

## BACTERIOLOGICAL STUDIES ON ASCITES IN BROILER CHICKENS

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### ABSTRACT

Ascites in poultry is a serious problem for the commercial broiler industry causing great economic losses. In the present study, the prevalence of ascites was studied in 200 broiler chickens. Also, the correlation between ascites and other systemic lesions at the same bird was investigated. Moreover, identification of the causative bacterial agents was conducted focusing on *E. coli* and *Salmonellae* isolates. The prevalence rate of ascites in examined broiler chickens was 17%. Ascites without systemic lesion was observed in 10% of birds while 7% of birds had ascites associated with other systemic lesions in the internal organs and hepatitis was the most frequent lesion. The bacteriological examination revealed that out of 49 samples collected, a total of 40 bacterial isolates were recovered (1.6%). Among the recovered isolates, *E. coli* was the most prevalent isolate ( $n=19$ ; 47.5%) followed by *Salmonella* spp. ( $n=10$ ; 25%), *Proteus* species ( $n=8$ ; 20%) and *Enterococcus faecalis* ( $n=3$ ; 7.5%). Antibiogram of *E. coli* isolates showed a high sensitivity against colistin sulphate while they were highly resistant to the other antimicrobials. Meanwhile, *Salmonella* isolates showed high sensitivities to ciprofloxacin and enrofloxacin while they were highly resistant to the other antimicrobials.

**Keywords:** Broiler chickens, ascites, *E. coli*, *Salmonella*, antimicrobial susceptibility.

### INTRODUCTION

The term "ascites"; also known as Water Belly, Pulmonary Hypertension and Right Ventricular Hypertrophy, is a disease in an excessive accumulation of serous fluid in a bird's abdominal cavity leading to carcass condemnation (Calnek *et al.*, 1991). Meanwhile, Julian (1990) reported it as a sign or lesion not a disease. The fluid may/or not contain yellow fibrin clots giving it a yellowish colour (Jacob, 2015).

Ascites is an economically important problem with high morbidity and mortality affecting mainly broiler chickens all over the world (Tafti and Karima, 2000). It is most commonly recorded in male broilers especially those held at high altitude and those exposed to cold weather (Milsavljevic, 2014). Although it has been reported in broilers raised in high and low altitude areas (Maxwell *et al.*, 1986).

Ascites is a multifactorial etiology leading to complexity of the prevention and controlling of this disorder (Knezevic and Milanka, 1996). Expression of ascites in susceptible individuals may be triggered by variety of managerial, nutritional, environmental and genetic insults that cause pulmonary vascular stress and

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inflammation e.g., ischemia, shear stress, infections (viral, bacterial, parasites), toxins (endotoxin or pollutants), as well as autoimmunity (Julian, 2007; Wick *et al.*, 2010 and Tamosiuniene *et al.*, 2011). Ascites is mostly due to behavioral and metabolic traits in broilers leading to vascular damage, increased vascular hydraulic pressure and/or lymph drainage blockage (Tafti and Karima, 2000). The main causes of ascites in broiler chickens are usually chronic passive congestion which is caused by right ventricular failure (Julian and Wilson, 1986) and hepatic fibrosis secondary to hepatitis (Calnek *et al.*, 1991) as well as other heart and kidney problems (Milsavljevic, 2014). Also, several situations can affect the occurrence of ascites in broiler chickens including respiratory diseases, atmospheric hypoxia, housing environment, toxins, rapid growth rates, high-energy rations as well as nutritional aspects and feed additives (Julian and Wilson, 1986 and Wideman, 1988).

Many Gram-negative bacterial infections are associated with ascites especially *E. coli* (Blanco *et al.*, 1998; Barnes *et al.*, 2008; Hasan *et al.*, 2010 and Syuhada *et al.*, 2014), *Pasteurella multocida*; cause of fowl cholera, and *Salmonella* (Calnek *et al.*, 1997 and Hasan *et al.*, 2010). Other Gram-negative infections including *Proteus mirabilis*, *Pseudomonas* spp., *Acinetobacter* spp., *Moraxiella* spp. and *Yersinia* spp. were recorded (Awan, 1997). Lipopolysaccharides (endotoxins) play an important role in induction of ascites by triggering pulmonary hypertension attributable to vasoconstriction (Chapman *et al.*, 2008; Lorenzoni and Wideman, 2008 and Wideman *et al.*, 2009). Moreover, Gram-positive bacteria were also recorded in induction of ascites such as *Enterococcus faecalis* (Murray, 1990 and Tankson *et al.*, 2001), *S. aureus* and other coagulase negative staphylococci (CNS) as well as *Corynebacterium* spp. (Awan, 1997).

