

Bacteriological Study of *Escherichia coli* Isolated from Different Infections in Diyala

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Abstract

The goal of present study was to Isola and Identifi--cation of "Escherichia coli" from different Infections and detection the sensitivity and resistance of *Ecoli* to antimicrobials Additionally detection of virulence factors . This study was conducted from the period from 1 / 6 / 2016 to 1/ 9 / 2016 in Baquba city in Iraq.. It included; Fiftin samples were collected from different infections from Baquba General Hospital and AL-Batool Hospital. Twenty isolates were found to be *Escherichia coli* .The susceptibility test was applied on these isolates against deferent antibiotics. The results revealed that the highest resistances were for Piperacilline(93.3%) and highest Sensitive Imipenem with 100%, While the lowest resistance were for Tobramycin (9%) . Moreover the results of virulence factors that had *E. coli* showed possession of all isolates many virulence factors and a high production of which increases the pathogenicity of it. All isolates were unable to produce urease and gelatinase, but heamolycin (35%) . As well as, Tow isolate (10%) were able to production Extended Spectrum β -Lactamases enzyme. Furthermore, four isolate (20%) were able to production metallo β -Lactamases Finally, six isolate(30%) were able to production Bacteriocin.

Conclusion: *E. coli* isolates highest resistances were for Piperacilline and highest Sensitive Imipenem with 100%, While the lowest resistance were for Tobramycin . additionally some of isolates production Extended Spectrum β -Lactamases enzyme, metallo β -Lactamases and Bacteriocin.

Keywords: *Escherichia coli* , Extended Spectrum β -Lactamases, Metallo β -Lactamases, Bacteriocin , Antibiotics

دراسة بكتريولوجية لبكتريا *E. coli* المعزولة من أخماج مختلفة في مدينة ديالى

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الخلاصة

الهدف من الدراسة الحالية هو عزل وتشخيص بكتريا الايشريكية القولونية من أخماج مختلفة وكشف حساسية ومقاومة هذه البكتريا للعوامل الضد مايكروبية ،بالاضافة الى الكشف عن عوامل الضراوة .جمعت النماذج للفترة من 2016/6/1 ولغاية 2016/9/1 في مدينة بعقوبة في العراق. وتضمنت: جمع 50 عينة من أخماج مختلفة من مستشفى بعقوبة التعليمي ومستشفى البتول. 20 عزلة كانت بكتريا الايشريكية القولونية .كما أجري اختبار الحساسية للعزلات تجاه مضادات حيائية مختلفة .أظهرت النتائج أن أعلى مقاومة كانت تجاه المضاد البراسيلين وبنسبة (93.3%) ،وأعلى حساسية للمضاد الاميبينيم وبنسبة(100%) بينما أقل مقاومة للمضاد التوبراميسين وبنسبة (9%). كما أوضحت نتائج عوامل الضراوة لبكتريا الايشريكية القولونية امتلاك كل العزلات لعوامل الضراوة والانتاج العالي يزيد من امراضيتها. كما ان كل العزلات منتجة لانزيمي اليوريز والجيلاتينيز ،أما أنتاجيتها للهيمولايسين فقد كان بنسبة (35%) .بالاضافة الى ذلك عزلتان (10%) كانت منتجة لانزيمات البيتا لاكتاميز واسعة الطيف . وأربع عزلات وبنسبة (20%) قادرة على أنتاج أنزيمات البيتا لاكتاميز المعدنية، وأخير "ست عزلات وبنسبة (30%) منتجة للبكتريوسين.

الاستنتاجات: كانت لعزلات بكتريا الايشريكية القولونية مقاومة عالية تجاه المضاد البراسيلين وأعلى حساسية تجاه المضاد الاميبينيم وبنسبة 100% بينما أقل مقاومة كانت تجاه المضاد التوبراميسين .بالاضافة الى ذلك كانت بعض العزلات منتجة لانزيمات البيتا لاكتاميز واسعة الطيف ،وانزيمات البيتا لاكتاميز المعدنية والبكتريوسين.

