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A study on the pathogenicity of Escherichia coli producing Extended-Spectrum beta-lactamase in animals

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ABSTRACT

This study intends to identify and analyze Enteropathogenic E. coli bacteria producing extended-spectrum beta-lactamase enzymes, evaluate their antibiotic resistance, and investigate the possibility of infection transfer from animals to people. The study conducted from January 2023 to May 2024. The study involved 40 male white rats from the College of Veterinary Medicine, University of Tikrit, housed in plastic cages with mesh metal covers. They were fed pellets and acclimatized for fifteen days. Culture media were prepared using various methods, including Mueller-Hinton Agar, MacConkey Agar, and UTI ChromoSelect Agar. The study involved inoculating samples with E. coli The modified method of Reed and Muench was used to estimate the median lethal dose in rats and perform bacterial counting. Tissue samples were stained with hematoxylin and eosin, and thin sections were cut and mounted on glass slides. A study on healthy control rats found that cardiac abnormalities were more pronounced in rats given a fatal dosage, with signs of structural abnormalities, bleeding, and tiny lumps. Cardiac dysfunction was indicated by haemorrhage and fragmented fibres at 14 days, necrosis, clogged coronary arteries, and leukocyte infiltration at 21 days, indicating direct toxicity to heart cells and impaired circulation. In rats' intestines, significant structural damage and inflammation were observed seven days after exposure to a fatal dosage, including flattened villi, atrophied cells, inflammatory cell infiltration, and necrosis of mucosal cells. The median lethal dosage for 50% death was 1 x 10^-3 cells. The study found that the fatal dosage significantly affected the architecture of the heart and intestines, and different organs had different recovery times.

In conclusion, a study found that rats exposed to a fatal dose of toxins experienced significant structural and functional changes in their intestinal and cardiac tissues. The rats showed inflammatory changes, decreased blood flow, and gradual atrophy and necrosis of heart muscle fibers.

1. Introduction

The World Health Organization (WHO) reports essentially 2.8 million new cases of Escherichia coli yearly [1]. Research's shows a consistent rise in the occurrence of Escherichia coli, with 6,534 instances of Shiga toxin-producing Escherichia coli reported by Formula student Netherlands at the start of 2021. Escherichia coli is an essential species often found in clinical microbiology labs and is the main culprit behind urinary tract infections [2]. The healthcare filed has significant financial challenges due to the costs associated with controlling E. coli O157:H7 infections, estimated at over $405 million annually [3]. Due to its relevance, the researcher's primary objective is to provide a thorough theoretical framework for a full knowledge of Escherichia coli. Understanding beta-lactamase-producing Escherichia coli is crucial for achieving research goals and clarifying the present condition of Escherichia coli [4].

Cholonic Escherichia coli can be classified into six types based on its pathogenicity in humans: enteropathogenic E. coli (EPEC), enterohaemorrhagic E. coli (EHEC), enterotoxigenic E. coli (ETEC), enteroaggregative E. coli (EAEC), enteroinvasive E. coli (EIEC), and diffusely adherent E. coli (DAEC). A kind of E. coli that causes illness in birds is called avian pathogenic E. coli (APEC) .[5], [6].

Pathogenic Escherichia coli often colonize various sites within the human body, causing a range of diseases. Enteropathogenic E. coli (EPEC), enterotoxigenic E. coli (ETEC), and diffusely adherent E. coli (DAEC) typically colonize the small intestine, leading to diarrhea. In contrast, enterohemorrhagic E. coli (EHEC) and enteroinvasive E. coli (EIEC) cause diseases in the large intestine. The small and large intestines are both colonised by enteroaggregative E. coli (EAEC). When the bacteria known as uropathogenic E. coli (UPEC) invades the urinary system and makes its way to the bladder, it may cause cystitis. If the infection reaches the kidneys and is left untreated, pyelonephritis may develop. Bacteremia can be caused by either UPEC or NMEC, which refers to newborn meningitis E. coli. Meningitis can also be caused by NMEC as it has the ability to cross the blood-brain barrier [7] .

Genetic factors can influence illness severity, with the B2 genotype often found in E. coli strains linked to extraintestinal pathogenicity (ExPEC). This genotype is linked to virulence genes. Horizontal gene transfer between commensal E. coli and ExPEC increases ExPEC efficiency. Genomic islands (GIs) allow pathogenic and non-pathogenic bacteria to transmit genetic material, including plasmids, phages, and large genomic segments. Pathogenicity islands (PIs) are pathogenic segments that can be transmitted from ExPEC to commensal bacteria.[8].

Warm-blooded animals, including humans, carry the common pathogenic bacterium Escherichia coli in their intestines, which can be transmitted through faeces. When it comes to

assessing water contamination, the Environmental Protection Agency suggests that measuring Escherichia coli levels is a more reliable approach than examining faecal coliforms. Surface water contamination is caused by runoff from farms, cities, and other human and animal activity, as well as faulty or insufficient sewage treatment [9].

This research focuses on studying the pathological analysis of beta-lactamase-producing Escherichia coli in the hearts and intestines of laboratory rats.

2. Material and Methods:

2.1 Pathological tests

Forty male white rats, each weighing approximately 200 grams, were obtained from the animal house at the College of Veterinary Medicine, University of Tikrit. They were housed in plastic rat cages equipped with mesh metal covers providing access to food and water, with six rats per cage. The animals were monitored daily for diet and bedding changes (wood shavings). They were fed pellets and acclimatized for fifteen days prior to the experiment to ensure their general well-being. The 40 rats were divided into two groups. The first group it contains 28 rats used to test the pathogenesis and it divided as seven groups, each group contains 4 rats. The second group contains 12 rats used to specify the lethal dose 50 divided into 4 groups where each group contains 3 rats.