Although antimicrobial agents are valuable tools to treat clinical disease and to maintain healthy and productive birds, antimicrobial drug use in livestock production has been implicated as a risk factor in the development and dissemination of drug resistance from livestock production farms (Gosh and LaPara, 2007). Food animals and their production environments are reservoirs of both resistant bacteria and resistance genes that could be transferred to humans either by direct contact between animals and humans or indirectly via the food production chain (WHO, 2011); or as a result of the spread of animal waste on land (Heuer and Smalla, 2007). Therefore, the appropriate antibiotic should better be selected on the basis of its sensitivity which could be detected by laboratory examination.

The present study aimed to investigate the prevalence of ascites in broiler chickens as well as identification of the causative bacterial pathogens.

## MATERIALS AND METHODS

### 2.1. Chickens

A total of 200 diseased Hubbard and Ross broiler chickens of different ages (2-5 weeks) from different farms in Beni-Suef and El-Fayoum Governorates were subjected to the present study during the period from January 2017 up to December 2017. These chickens were subjected to clinical and postmortem examinations to detect ascites.

### 2.2. Samples

Samples were collected aseptically from 34 broiler chickens suffered from ascites with or without septicaemia signs. A total of 49 samples were collected from the affected tissues. Samples from the ascetic fluids as well as the other internal lesions; airsacculitis, pericarditis and hepatitis, were collected from slaughtered diseased and freshly dead chickens.

### 2.3. Bacteriological examination

The collected samples were aseptically inoculated into tryptone soya broth and MacConkey broth and incubated aerobically at 37°C for 24 hrs. Then a loopful of the broth culture was streaked onto tryptone soya agar and MacConkey's agar and incubated aerobically at 37°C for 24-72hrs. All the recovered isolates were identified morphologically and biochemically according to schemes described by Collee *et al.* (1996) and Quinn *et al.* (2002).

### 2.4. Identification of bacterial isolates

#### 2.4.1. Morphological and biochemical identification

All the recovered *E. coli* and *Salmonellae* isolates were identified morphologically and biochemically according to Collee *et al.* (1996) and Quinn *et al.* (2002). For Gram negative isolates the following tests were used; oxidase, catalase, indole, methyl red, Voges Proskauer, citrate utilization, urease, H<sub>2</sub>S production on TSI, nitrate reduction and sugar fermentation. Other non-biochemical tests including motility test and haemolysis onto blood agar were applied. Meanwhile, Gram positive isolates the following tests were used; catalase, sorbitol and arabinose fermentation and gelatin liquefaction. Other non-biochemical tests including haemolysis on blood agar and Growth on Bile aesculin agar and modified Edward's media were applied.

#### 2.4.2. Identification by using API20E kit

The appropriate API kit (API20E, Oxoid) was used for identification of the isolates of Family Enterobacteriaceae members. API strips should only be used to identify pure

cultures. It was used according to the manufacturer's instruction.

### 2.5. Antibiotic susceptibility test

All bacterial isolates from ascetic chickens were tested for their antimicrobial susceptibility to 14 different antimicrobial discs including; apramycin (15µg), ciprofloxacin (15µg), cefotaxime sodium (30µg), colistin sulphate (10µg), sulphamethoxazol-trimethoprim (1.25+23.75µg), doxycycline HCl (30µg), enrofloxacin (5µg), lincomycin (10µg), spectinomycin (100µg), fosfomycin (300µg), gentamycin (10µg), floropenicol (30µg), streptomycin (10µg) and spiramycin (100µg) (Oxoid, Basing Stoke, UK). Antimicrobial susceptibility testing was performed using disc diffusion method on Muller Hinton agar according to Clinical and Laboratory Standards Institute (CLSI, 2016). The antimicrobial susceptibility was based on the induced inhibition zones according to the guidelines of the CLSI (2016). Resistance to three/or more antimicrobials of different categories was taken as multidrug resistance (MDR) according to Chandran *et al.* (2008).