الكلمات المفتاحية: الايشريكية القولونية ،انزيمات البيتا لاكتاميز واسعة الطيف ،انزيمات البيتا لاكتاميز المعدنية، البكتريوسين ،المضادات الحياتية.

Introduction

Escherichia coli (*E. coli*) bacteria usually live in the entrails of community and animals. mainly *E. coli* are not dangerous and in fact are an essential part of a healthy human intestinal region. However, some *E. coli* are pathogenic, importance they can foundation sickness. ⁽¹⁾ *E. coli* is the mainly prevalent infecting individual in the family of gram- -negative bacteria identified as Enterobacteriaceae. ⁽²⁾ *E. coli* bacteria were revealed in the "human colon in 1885 by German bacteriologist " Theodor- Escherich. ⁽³⁾ *E. coli* is a facultative "aerobic and anaerobic growth" gram-negative organism, stick formed, may or may not be motile. a little rods are flagellated and a few are not). ⁽⁴⁾ Bacteria that can be usually develop greatest at 37 C. *E. coli* is a Gram-negative that cannot sporulate. for that reason, it is simple to destroy by easy boiling or essential sterilization. ⁽⁵⁾ *E. coli* has single one circular- chromosome, several beside with a circular plasmid. ⁽⁶⁾ . *E. coli* is a main human pathogen that occurs in numerous unlike types of infections of the human body, this suitable to *E. coli* have different virulence factors as producing a extensive" variety of enzymes and toxins". ⁽⁷⁾ Nearly all strains of *E. coli* top secret a group of" enzymes which includes hemolysin, Extended Spectrum β -Lactamases enzyme, Metallo β -Lactamases enzyme" , "Bacteriocin, Catalase enzyme. The main function of these proteins may be alter limited host tissues into nutrients obligatory for bacterial increase". Extended-spectrum β -lactamases (ESBLs) are a group of plasmid-mediated, diverse, composite and fast evolving enzymes that are posing a main' therapeutic challenge today in the treatment of hospitalized and community-based patients. these enzymes share the ability to hydrolyze third-cohort cephalosporins and aztreonam and yet are reticent by clavulanic acid". ⁽⁸⁾ In accumulation, "ESBL-producing organisms exhibit co-resistance to many other classes of antibiotics", follow-on in restriction of therapeutic option. due to inoculum effect and- substrate specificity, their discovery is also a most important challenge. ⁽⁹⁾⁽¹⁰⁾. The ever-increasing and quick "spread of metallo-beta-lactamase (MBL) producing Enterobacteriaceae", mostly *Escherichia coli*, Metallo- β -lactamases era a varied set of enzymes that catalyze the hydrolysis of a broad range of β -lactam drugs including carbapenems. This multiplicity is reflected in the inspection that the enzyme mechanisms disagree based on whether 1 or 2 zincs are bounce in the lively site which, in turn, is

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dependent on the subclass of β -lactamase⁽¹¹⁾ The dissemination of the genes encoding these enzymes amongst Gram- -negative bacteria has made them an important cause of resistance". In addition, there are currently no clinically accessible inhibitors to block metallo- β -lactamase action⁽¹²⁾ .Bacteriocins are bacterially produced peptides that are active in opposition to other bacteria and against which the producer has a particular immunity- mechanism, Further, almost colicins are plasmid encoded, whereas microcin encoding genes are also initiated on the chromosome.^{(13),(14)}

Equipment and Methods

Samples collection

Fifteen different clinical samples were collected from patients and carriers in Baquba General Hospital and Al-Batool Hospital over period from 1/6/2016 to 1/9/2016. The samples were included (14 from urine, 9 from umbilical cord, 15 from wound and 12 from burn).