2.2 Preparation Methods of Culture Media

2.2.1 Infusion (BHI) Broth with 0.1% Agar, Nutrient Agar, and Tryptic Soy Agar:

These media were prepared according to the manufacturer's instructions. A total of 37.0 grams of medium was dissolved in 1 liter of distilled water with heating until completely dissolved, followed by autoclaving (Webco, Germany) at 121°C and 15 psi for 15 minutes. The sterilized media were then poured into sterile tubes, labeled, and incubated at 37°C for 48 hours in an incubator (Mennert, Germany) to check for contamination. Last but not least, they were kept at 4°C in a refrigerator (Kelon, Korea) until they were needed.

2.2.2 Mueller-Hinton Agar:

Following the instructions provided by the manufacturer, this medium was created. I dissolved 55.07 grammes in 1 litre of water by heating it until it boiled and completely dissolved. After that, it was put in an autoclave for 15 minutes at 121°C and 15 pressure to keep the medium from getting too hot. Put on clean Petri dishes (Biozek, Switzerland) and kept at 4°C until needed, after being cooled to 50°C.

2.2.3 Preparation of Synthetic Culture Media:

1. **UTI ChromoSelect Agar:**

The medium was manufactured following the manufacturer's specifications. The procedure included dissolving 55.4% in 1 L of sterile distilled water, heating to a boil until the contents were dissolved, and then autoclaving for 15 min at 121 °C and 1 bar. Heat it to fifty degrees Celsius, transfer it to sterile Petri dishes, and keep them at four degrees Celsius until you're ready to use them.

2. **CHROMagar ESPL:**

This medium, which included both a base and a supplement, was prepared

according to the manufacturer's instructions. Last but not least, the base was prepared by autoclaving the combination at high pressure and temperature. Earlier, a solution of the base powder in distilled water was prepared by boiling it, adding a little amount of Tween 80, and stirring until the mixture was fully dissolved. Consistently, 570 milligrammes of powder and 10 millilitres of sterile distilled water were mixed to make the food supplement. To ensure adequate incorporation with the base, the mixture was heated to 45 degrees Celsius and then stirred continuously. After that, the liquid was poured into clean Petri dishes and stored in a dry, dark spot until it was required. The temperature was maintained at 4 degrees Celsius.

2.3 Sample Inoculation:

After putting the samples into BHI broth, we kept them in an incubator at 37°C for 24 hours. The cultures were then moved to UTI ChromoSelect Agar using a clean loop after being incubated for 48 hours at 37°C. To identify bacteria that produce extended-spectrum beta-lactamase (ESBL), positive samples were cultivated on CHROMagar ESPL and incubated at 37°C for 24-48 hours.

2.4 Estimating Lethal Dose 50% in rats and bacterial counting

To estimate the median lethal dose (LD50) in rats and perform bacterial counting, the method of Reed and Muench (1938) [10] was modified. Bacteria were cultured on soybean agar at 37°C for 24 hours, then concentrated via centrifugation at 3000 rpm for 15 minutes. The bacterial cells were washed three times with phosphate-buffered saline (PBS) for 5 minutes each, discarding the supernatant. Serial tenfold dilutions of the bacteria were prepared in PBS, and six dilutions (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}) were tested using 28 rats divided into seven equal groups, with four rats per group. The final group served as the control. The number of viable bacteria in each dilution was determined using the spreading method on nutrient agar plates, with 0.1 mL of each dilution spread across three plates per dilution. Plates were incubated at 37°C for 18 hours, and the colony-forming units (CFU) were counted to calculate the average number of colonies per plate. The number of colonies per 0.1 mL was multiplied by 10 to estimate the CFU per milliliter and further multiplied by the dilution factor to obtain the bacterial count per milliliter.

For experimental infection using the LD50, the modified method [11] was employed. Twelve rats were divided into four groups of three rats each. Food was withheld for two days before infection, and daily doses of cephalosporin were administered using an oral tube throughout the experiment. A bacterial suspension with a concentration of 4×10^{-6} CFU/mL was prepared based on the LD50. Two rats from each group received 0.5 mL of the bacterial suspension orally, with the first rat serving as the control. Animals were dissected after 7, 14, and 21 days, with three rats dissected at each time point. The study focused on isolating bacteria from the internal organs of the experimentally infected rats to monitor bacterial dissemination and assessing the pathological changes induced by the bacteria in these organs.

After the rats were given the fatal dosage, their tissue samples were stained with hematoxylin and eosin (H&E). A 10% H&E solution was prepared in distilled water. Tissues

were cut into small, manageable pieces, fixed in 10% formalin for 24 to 48 hours, and then washed with water to remove excess formalin. The tissues were dehydrated in a series of increasing alcohol concentrations (70% to 100%) before being stained in the prepared H&E solution for 30 minutes to one hour. After staining, tissues were washed with water to remove excess stain and dehydrated again in a series of increasing alcohol concentrations. The tissues were then embedded in a compound solution (e.g., olive oil or paraffin) for preservation. Thin sections were cut using a microtome, mounted on glass slides, allowed to dry, and covered with glass coverslips using special mounting solutions.

3. Results and Discussion

3.1 Heart

Healthy control rats' heart tissue removed after seven days showed elongated cardiac muscle fibres organized in parallel bundles containing a single nucleus. The cardiac muscle bundle had loose fibrous tissue with fibrous regions and dispersed white blood cells (Figure 1).

