coli* isolated from calves with diarrhea, we conducted this study to describe the antimicrobial resistance patterns and serotypes of *E. coli* isolates involved in calf diarrhea.

MATERIAL AND METHODS

Calf diarrhea is a multifactorial syndrome; multiple enteric pathogens are involved in the development of the disease. In this study, we were limited to isolating and identifying *E. coli* in calves with diarrhea without explicitly pointing to case definition.

Study site and sample collection

The study was conducted in the province of Tizi-Ouzou situated in the north of Algeria between 36°28' and 36°55' latitude north and 3°45' and 4°31'east. It covers an area of 2993 km^2, which represents 0.13% of the national territory. Tizi-Ouzou is bordered from the north by the Mediterranean Sea, from the south by the Department of Bouira, from the east by the Department of Bejaia, and from the west by the Department of Boumerdes.

After obtaining permission from the cattle breeders, 154 fecal swabs were collected from diarrheic calves originating from 22 farms. One fecal sample per animal was obtained rectally using a sterile cotton swab during a veterinarian intervention. All samples were transported in sterile, cold storage jars (+4 °C) to the laboratory for further analysis.

Species identification

After dilution overnight in buffered peptone water at 37 °C, fecal swabs were seeded onto MacConkey agar plates (MC) and MacConkey agar supplemented with 2 µg/L of cefotaxime (MC+ CTX) for cefotaxime resistant (CTX^R) *E. coli* recovery. Plates were then incubated aerobically for 24h to 48h at 37 °C. Following, all suspected colonies (pink and non-mucoid on MacConkey agar, colorless on Sorbitol MacConkey agar) were picked, purified, and primarily identified on the basis of conventional biochemical tests (Indol, Methyl-red, Voges-Proskauer, and Citrate). Final identification of *Escherichia coli* isolates was done using API20E commercial kit (Biomérieux, Marcy l'Etoile, France). After identifying the species, the serotyping was carried out, from a pure and fresh culture of *E. coli* isolated on BHI Agar, by rapid slide agglutination tests using antibody sera which correspond directly to the O antigens. The agglutination reaction occurs when specific antibodies present in serum bind to the

corresponding bacterial antigens and can be observed over a dark surface.

In this study, 13 antigens were used (O111, O55, O26, O86, O119, O127, O125, O126, O128, O114, O124, O142 and O157). The reagents used are based on specific antibodies obtained from the immune sera of rabbits (Bio-Rad®).

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed on Mueller-Hinton agar (Conda®) using the disk diffusion method, according to Clinical Laboratory Standards Institute standard guidelines (CLSI 2020). *E. coli* isolates were tested against the following antimicrobial agents: ampicillin (AMP, 10 µg), amoxicillin + clavulanic acid (AMC: 20 µg + 10 µg), cefotaxime (CTX, 30 µg), ceftazidime (CAZ, 30 µg), cefoxitin (FOX, 30 µg), tetracycline (TET, 30 µg), ciprofloxacin (CIP, 5 µg), trimethoprim-sulfamethoxazole (STX, 1.25 µg + 23.75 µg), gentamicin (GEN, 10 µg), streptomycin (STR, 10 µg) and Chloramphenicol (CHL, 30 µg). The production of ESBL was detected by placing three antibiotic disks in the same line: cefotaxime, ceftazidime, and amoxicillin/clavulanic acid. Isolates were ESBL-positive if the ghost zone between these three antibiotics was visible (CLSI, 2020).

Statistical analysis

Statistical analysis was performed using Microsoft Excel 2016. The chi-square test was used to check whether the prevalence of *E. coli* is dependent on the age of the calves. Results were considered significant when $p < 0.05$.

RESULTS

Occurrence of E. coli in calf diarrhea

From 154 cultured samples, 128 (83.1%) strains of *E. coli* were isolated. According to the age groups of the calves, the frequencies of *E. coli* isolation were 43 (33.59%) in the first 2 months old, 67 (52.54%) in aged 2-4 months old, and the remaining 18 (14.06 %) were associated to the calves with 4–6 months of age (Table 1).