## RESULTS

### 3.1. Prevalence of ascites in the examined broiler chickens

Out of 200 broiler chicken, 34 ones (17%) showed ascites lesions in PM examination (Table 1). Of them, 20 birds (10%) had ascites only while 14 birds (7%) had ascites associated with septicaemic lesions in the internal organs (at least one organ was affected). The affected internal organs included liver ( $n=10$ ), air sacs ( $n=3$ ) and pericardium ( $n=2$ ). On the other hand, 166 (83%) had no ascites lesion.

**Table 1:** Prevalence of ascites in examined broiler chickens.

No. of birds	Positive Ascites						Negative Ascites	
	Ascites only		Ascites + Septicaemia		Total		No.	%
	No.	%	No.	%	No.	%		
200	20	10	14	7	34	17	166	83

%: was calculated according to the number (No.) of birds.

### 3.2. Bacteriological examination

Out of 49 samples collected from different lesions of broilers chickens with ascites; with and without septicaemia, a total of 40 bacterial isolates were recovered with a percentage of 81.6%. Bacterial isolation

was distributed as follow; 28 bacterial isolates (82.4%) from ascetic fluid samples, 8 (80%) from liver, 2 (66.7%) from air sacs and 2 (100%) from pericardium. On the other hand, 9 samples (18.4%) showed negative bacterial isolation (Table 2).

**Table 2:** Results of bacteriological examination of different samples collected from broiler chickens with ascites/septicaemic lesions.

Samples	No. of samples	Positive bacterial isolation		Negative bacterial isolation	
		No.	%	No.	%
Ascetic fluids	34	28	82.4	6	17.6
Liver	10	8	80	2	20
Airsacs	3	2	66.7	1	33.3
Pericardium	2	2	100	0	0
<b>Total</b>	<b>49</b>	<b>40</b>	<b>81.6</b>	<b>9</b>	<b>18.4</b>

%; was calculated according to the corresponding number (No.) of the samples.

### 3.3. Prevalences of different bacterial pathogens recovered from ascites/septicaemic lesions in broiler chickens.

The recovered bacterial isolates ( $n=40$ ) were identified as follow; 19 *E. coli* isolates with a prevalence rate of 47.5%, 10 *Salmonella* species (25%), 8 *Proteus* species (20%) and 3 *Enterococcus faecalis* species (7.5%). Concerning ascetic fluid bacterial isolates ( $n=28$ ), 12 isolates (42.9%) were *E. coli*. Moreover, 9

*Salmonella* (32.1%), 4 *Proteus* species (14.3%) and 3 *Enterococcus* species (10.7%) were identified. Out of 8 bacterial isolates recovered from liver, 4 *E. coli* (50%), 1 *Salmonella* species (12.5%) and 1 *Proteus* spp. (12.5%) were identified. Belonging the air sac isolates ( $n=2$ ), they were identified as *E. coli* and *Proteus* species (one, 50% for each) meanwhile all pericardial isolates ( $n=6$ ) were *E. coli* (100%) (Table 3).

**Table 3:** Prevalences of bacterial pathogens causing ascites and different septicaemic lesions in broiler chickens.

Site of Samples	No. of isolates	<i>E. coli</i>		<i>Salmonella</i> spp.		<i>Proteus</i> spp.		<i>E. faecalis</i>	
		No.	%	No.	%	No.	%	No.	%
Ascetic fluid	28	12	42.9	9	32.1	4	14.3	3	10.7
Liver	8	4*	50	1	12.5	3	37.5	0	0
Air sac	2	1*	50	0	0	1	50	0	0
Pericardium	2	2*	100	0	0	0	0	0	0
<b>Total</b>	<b>40</b>	<b>19</b>	<b>47.5</b>	<b>10</b>	<b>25</b>	<b>8</b>	<b>20</b>	<b>3</b>	<b>7.5</b>

%; was calculated according to the corresponding number (No.) of isolates.

\*: *E. coli* isolates from the colisepticaemic lesion of the internal organs (Total No. = 7 isolates)

### 3.4. Antibiotic susceptibility test

Regarding the results of *in-vitro* susceptibility testing showed that *E. coli* isolates ( $n=19$ ) were highly resistant to most of the tested antimicrobials. The highest resistance was recorded against cefotaxime sodium and florphenicol, apramycin, ciprofloxacin and

gentamicin (94.7% for each) followed by enrofloxacin and lincomycin and streptomycin (89.5% for each), sulphamethoxazol-trimethoprim and doxycycline HCl, and spiramycin (78.9%) and finally, fosfomycin (57.9%) and spectinomycin (52.6%). On the other hand, they were highly sensitive to

colistin sulphate only (73.7%). MDR was detected in all the tested isolates (100%).