Healthy control rats' heart muscles dissected after 14 and 21 days had hypertrophied muscle fibres aggregated and stacked, separated by loose connective tissue with fibrous regions and dispersed white blood cells. Figure 2 shows little capillary blood capillaries packed with blood.

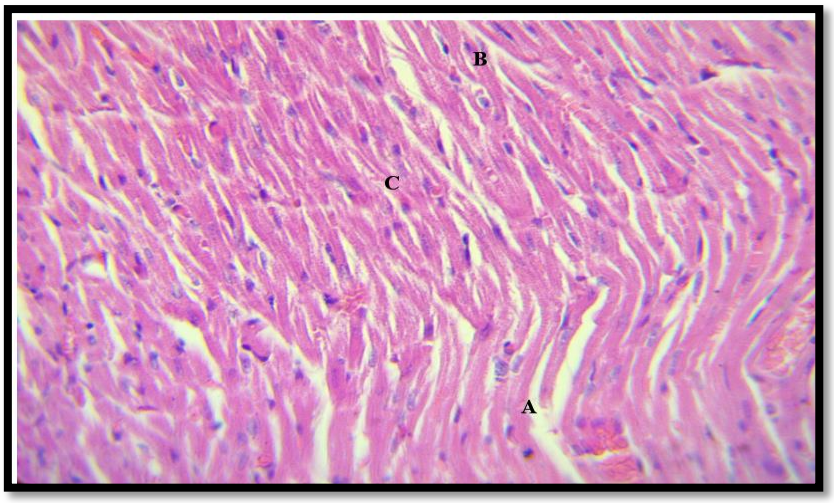

Figure 1. control rat heart after seven days: (A) Muscle fibres lining the heart, (B) The bundle of fibres that form up the heart, (C) Fibrous region. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

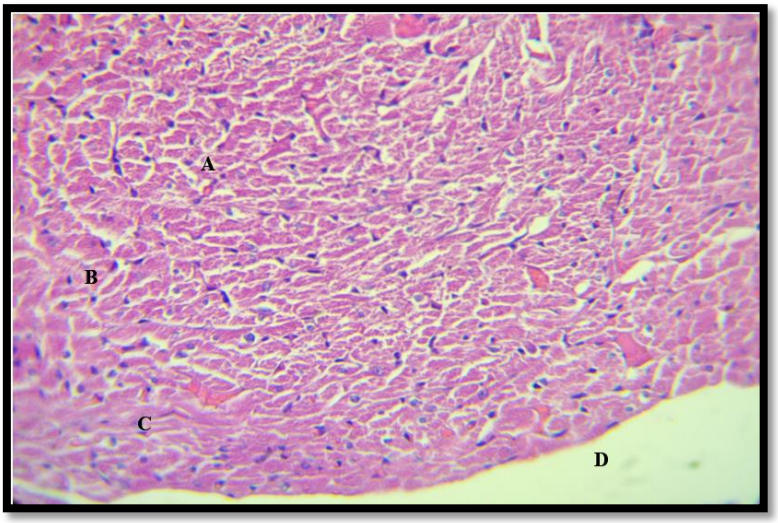

Figure 2. Hearts of healthy rats as a control after 14 days: (A) Heart muscle - a general outline of heart muscle fibres, (B) The bundle of fibres that make up the heart, (C) Vascular system of the heart, (D) Chambers of the heart. Pigmentation: Bromoeosin C20H8Br4O5. Magnification: 40x.

The cardiac muscles of rats subjected to the fatal dosage showed significant structural and functional alterations. Cardiac muscle fibres exhibiting symptoms of atrophy and distortion were seen upon dissection of the hearts of rats examined seven days after exposure to the fatal dosage, suggesting structural changes in the arrangement and form of the muscle fibres. Further evidence of a detrimental effect on cardiac blood circulation was the atrophy of these cardiac muscle fibres, which manifested as tiny, contrasted lumps encircled by coronary blood vessels exhibiting bleeding. Directly toxic effects on heart cells and tissues, resulting in disruptions in cellular structure and heart function, may explain these structural and pathological alterations in the cardiac muscles that were caused by the fatal dosage that was delivered. As the heart's health and function decline, damage to the coronary blood veins and poor blood perfusion to the heart's internal sections may lead to haemorrhage and the development of visible tiny masses. See Figure 3.

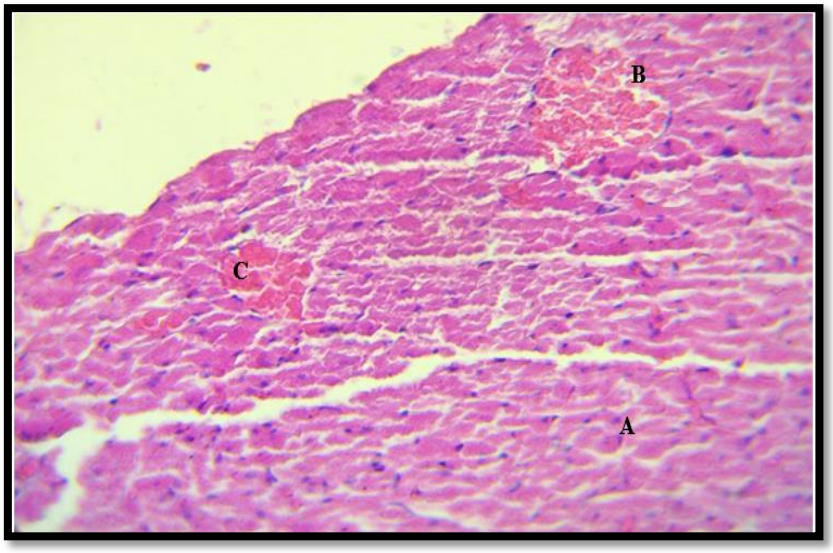

Figure 3. After seven days of dissection, the rat's sick heart: (A) Signs of atrophy and deformation in the cardiac muscle fibres. (B) A heart attack resulting in bleeding from a coronary artery. (C) Diseased Interstitial cells are located between the fibres of cardiac muscle. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