Table 1: Distribution of *E. coli* involved in diarrheic calves according to age groups

Age groups	No. of Samples	*E. coli* positive samples (%)	*E. coli* negative samples (%)	*P*
1 day to 2 months	51	43 (84.31%)	8 (15.69%)	0.58
2 - 4 months	83	67 (80.72%)	16 (19,28%)	
4 - 6 months	20	18 (90%)	2 (10%)	
Total	154	128 (83.12%)	26 (16.88%)	

The serological identification of the retrieved isolates revealed that 67 (52.3%) of the isolated strains were typable with O antisera, while 61 isolates (47.6%) were untypable. The most common serogroup was O55 (13.3%), followed by O128 (10.1%) and O111 (7.8%), O119 (7%), O126 (6.2%), O26 (5.5%), and O114 (2.3%). The frequency of *E. coli* serogroups was illustrated in Table 2. There is no statistically significant difference in the prevalence of *E. coli* serogroups ($p > 0.05$).

Table 2: Serogrouping of *E. coli* isolates involved in calf's diarrhea

Serotypes	No. of isolates	Percentage (%)
Non sero-typeable	61	47.65
O55	17	13.30
O128	13	10.10
O111	10	7.80
O119	9	7.0
O126	8	6.20
O26	7	5.50
O114	3	2.30
Total	67	52.34

Occurrence of antimicrobial resistance in E. coli

All isolates were tested for susceptibility to a panel of 11 antimicrobials. As shown in Table 3, the results of antimicrobial susceptibility testing in this study showed relatively high resistance rates against most of the antibiotics tested. Resistance to tetracycline was most common (37.5%, n=48), followed by Streptomycin (22.7%, n=29), AMP and SXT (18.7%, n=24), AMC (12.5%, n=16) and GEN (8.6%, n=11), and the lowest resistance level was observed against CHL (6.2%, n=8), CIP (3.1%, n=4), CTX and CAZ (2.3%, n=3). All isolates were susceptible to Cefoxitin (Table 3).

Table 3: Antimicrobial resistance of *E. coli* isolates involved in diarrheic calves

Antibiotics	Abbreviation	Resistant		Susceptible	
		No. of isolates	%	No. of isolates	%
Ampicillin	AMP	24	18.7	104	81.2
Amoxicillin/Clavulanic acid	AMC	16	12.5	112	90.6
Cefotaxime	CTX	3	2.3	125	97.7
Ceftazidime	CAZ	3	2.3	125	97.7
Cefoxitin	FOX	0	0	128	100
Ciprofloxacin	CIP	4	3.1	124	96.9
Sulphamethoxazole/ Trimethoprim	STX	24	18.7	104	81.2
Tetracycline	TET	48	37.5	80	62.5
Gentamicin	GEN	11	8.6	117	91.4
Streptomycin	STR	29	22.7	103	77.3
Chloramphenicol	CHL	8	6.2	120	93.7

Multiple antimicrobial resistances

Out of 128 isolates tested for resistance against all 11 antibiotics, 67 (52.3%) of the isolates were susceptible to all the antibiotics tested, and 61 (47.7%) were resistant to at least one antibiotic. However, 23 (17.96%) showed multiple drug resistance (resistant to at least three classes of antibiotics). From this latter, 15 isolates (11.6%) were resistant to ≥ 4 antibiotic classes, and 9 (7.03%) were resistant to 5 classes of antibiotics (Table 4, 5).

Table 4: Calve associated *E. coli* isolates resistance according to the number of antibiotics classes

No. antimicrobial families	No. of strains	Percentage (%)
Susceptible	67	52.30
1 class	28	21.87
2 classes	10	7.81
3 classes	8	6.25
4 classes	6	4.68
5 classes	9	7.03

Table 5: Patterns of resistance to antibiotics among *E. coli* recovered from diarrheic calves

Resistance Phenotype	No. of isolates	%	No. of antibiotic classes with resistance
Susceptible	67	52.34	0
CHL	1	0.78	1
GEN	1	0.78	1
STR	1	0.78	1
TET	22	17.18	1
AMP, AMC	2	1.56	1
AMP, SXT	1	0.78	2
AMP, STR	1	0.78	2
AMP, TET	1	0.78	2
SXT, TET	1	0.78	2
TET, STR	2	1.56	2
GEN, STR	1	0.78	1
CIP, GEN	1	0.78	2
AMP, AMC, GEN	1	0.78	2
AMP, SXT, STR	3	2.34	3
AMP, AMC, TET	1	0.78	2
SXT, TET, STR	4	3.12	3
TET, GEN, STR	1	0.78	2