Isolation and Identification of *Escherichia coli*

The collected samples were inoculated on the blood agar, incubated at 37°C for 24 hours. The isolates were examined for their shape, size, colour, pigments, and haemolytic activity. Then transferred and streaked on MacConkey agar for detecting the ability of each isolate to ferment lactose. Every one plate was incubated at 37°C for 1 day then a single pure then transferred to Eosin methylene blue agar (EMB) appearing as a metallic green sheen. pure isolated colony was transferred to Nutrient broth medium for the preservation and to carry out other biochemical tests that confirmed the identification of isolates. The isolate was recognized according to the "Bergey's Manual".^{(15),(16)} As the following: gram stain and biochemical tests. Standard biochemical tests were used for detecting *E. coli* strains.

Antimicrobial susceptibility test

The sensitivity and resistance of *E. coli* to antimicrobials was tested by the disc diffusion method on Mueller-Hinton agar using antibiotic "discs according" to medical and Laboratory standard association (CLSI) guidelines.⁽¹⁷⁾ Twelve antibiotics were tested: Ampicillin (30Mg), Imipenem (10Mg), Cefixime (30Mg), Ciprofloxacin (5Mg), Cefotaxime (10Mg), Augmentin (10Mg), Nitrofurantoin (15Mg), Ceftazidime (15Mg), Tobramycin (30Mg), Gentamicin (10Mg), Piperacillin (5Mg) and Co-trimoxazole (30Mg). Interpretation of

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inhibition zones was carried out based on the manufactures and CLSI guidelines .⁽¹⁸⁾ Then the plates are incubate during the night at 37°C, and the region of reticence of bacterial growth is use-d sa- a calculate of defenselessness, "where big zones of inhibition signify that the organism is susceptible", while little or on region of inhibition indicate confrontation. "An analysis of intermediate is particular for zones which fall between the established cutoffs for the other interpretations".⁽¹⁹⁾

Detection of virulence factors & Biochemical test

The *Ecoli* ability to produce some of virulence factors (enzymes and toxins) were recognized and tests were applied on 20 isolates that identified. it included: Haemolysin production, urease production and · identified by Biochemical test such as Triple Sugar Iron Agar (TSI) , IMViC examination "indole, methyl red, Voges-Proskauer, dan citrat".⁽²⁰⁾

Detection of Extended-spectrum β -lactamases (ESBLs)

Extended-spectrum β -lactamases production saw tested by compact disk estimate. using double disc synergy" test. Briefly", a disinfected Mueller-Hinton agar was prepared and" a 0.5 MacFarland equivalent standard of the test organisms was streaked on the surface of the agar with a sterile loop and permitted for 15-20 mins to pre-diffuse". An Augmentin which is a combination of clavulanic acid 20 (μ g) and amoxicillin (10 μ g) was placed at the center of the petri-dish and cefotaxime (30 μ g), "ceftaxidime (30 μ g), aztreonam (30 μ g) ciprofloxacin (30 μ g) were placed 15mm apart center to centre on the plates with a sterile forceps". These erew incubate at 35°C for 18-24 h. An superior zone of reserve from 5 mm beyond in the attendance of Augmentin -is regarded as positive for phenotypic production of (ESBL) enzyme.⁽²¹⁾

Detection of "Metallo- β -lactamases' (M.B.L.s)

M.B.L assembly saw detected by the stage combine disc examination described by Franklin et al. in all carbapenemase screening positive isolate. In this examination, 2 imipenem discs (10 μ g), 1 contain 10 μ l of 0.1 M (292 μ g) anhydrous EDTA (Sigma Chemicals, St. Louis, MO) were used. They erew located on a MHA plate inoculated with 0.5 McFarland deferment of the test isolate. Plates erew incubate for "16–18 hours' at 35°C. After incubation, the width of inhibition zones saw exact. 'An add to in zone diameter of >4 mm around the imipenem-

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EDTA disc compared to that of the imipenem disc alone was considered positive for MBL production".⁽²²⁾

Detection of Bacteriocin (colicin)

The occurrence of colicin production was strong-minded using the agar overlay method with pointer strain *E. coli* CL173. momentarily, agar plates were stab inoculated with the test strains and incubated overnight at 37°C. Colonies were lysed for 15 min using cellulose pads impregnated with chloroform. "To get rid of residual chloroform vapour the plates were then showing to air and overlaid with soft agar containing an indicator strain and incubated overnight at 37°C".⁽²³⁾