The data show that cardiac muscle fibres had disintegrated, appearing fractured and scattered when the hearts of the rats tested were dissected 14 days after exposure to the fatal dosage. Haemorrhage between muscle fibre bundles is another indicator of blood leaking out of the heart, possibly due to a pressure imbalance or injury to the blood arteries. The heart's function and capacity to pump blood properly are compromised due to atrophy, marked by the contraction and shrinking of the cardiac muscle fibres.

To accurately assess the degree of apparent physiological and pathological consequences, one must thoroughly comprehend the underlying biological processes and harm mechanisms. Myocarditis, which damages myocardial tissue and reduces heart function, is one possible cause of these morphological and functional alterations. Acute blood supply deficit, arterial sclerosis, and high blood pressure are all conditions that strain the heart tremendously, which may lead to erosion and damage processes that harm the heart muscle fibres. Consequently, pathogenic processes may be better understood, and medicines can be developed to enhance heart function and minimize damage via dissecting and studying cardiac muscle fibres and related alterations, as shown in Figure 4.

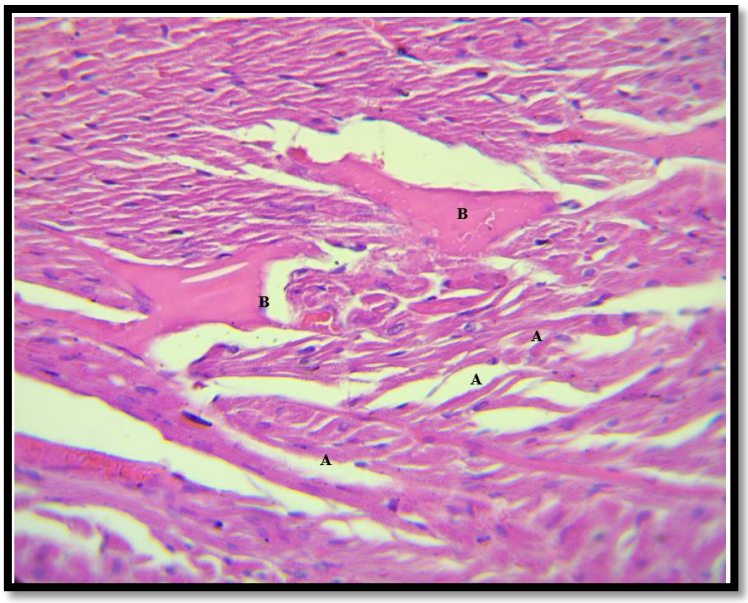

Figure 4. The affected heart of the dissected rat after 14 days : (A) Heart muscle fibres deterioration and shrinkage, (B) Decomposed hemorrhage . Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x

Some cardiac muscle fibres showed signs of modest necrosis, defined as partial loss of tissue structure and muscular function, in the findings for the rat dissected 21 days after being given the fatal dosage. Also seen are enlarged and crowded coronary arteries, which point to a problem with blood flow to some heart regions. In addition, it is seen that some cardiac muscle fibres are either disintegrating or atrophying. A decrease in size and function characterizes the former, while the latter is characterized by structural distortion and fragmentation. White blood cells and leukocytes in the tissues suggest that these cells have leaked out of blood vessels. The toxic effects of the poisonous dosage may directly destroy muscle fibres and alter cardiac blood circulation, two of the many potential causes of these structural and pathological abnormalities in the heart muscle. Structural alterations in coronary arteries may cause damage to cardiac muscle fibres and worsen cardiac blood perfusion. The body may also try to counteract the harmful consequences of the toxic dosage by undergoing inflammatory responses or immune system impacts, which may lead to cellular leakage and alterations in muscle fibres, as illustrated in Figure 5.

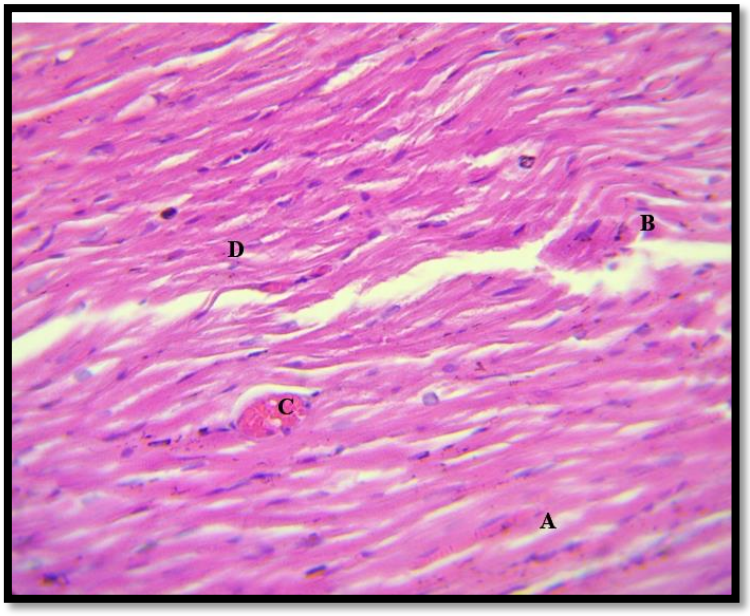

Figure 5 shows the heart of the second afflicted rat 21 days later, following dissection: (A) Cardiac muscle fibres deterioration and death, (B) Numerous fibres of muscle perish, (C) Blood congestion, (D) Leukocytes. Pigmentation: Bromoeosin C20H8Br4O5. Magnification: 40x.