Resistance Phenotype	No. of isolates	%	No. of antibiotic classes with resistance
AMP, SXT, TET, STR	1	0.78	4
SXT, TET, GEN, STR	1	0.78	3
AMP, AMC, TET, CHL, STR	1	0.78	4
AMP, CIP, SXT, TET, STR	1	0.78	5
SXT, TET, GEN, STR, CHL	1	0.78	4
AMP, AMC, SXT, TET, STR, CHL	4	3.12	5
AMP, AMC, SXT, TET, GEN, STR	1	0.78	4
AMP, AMC, CTX, CAZ, SXT, TET, STR	2	1.56	4
AMP, AMC, CIP, STX, TET, GEN, STR	2	1.56	5
AMP, AMC, SXT, TET, GEN, STR, CHL	1	0.78	5
AMP, AMC, CTX, CAZ, CIP, SXT, TET, GEN, STR	1	0.78	5

Looking specifically at the ESBL-producing phenotypes, out of 128 *E. coli* isolates tested, three (D78, D104, and D123) were revealed positive. These latter were resistant to at least four antibiotic classes. Two ESBL-producing *E. coli* isolates belonged to serogroup O55 (Table 6).

Table 6: Serogroups and patterns of antibiotic resistance of the ESBL-Producing *E. coli*

Isolates cote	ESBL	Resistance Phenotype	Serogroup
D78	+	AMP, AMC, CTX, CAZ, CIP, STX, TET, GEN, STR	ND
D104	+	AMP, AMC, CTX, CAZ, SXT, TET, STR	O55
D123	+	AMP, AMC, CTX, CAZ, SXT, TET, STR	O55

ND: Not determined

DISCUSSION

Diarrhea within farm animals, especially in neonatal calves, is one of the most challenging clinical syndromes encountered by practicing large animal veterinary practitioners in Algeria (Dadda et al., 2018). Systemically ill calves (depression, anorexia, fever) often suffer from *E. coli* septicemia, and thus, Gram-negative-spectrum antibiotics are advised to treat them. As determined by bacterial examination of fecal samples collected from diarrheic calves, the occurrence of *E. coli* in the present study was 83.1%.

A similar rate was reported in India (85.04%) (Picco et al., 2015). While lower prevalence was reported in Algeria (62%) (Selles et al., 2018) and Egypt (37.4%) (Fouad et al., 2022). The variation in the occurrence of *E. coli* in diarrheic calves could be related to different factors, including the study area, age of calves, farm and sample sizes, management, quality of colostrum, and hygiene measurements (Brunauer et al., 2021). The prevalence of *E. coli* is not statistically different according to age groups ($p = 0.58$). According to a previous study, the frequency of *E. coli* was higher in young calves and subsequently declined as the calves aged (Osman et al., 2013).

Antibiotic resistance is a worldwide problem that has already been identified by several researchers and recognized as a public health problem by the World Health Organization. The unregulated use of antibiotics in bovine farms may enhance the spread of drug-resistant bacteria, particularly ESBL-producing *E. coli*, in the community. In this study, serological tests showed the identification of serogroups O26, O55, O111, O114, O119, O126, and O128 from 52.34% of the *E. coli* isolates. The detected serogroups are frequently associated with pediatric diarrhea (Lanz Uhde et al., 2008; Wani et al., 2013). Similar findings were observed in a previous investigation (Algammal et al., 2020). However, further research revealed different serogroups from those reported in the present study (Lanz Uhde et al., 2008; Vagh and Jani, 2010; Enany et al., 2019). It has been established that food-producing animals may represent an important reservoir of Shiga toxin-producing *E. coli* (STEC); however, highly pathogenic isolates for humans (enterohemorrhagic *E. coli*: EHEC O157:H7) are not detected so frequently in domestic and wild animals. However, the carrier-status is often underestimated, which is due to the sensitivity of detection methods and the shedding and transmission capacity of the EHEC O157:H7 in ruminants and none-ruminants Furthermore, EHEC O157 can contaminate and colonize vegetables and fresh fruits and also present possible reservoir of this infectious agent (Velhner et al., 2020).

From an antibiotic resistance standpoint, 47.7% of *E. coli* isolates were resistant to at least one antimicrobial agent, while 17.96% were multi-drug re-

sistant (MDR). Similar results were in a study conducted at Tizi-Ouzou province of Algeria on *E. coli* recovered from healthy cow fecal samples (Sadi et al., 2024). Higher levels of multi-drug resistance were reported from different studies around the world (Algammal et al., 2020; Selles et al., 2018; Sobhy et al., 2020; Maciel et al., 2020). Higher rates of multidrug-resistant *E. coli* isolates from diarrheic calves were observed by Selles et al. (2018) in western Algeria 68.75% and Maciel et al. (2020) in Brazil 53.3%.