On the other hand, *Salmonella* isolates ( $n=10$ ) were highly sensitive to ciprofloxacin and enrofloxacin (80%). On the other hand, they were highly resistant to colistin sulphate, trimethoprim-sulphamethoxazol and lincomycin (80% for each) followed by spectinomycin, florophenicol, streptomycin and spiramycin (70%). MDR was detected in all *Salmonella* isolates (100%).

## DISCUSSION

Poultry industry has reached great levels of development and became one of the most dynamic areas of agriculture. Poultry is the main protein feed of animal origin for human consumption worldwide (Milsavljevic, 2014) due to efficiency of production cost as well as its short life cycle. In Egypt, great efforts were directed toward the poultry industry to meet the high requirements of animal protein.

Ascites is an economically important problem with high morbidity and mortality mainly affecting broiler chickens over the world (Tafti and Karima, 2000). Ascites is an important metabolic disorder in broiler industry, characterized by hypoxaemia, raised cardiopulmonary system workload (Luger *et al.*, 2003), an excessive accumulation of fluid in peritoneal cavity (Olkowski *et al.*, 2003), hypertrophy of the right ventricle associated with flaccid heart and finally death (Luger *et al.*, 2003). Large number of organs (including the heart, liver, lung, etc.) is involved in the disease (Singh *et al.*, 2013). Although the incidence of ascites in well-managed flocks is very low, it leads to important economic losses to the poultry industry (Balog, 2003 and Bin *et al.*, 2007). It is a major cause of mortality in broilers which can reach; in extreme conditions, up to 25% although it is frequently 5 to 12% (Hassanzadeh *et al.*, 2014). Ascites mainly affects fast growing broiler chickens especially males that showed higher levels of ascites than females (Jimenez *et al.* 1998). Although, it was observed that there was no connection between sex and packed cell volume or ascites heart index, in ascitic birds, and therefore the effect of the sex of the birds is still somewhat unclear (Shlosberg *et al.* 1997).

In this study, the prevalence of ascites was studied in diseased 200 broiler chickens. Also, the correlation between cellulitis and other systemic lesions of the same bird was studied. Moreover, identification of the causative bacterial agents was conducted focusing on *E. coli* and *Salmonella* isolates.

The data illustrated in table (1) revealed that the prevalence rate of ascites in examined broiler chickens was 17%. Ascites without systemic lesion was observed in 10% of birds while 7% of birds had ascites associated with other systemic lesions in the internal organs (at least one organ). The affected organs included liver ( $n=10$ ), airsacs ( $n=3$ ) and pericardium ( $n=2$ ). On the other hand, 83% of birds had no ascites lesion. This result was supported by those reported by Muirhead (1987) and Hassanzadeh *et al.* (2014) who reported that ascites can account up to 25% of broiler losses. Lower incidence was reported by Maxwell and Robertson (1997) who estimated the incidence of ascites as 4.7%. Moreover, Awan (1997) surveyed in 3 chicken farms. Ascites lesions were found in 0, 50, and 64% of the birds taken from Farm A, B, and C, respectively. The difference in ascites incidences might be attributed to that ascites is a multifactorial syndrome as environmental, managerial, nutritional, genetic and physiological factors all together are responsible for ascites syndrome (Baghbanzadeh and Decuypere, 2008 and Singh *et al.*, 2013) where the incidence of ascites in well-managed flocks is very low (Balog, 2003 and Bin *et al.*, 2007).

The relationship between ascites and other lesions; especially colibacillosis lesions, of the different organs in broilers appears to be complex and varies from flock to flock. The present results suggested that common predisposing factors may exist for both types of disease. The occurrence of multiple lesions may be underestimated, because other types of lesions in conjunction with ascites may not be detected at the time of inspection, as birds condemned for ascites are not examined further. From other point of view, the present results showed that hepatitis was the most frequently associated with cellulitis while airsacculitis and pericarditis were less frequent.