Intestine

When healthy rats (controls) are dissected seven days later, the findings show that the small intestine of these rats has villi, which are defined as intestinal folds lined with simple columnar cells. A subset of these columnar cells, goblet cells, secrete mucus that coats and protects the small intestine's surface from drying out. The villi's core comprises loose connective tissue containing many white blood cells. This architectural configuration aligns with how the small intestine normally appears in rats in good condition. Nutrient absorption occurs in the columnar cells, while mucus secretion by the goblet cells protects the intestinal wall and helps food flow through the digestive tract. Due to their function in protecting the body from potentially infectious bacteria and hazardous environmental variables, a high concentration of white blood cells in the loose connective tissue indicates healthy immune function. These organizational features mirror the small intestine's physiological role in nutrition absorption and detoxification. Figure 6 shows that this anatomical feature keeps the digestive tract intact and functioning correctly in healthy rats. Dissecting healthy rats after 14 or 21 days reveals a similar pattern.

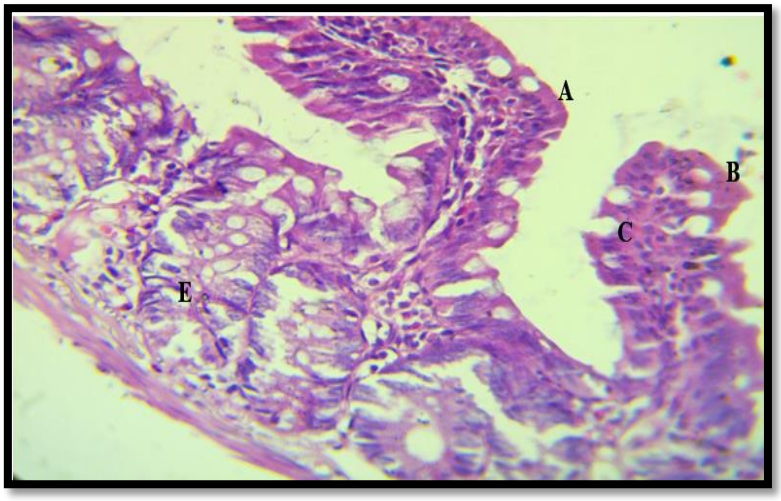

Figure 6 shows the intestinal anatomy of rats seven days after injection: (A) intestinal tissue is small, (B) Basic Epithelial Cells with Columnar Shapes, (C) Cells that are reminiscent of a goblet, (D)White blood cells are located in the core, (E) Glands of the digestive tract on the bottom of the page. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

The intestines of rats exposed to a lethal dose showed significant structural changes after seven days. The villi, which appeared flattened on the surface of the mucosa, were completely shrinkage. Atrophied cells lining the mucosa were observed to have contracted or shrinkage due to the damage. The basal layer of the mucosa was filled with inflammatory cells, including white blood cells and lymphocytes, indicating an inflammatory response. The intestinal glands appeared tubular and affected, with necrosis of many mucosal cells, suggesting a deterioration in their function and ability to secrete protective mucus. This severe structural change is attributed to the lethal dose, disrupting the biological balance of intestinal tissue, deteriorating conditions surrounding mucosal cells, inflammation, and impairment of mucosal glands. The analysis indicates severe damage to the intestines due to the lethal dose, necessitating immediate medical intervention and correction, as shown in Figure 7.

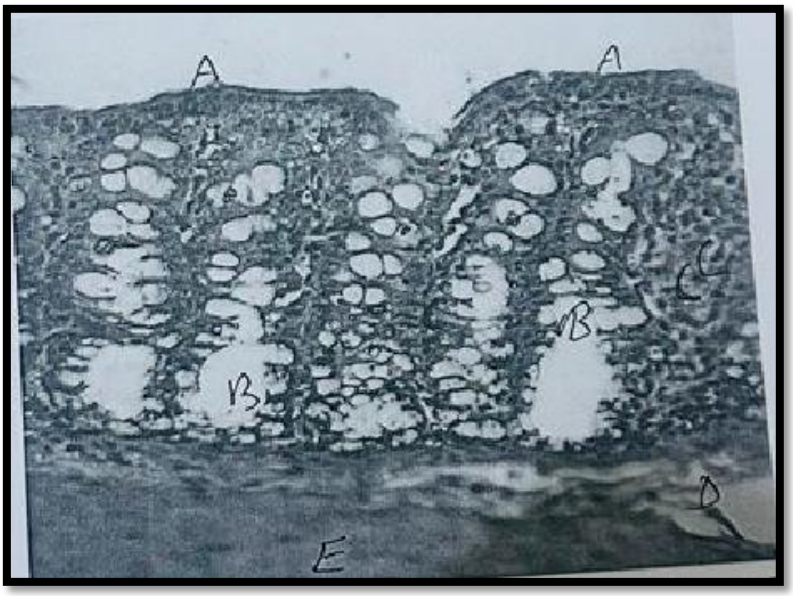

Figure 7. After seven days of dosing, the second rat's intestinal tract showed the following changes: (A) Villi reduction and atrophy, (B) deterioration of mucosal glandular cells, (C) infiltration of white blood cells, (D) lamina submucosa, and (E) layer of muscle. Pigmentation: Bromoeosin C20H8Br4O5. Magnification: 40x