In the present study, the resistance level for individual antibiotics tested was generally low, with a higher level of resistance against 'older' and commonly used drugs in therapeutics such as tetracycline, followed by streptomycin, sulphamethoxazole/trimethoprim and ampicillin. The resistance rate against newer drug classes, such as cephalosporin, was lower in the present study. In line with our findings, a study from Egypt reported remarkably higher rates of resistance to tetracycline, streptomycin, ampicillin, and trimethoprim-sulfamethoxazole with 79.5%, 67%, 54.5%, and 43%, respectively (Sobhy et al., 2020). Furthermore, resistance to gentamicin, chloramphenicol and ciprofloxacin was recorded in 8.6%, 6.2%, and 3.1% of the tested *E. coli*, respectively. Since 52.34% of the isolated serotypes were involved in human diseases, the observed resistance may be due to the transfer of human bacteria, in which resistance has already been developed to animal hosts. Besides, using human drugs for the treatment of infected animals or, alternatively, the use of wastewater, for irrigation, containing excretions of these antibiotics and their metabolites may enhance the spread of antibiotics resistance (Sobhy et al., 2020).

Analysis of the antimicrobial resistance pattern showed that antimicrobial resistance is a growing phenomenon in Northern Algeria. Thirty phenotypes of antibiotics resistance ranging from one antimicrobial to a combination of seven were observed. This circumstance underscores the need for *E. coli* antibiotic susceptibility testing. From the empirical point of view, we find herein that the most regularly used antibacterial agents in cattle, namely tetracycline, had the most common resistance patterns, which could explain treatment failures.

ESBL-producing *E. coli* has emerged as a major problem worldwide. Primarily, ESBL-producing *E. coli* isolates were only observed in human clinical isolates. However, these bacteria have increased drastically in food-producing animals, making them a natural reservoir and contributing to their spread (Seiffert et al., 2013). Furthermore, bacteria producing enzymes hydrolyzing penicillin and cephalosporins are often resistant to most commonly used antimicrobials (Pfaller and Segreti, 2006; Berthod et al., 2012).

In our study, 2.3% of the isolates were ESBL-producing E. coli resistant to at least four classes of antibiotics. Accordingly, previous reports showed lower prevalence of ESBL-producing *E. coli* (0.97%) in a study focusing on *E. coli*

isolated from healthy calves, diarrheic calves and healthy dairy cows from different farms in Khuzestan province, Iran (Mozhdeh et al., 2017), and higher prevalence of ESBL-producing *E. coli* (26 out of 71, 36.6%) in diarrheic calves of Tunisia (Ben Haj Yahia et al., 2023).

Two of the three ESBL-producing *E. coli* isolated in the present study belonged to serogroup O55. Factors such as owning domestic food animals and living near a drainage flow path from a commercial food animal operation may have increased the risk of ESBL-producing *E. coli* carriage among children (Amato et al., 2023). Other factors may have increased the risk of *ESBL* producing *E. coli* carriage such as household dog ownership and placing animal feces on household land/crops (Mitman et al., 2022; Amato et al., 2023).

CONCLUSION

This study showed important human enteropathogenic serogroups in isolates of *E. coli* from diarrheic calves in Algeria. The intensive use of antibiotics in extensive livestock farming is responsible for the increase in multidrug-resistant *E. coli* isolates. Calves could play a role disseminating enteropathogenic serogroups in humans and antibacterial resistance genes. Furthermore, MDR could spread through the use of livestock feces as manure. Accordingly, there is a need to formulate and enforce policies to regulate the use of antimicrobials in the country; an antimicrobial surveillance program is also necessary. Public health education about the health implications of indiscriminate use of antimicrobials is required.

ACKNOWLEDGEMENT

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. We thank the veterinarians and breeders who contributed to this study.

Author's Contribution

Conceptualization: MS, MA, LB and YT. Methodology: MS and MA. Formal analysis: YT and LB. Investigation: MS, MA and LB. Writing-original draft preparation, MA, MS and LB. Writing-review and editing: MA and YT. All authors read and approved of the final manuscript.

Competing interest

The authors declare that they have no conflict of interest.

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Received: 18.07.2024.
Accepted: 13.10.2024.