The previously obtained and discussed results in table (1) were reinforced by the data

illustrated in table (2) which studied the bacteriological examination of samples collected from different lesions of broiler chickens with ascites either associated with septicaemic lesions or not. Samples were collected from ascetic fluid as well as the other internal lesions; airsacculitis, pericarditis and hepatitis. The results revealed that out of 49 samples collected from different lesions, a total of 40 bacterial isolates were recovered; with a percentage of 81.6%. The isolates were distributed in samples from 34 ascetic fluids, 10 liver, 3 air sacs and 2 pericardium as follow; 28 isolates (82.4%), 8 (80%), 2 (66.7%) and 2 (100%), respectively. On the other hand, 18.4% of samples showed negative bacterial isolation.

The negative bacterial isolation of some ascetic samples was firstly attributed to non-infectious causes of ascites in broiler chickens due to many interacting factors such as genetics, environment and management (Aftab and Khan, 2005) such as atmospheric hypoxia, housing environment, respiratory diseases, rapid growth rates, high-energy rations, nutritional aspects and feed additives (Julian and Wilson; 1986 and Wideman, 1988). On the other hand, the negative isolation of some ascetic samples may attributed to that some microorganisms might be associated with ascites but not grew on the used culture media and need specific/enriched culture media for their growth including some bacteria as *Clostridium perfringens* infection (Jacob, 2015 and Hargis, 2018), some fungi including pulmonary aspergillosis; caused by *Aspergillus fumigatus*, that can cause ascites in broiler chickens due to right ventricular failure (Julian and Goryo, 1990 and Dhama *et al.*, 2013) as well as viral infections (Anjum, 1990) as viruses need tissue culture for their isolation. Additionally, the presence of antibiotic residues may explain false negative bacterial isolation as the withdrawal time was not respected in the herds under study.

Detailed data of the previous results were illustrated in table (3) which showed the results of identification and the prevalences of different bacterial pathogens recovered from broiler chickens with ascites. Among the recovered isolates ( $n=40$ ), *E. coli* was the most prevalent as 47.5% followed by *Salmonella* species (25%), *Proteus* species (20%) and *Enterococcus faecalis* species (7.5%). Concerning ascetic fluid bacterial isolates ( $n=28$ ), 12 isolates

(42.9%) were *E. coli*. Moreover, 9 *Salmonella* (32.1%), 4 *Proteus* species (14.3%) and 3 *Enterococcus* species (10.7%) were identified.

The current results were supported with those reported *E. coli* as a cause of ascites (Blanco *et al.*, 1998; Barnes *et al.*, 2008; Hasan *et al.*, 2010 and Syuhada *et al.*, 2014), and also *Salmonella* spp. (Calnek *et al.*, 1997 and Hasan *et al.*, 2010) while Awan (1997) recorded *Proteus* spp. and other Gram-negative as causes of ascites. Lipopolysaccharides (endotoxins) play an important role in induction of ascites by triggering pulmonary hypertension attributable to vasoconstriction (Chapman *et al.*, 2008 and Lorenzoni and Wideman, 2008). Moreover, Gram-positive bacteria were also recorded in induction of ascites such as *Enterococcus faecalis* (Murray, 1990 and Tankson *et al.*, 2001).

Antimicrobial therapy is one of the primary control for reducing both the incidence and mortality associated with avian colibacillosis therefore reducing their enormous losses in the poultry industry (Blanco *et al.*, 1997). However, resistance to existing antimicrobials is widespread and of concern to poultry veterinarians (Allan *et al.*, 1993 and Peighambari *et al.*, 1995). *In-vitro* antimicrobial susceptibility testing of veterinary pathogens can provide valuable guidance to the veterinarian in the choice of appropriate chemotherapy (Blanco *et al.*, 1997). Moreover, it is very useful to detect the multidrug resistant isolates.