A second rat's intestines had extensive necrosis, sloughing, and loss of columnar epithelial cells after seven days after dissection. The intestinal glands were packed with necrotic mucosal cells with widespread cavitations on the basal lamina. Because of the toxic consequences of the fatal dosage, which caused extensive damage and erosion in the columnar epithelial layer, these alterations have occurred. Extensive cavitations caused by corrosion and disintegration filled the intestinal glands packed with necrotic mucosal cells. The infiltration of several inflammatory white blood cells around the glands revealed a high level of inflammation. Figure 8 shows that the fatal dosage caused significant necrosis, tissue damage, loss of epithelial cells, and glandular inflammation; hence, the afflicted rats need urgent medical attention to provide the therapy and support they need.

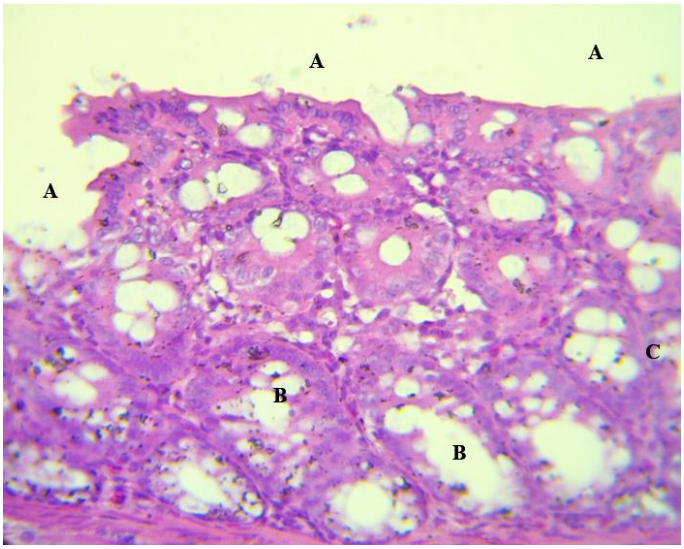

Figure 8. After seven days of injection, the third rat's afflicted intestines: (A) Intestinal mucosal surface necrosis accompanied by villi loss, (B)The cells lining the intestinal glands necrosis. (C) White blood cells and lymphocytes that cause inflammation infiltrate. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

The dissection of the intestines of a second rat exposed to a lethal dose of toxins showed severe negative effects on the basement membrane of the small intestines. The intestines had widely distributed intestinal glands, but most cells were necrotic and deteriorated. Wide cavities were found within these glands, indicating severe damage. The connective tissue between the glands was also affected, with white blood cells and lymphocytes infiltrating it. This deterioration is attributed to the lethal dose of toxins the rats were exposed to, highlighting the severe damage that toxic doses can cause to the intestines' structure and function, as shown in Figure 9.

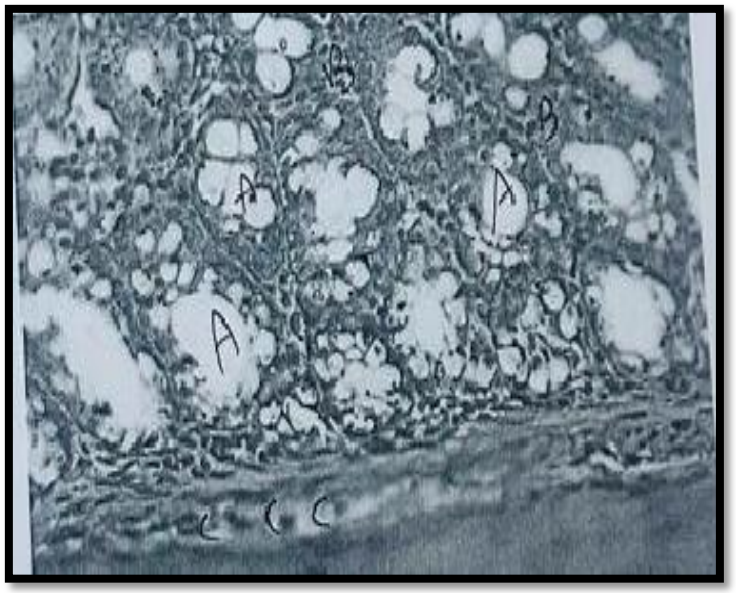

Figure 9. Third rat intestine, which was given the drug and then dissected fourteen days later: (A) Gastrointestinal Glands with Mucosal Cell Erosion, (B) Immune System Infiltration, (C) Metastatic Cells in the Layer Below the Mucosa. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

After being exposed to a fatal amount of toxins for 14 days, the third rat's intestines exhibited significant degeneration. The basement membrane of the small intestines was severely damaged, with all widely distributed intestinal glands severely damaged. Wide cavities were found within these glands, indicating severe damage. The necrotic and damaged connective tissue between the glands caused the creation of vast voids. The spaces inside the intestines were filled with white blood cells and lymphocytes, which extended into the basement membrane. It is believed that the toxic dosage is responsible for this decline.

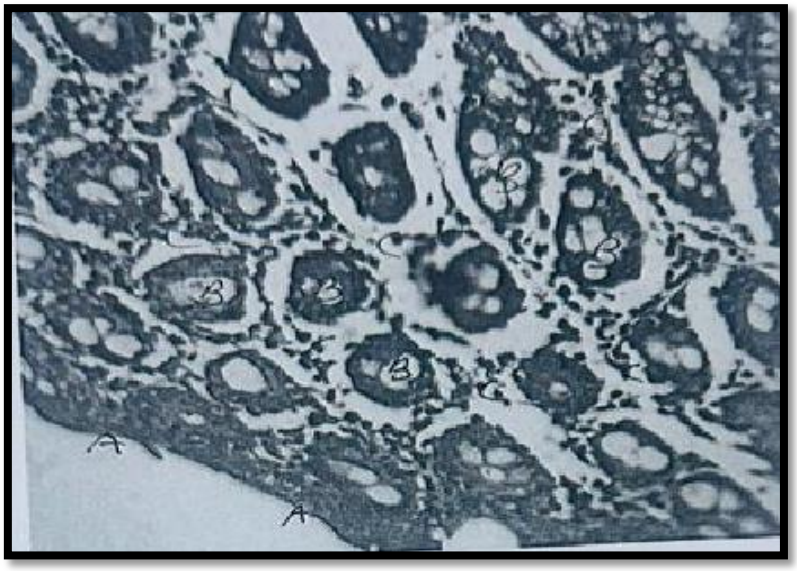

Figure 10 depicts the third rat's intestines after 14 days of intestinal intake and biopsy: (A) Intestinal dilation Villi loss from the mucosal membrane of the intestines (B) The digestive glands deteriorate and shrink (C) Cells of white blood and lymphatic infiltration into the basement membrane. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

After 21 days of exposure to a lethal dose, rats' intestines showed significant structural and functional changes, with a notable separation between the mucosal and muscular layers. The basal membrane contained mucus secretion glands, indicating the mucosal barrier's integrity. The mucosal layer of the intestines degenerated and damaged, indicating severe toxicity effects. White blood cells surrounded the mucosa, suggesting an inflammatory response to the damage. These changes indicate the progression of severe intestinal conditions after prolonged exposure, attributing the separation between layers and deterioration of mucosal cells to the lethal dose's impact on the intestines' structure and function.

In a third rat, the intestines showed significant structural and functional damage due to a lethal dose. The mucosal layer of the intestines was separated, indicating the damage caused by the lethal dose. The basal membrane, filled with mucus secretion glands, was damaged, indicating the severe negative effects of toxicity. White blood cells surrounded the mucosa, suggesting a reactive inflammatory response. These changes indicate the progression of severe intestinal conditions after prolonged exposure to the lethal dose, attributing the separation between layers and deterioration of mucosal cells to the severe impact of the lethal dose on the intestines' structure and function, as shown in Figure 12.

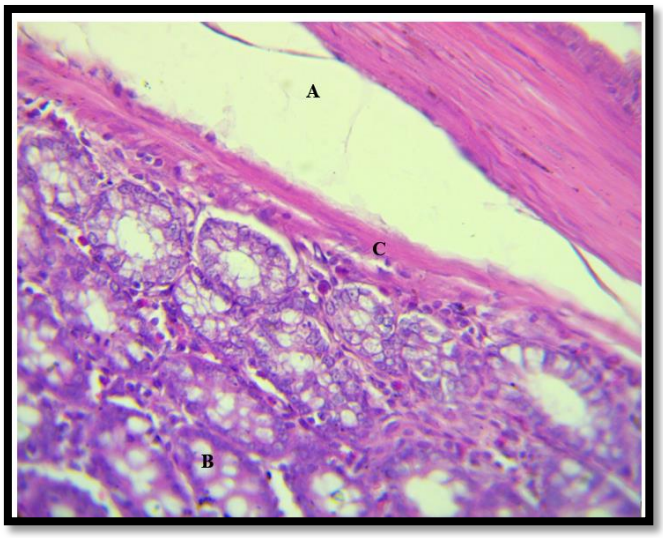

Figure 11. Dissection and Administration of the Second Rat's Intestines 21 Days Later: (A) The Submucosal Layer and the Muscular Layer of the Intestinal Tissue Are Visibly Separate. (B) Deterioration of Epithelial Cells in the Intestinal Gland, (C) Cells of white blood between the glands. Pigmentation: Bromoeosin $C_{20}H_8Br_4O_5$. Magnification: 40x.

Figure 12. Third Rat Intestinal Lesions Following 21 Days of Treatment and Dissection: (A) Deterioration and Cell Death, (B) Deterioration of Cells in the Intestinal Gland, (C) Mucus Droplets in Excess, (D) Cells that Alleviate Inflammation, (E) Several fibres of muscle deterioration. Pigmentation: Bromoeosin C20H8Br4O5. Magnification: 40x.

The findings of the bacterial count and the half-lethal dosage mortality rate are shown in Table 1. Table 2 shows the proportion of germs in the experimental rats' hearts and intestines at different time points after injection

Table 1: Results of Bacterial count and lethal dose LD50

Group	Dilution	Mean of Bacteria/Dish	Death	% of death	Living
1	$^{1-}10\times1$	-	4	%100	0
2	$^{2-}10\times1$	-	3	%75	1
3	$^{3-}10\times1$	4000	2	%50	2
4	$^{4-}10\times1$	200	1	%25	3
5	$^{5-}10\times1$	23	1	%25	3
6	$^{6-}10\times1$	0	0	%0	0

Table (2): Results of bacterial count of heart and intestine after injection of lethal dose LD50

Period of injection (Days)	Blood of Heart	Intestine
7	+	+
14	-	+
21	-	-

Half of the animals in the experiment died, suggesting that 1 x 10^{-3} cells was the median fatal dosage, as shown in Table 1. This result contradicts the findings of [12], who looked into the median fatal dosage for colonic Escherichia coli samples taken from Baghdad's Yarmouk Hospital. The median fatal dosage in their investigation, which used BALB/c mice, was 1x10^{-9} cells. One possible explanation for this variation is that beta-lactamase-producing colonic Escherichia coli is more pathogenic than regular colonic Escherichia coli. In addition, Ali et al. found that Escherichia coli colonization peaked three days after infection began, with infection regression beginning 12 days after infection in the brain and continuing for 15 days in the lungs, kidneys, and intestines, and continuing for 21 days in the liver, spleen, and heart.