In the present work, all the recovered *E. coli* ( $n=19$ ) and *Salmonella* spp. ( $n=10$ ) were subjected to *in-vitro* antimicrobial susceptibility tests against 14 different antimicrobial drugs to detect the drug of choice for treatment as well as to detect MDR isolates. The results of antibiogram of *E. coli* isolates showed that a high sensitivity was observed against colistin sulphate only (73.7%). On the other hand, *E. coli* isolates were highly resistant to the other tested antimicrobial agents. Regarding the result of colistin sulphate susceptibility, it was supported by several previous reports in Egypt and worldwide. In Egypt, the current result was the same with those obtained by Radwan *et al.* (2020) who applied the *in-vitro* susceptibility on 80 *E. coli* isolates against 11 antimicrobials and found that 70% of strains were sensitive to

colistin meanwhile El-Seedy *et al.* (2019) found that colistin had the highest sensitivity (63.6%). Regarding the increasing incidences of antibiotic-resistance of *E. coli* isolates in such study; these findings were coincided with those recorded by many authors in Egypt (Radwan *et al.*, 2014, 2016 and 2018& 2020; Awad *et al.*, 2016; Amer *et al.*, 2018; El-Seedy *et al.*, 2019 and Qurani, 2019). Therefore, no single antimicrobial drug was effective by 100% against *E. coli* isolates, which might be due to development of resistance due to indiscriminate use of antibiotics (Sharada *et al.*, 2001).

Moreover, in the current study, MDR was detected in all *E. coli* isolates (100%). Such results agreed also with several previous reports in Egypt and all over the world. In Egypt, Amer *et al.* (2018); Qurani (2019) and Radwan *et al.* (2020) found that all *E. coli* isolates were MDR. Meanwhile, Radwan *et al.* (2014) recorded MDR in 90.4% of isolates.

On the other hand, the results of antibiogram of *Salmonella* isolates revealed high sensitivity to ciprofloxacin and enrofloxacin (80%). On the other hand, they were highly resistant to the other tested antimicrobial agents. These results coincided with those reported by Yoshida *et al.* (1993); Yah and Eghafona (2007); Khan *et al.* (2010) and Fallah *et al.* (2013) who reported the high resistance of *Salmonella* isolates chicken against most of these antimicrobials. Moreover, in the present study, MDR was detected in all *Salmonella* isolates (100%). Yah and Eghafona (2007) and Fallah *et al.* (2013) reported lower values of MDRI for *Salmonella* recovered from chickens; 42.6% and 34.1%, respectively. Antimicrobial-resistant *Salmonella* is a public health concern since resistance in *Salmonella* limits the therapeutic options available to veterinarians and physicians in the treatment of human salmonellosis (Witte, 1998).

## CONCLUSION

Avian ascites is a serious problem for the commercial broiler industry causing great economic losses. The prevalence rate of ascites in examined broiler chickens was 17%. Ascites may be associated with other systemic lesions in the internal organs. *E. coli* is the most prevalent bacterial agent causing ascites followed by *Salmonella* spp.

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### دراسات بكتريولوجية عن الاستسقاء في بداري التسمين

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يعتبر استسقاء الطيور مشكلة خطيرة لصناعة الدواجن مما يتسبب في خسائر اقتصادية كبيرة. في هذه الدراسة تمت دراسة انتشار الاستسقاء في ٢٠٠ دجاجة تسمين. كما تم دراسة الارتباط بين الاستسقاء والآفات الجهازية الأخرى للطائر نفسه. علاوة على ذلك ، تم التعرف على المسببات البكتيرية مع التركيز على عزلات الإيشيريشيا كولاي والسالمونيلا. بلغ معدل انتشار الاستسقاء في بداري التسمين ١٧٪. لوحظ استسقاء بدون آفات جهازية في ١٠٪ من الطيور بينما ٧٪ من الطيور مصابة بالاستسقاء المرتبط بآفات جهازية أخرى في الأعضاء الداخلية وكان التهاب الكبد هو الأكثر شيوعاً. أظهر الفحص البكتريولوجي أنه من أصل ٤٩ عينة تم جمعها ، تم عزل ٤٠ عزلة بكتيرية (١,٦٪). من بين المعزولات كانت الإشريشيا كولاي هي الأكثر انتشاراً بنسبة ٤٧,٥٪ تليها بكتريا السامونيلا بنسبة ٢٥٪ ، ثم ميكروب البروتيس بنسبة ٢٠٪ وأخيراً النيتيروكوكس فيكالييس بنسبة ٧,٥٪. أظهر اختبار المضادات الحيوية لعزلات الإشريشيا كولاي حساسية عالية ضد سلفات الكوليستين بينما كانت شديدة المقاومة لمضادات الميكروبات الأخرى. في حين أظهرت عزلات السالمونيلا حساسية عالية للسيبروفلوكساسين والإنزوفلوكساسين بينما كانت شديدة المقاومة لمضادات الميكروبات الأخرى.