In contrast, our results showed that all organs were infected by the seventh day, which is in line with the research conducted by Ali et al. Nevertheless, as

seen in Table 2, the lungs, kidneys, and heart began to show signs of recovery starting from the fourteenth day forward. Our work employed rats as its experimental animals, whereas Ali et al. used mice, which might explain the discrepancy.

In addition, the results shown here agree with a study by [13] that sought to investigate the pathogenicity of colonic Escherichia coli in experimental mice. After seven days of giving the pathogenic dose to the animals, the researchers found that concentrations and colonization peaked. But the lungs, heart, liver, kidneys, and spleen all started to improve on day seven. However, the liver and heart showed a delay in clinical recovery. Indeed, our investigation on the liver did not show any improvement until the 21st day. Although this may be the case, different research by [14] found that both normal-weight and diet-induced obese mice infected with colonic Escherichia coli had elevated cardiac indices compared to control animals. In obese mice, researchers found cytoplasmic disintegration, increased cardiac muscle area, and vacuolar degeneration in cardiac muscle fibres. These results are consistent with our investigation, which also found atrophying and disintegrating heart muscle fibres.

Conclusion

The study reveals that rats exposed to a fatal dose of toxins experience significant structural and functional changes in their intestinal and cardiac tissues. Healthy control rats showed normal structures, while those exposed to the fatal dosage showed inflammatory changes, decreased blood flow, and gradual atrophy and necrosis of heart muscle fibers. The intestinal tissues were disrupted by inflammatory reactions, villi atrophy, and epithelial cell necrosis. The study suggests that host susceptibility and pathogenicity may vary across strains, and the findings underscore the need for further investigation into the biological processes causing toxin-induced tissue damage.

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دراسة عدوى السلالات من الإشريشيا القولونية التي تنتج إنزيمات البيتا لاكتاماز ذات الطيف الواسع في الحيوانات

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الملخص

هدفت هذه الدراسة إلى تحديد وتحليل بكتيريا الإيشريشيا القولونية الممرضة المعوية المنتجة لإنزيمات البيتا–لاكتاماز واسعة الطيف، وتقييم مقاومتها للمضادات الحيوية، والتحقق من إمكانية انتقال العدوى من الحيوانات إلى البشر. تم إجراء الدراسة من يناير 2023 إلى مايو 2024.

شملت الدراسة 40 فأراً أبيضاً من الذكور من كلية الطب البيطري، جامعة تكريت، وقد تم إيواؤها في أقفاص بلاستيكية مغطاة بشبك معدني. تم تغذيتهم بكرات الطعام وتم تكييفهم لمدة خمسة عشر يوماً. تم تحضير أوساط الزرع باستخدام طرق متنوعة، بما في ذلك أجار مولر–هينتون، أجار ماكونكي، وأجار كروموسيلكت الخاص بالتهابات المسالك البولية. شملت الدراسة تلقيح العينات بالإشريكية القولونية. تم استخدام الطريقة المعدلة لريد وموينش لتقدير الجرعة القاتلة الوسطية في الفئران وإجراء العد البكتيري. تم تلوين عينات الأنسجة بهيماتوكسيلين وإيوسين، وقطعت مقاطع رقيقة ووضعت على شرائح زجاجية.

وجد في هذه الدراسة على فئران التحكم السليمة أن الشذوذات القلبية كانت أكثر وضوحًا في الفئران التي أعطيت جرعة قاتلة، مع علامات على تشوهات هيكلية، نزيف، وتكتلات صغيرة. أشارت الخلل الوظيفي القلبي إلى النزيف والألياف المجزأة بعد 14 يوماً، والنخر، وانسداد الشرايين التاجية، وتسرب الكريات البيضاء بعد 21 يوماً، مما يشير إلى سمية مباشرة لخلايا القلب وضعف الدورة الدموية. في أمعاء الفئران، لوحظت أضرار هيكلية كبيرة والتهاب بعد سبعة أيام من التعرض لجرعة قاتلة، بما في ذلك تسطح الزغابات، وضمور الخلايا، وتسلل الخلايا الالتهابية، ونخر الخلايا المخاطية. كانت الجرعة القاتلة الوسطية لوفاة 50% من الفئران هي 1 × 10^–3 خلايا. وجدت الدراسة أن الجرعة القاتلة أثرت بشكل كبير على هيكل القلب والأمعاء، وكان للأعضاء المختلفة أوقات تعافي مختلفة.

في الختام، وجدت الدراسة أن الفئران التي تعرضت لجرعة قاتلة من السموم تعرضت لتغيرات هيكلية ووظيفية كبيرة في أنسجة الأمعاء والقلب. أظهرت الفئران تغيرات التهابية، وانخفاض في تدفق الدم، وضمور تدريجي ونخر في ألياف عضلة القلب.

الكلمات المفتاحية: الإيشريشيا القولونية، LD50، إنزيمات البيتا لاكتاماز، عدوى القلب، عدوى الأمعاء