Results and Discussion**Isolation and Identification**

Fifteen samples were collected from patients and carriers, the samples comprised from (urine, umbilical cord , wound and burn). Twenty isolates (25%) have the ability to grow on the MacConky agar which "considered choosy and discrepancy media for gram off-putting bacteria "⁽²⁴⁾. All 20 isolates had ability to ferment Lactose and form large Pink colonies, smooth. They are grow on "Eosin methylene blue-- agar "(EMB) "choosy and degree of difference media" appearing as a metallic green sheen .Microscopic examination was used to all 20 isolates after staining by gram stain and cells appeared as Gram-negative rods. For further identification some of the biochemical tests was performed on 20 isolates, included: catalase test was all 20 isolated gave positive results ,While 20 isolates gave the negative result for all of oxidase test, H₂S production test and Gelatin laquification test . Also all 20 isolates were positive to Indol test and Methyl red but Negative result for Voges-Proskauer test and Citrate Utilization Test . Additionally , nitrate reduction test was not applied for further identification because the *E. coli* often unable reduce nitrate to nitrite.⁽²⁵⁾ 7(35%) isolated can be produced Haemolysin. *E. coli* can be production haemolysin that enzyme imported play role in against immune cells for host.⁽²⁶⁾

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<i>E-Coli</i>	Testes
-	Gram stain
-	Oxidase test
+	Cat-alase- test
+	Haemolysin production
+	Indol production test
+	Methyl- red- test
-	Voges proskauer- test
-	Citrate utilization- test
-	H ₂ S- production- test
-	Urea hydrolysis- (urease test)
-	Gelatin laquification- test
+	Lactose fermentation- test

Susceptibility test of *Ecoli*:

The sensitivity of 20 isolates were tested against 12 antibiotics. The susceptibility test was applied according to the Kirby-Baure Method (antibiotic disc diffusion method).

Table (1): Rate sensitivity and resistance of different antibiotics for *Ecoli*.

<i>Ecoli</i>			Antibiotics
R	I	S	
%67.5	0	%32.5	Ampicillin
0	0	%100	Imipenem
%66.66	%13.33	20%	Cefixime
%40	%13.33	60%	Cefotaxime
%73.3	%20	6.66%	Augmentin
%86.66	%6.66	%6.66	Nitrofourantoin
%46.6	%6.66	%46.6	Ceftazidime
%9	0	91%	Tobramycin
%40	%13.33	46.6%	Gentamicin
%33.33	%6.66	60%	Ciprofloxacin
%93.3	0	%6.6	Piperacillin
%75	0	%25	Co-trimoxazole

The results in table (1) showed that isolates were resistance for β -lactamases antibiotic suchas: Piperacillin (93.3%), Ampicillin (67.5%) ,Cefixime (66.66%) ,Cefotaxime (40%),ceftazidime (46.6%) this results was agreed with studies ⁽²⁷⁾, who reported (61.1%) to Ampicillin and (42.8%) to Cefotaxime, ⁽²⁸⁾ but disagrees with the work of Bonomo *etal.* (2003) for the resistance of Cefotaxime (13.3%) ⁽²⁹⁾" because of modify in incursion of external cell membrane because has protein called burin the cell wall is enclosed with an outer

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film that establishes a permeability barrier against the antibiotic".⁽³⁰⁾ While aminoglycosides antibiotics group such as Gentoamycin(9%),Tobramycin (13.33%) this result Gentoamycin agreed with studies conducted in Ethiopia (57.8%).⁽³¹⁾Because this antibiotics can able inhibition of syntheses protein by linked with small ribosome unite (30S).⁽³²⁾ Quinolones antibiotics such as Ciprofloxacin (33.3%)this result agreed with study by Mavroidi.*etal.*(2012) .⁽³³⁾ Because this antibiotics can able inhibition of DNA syntheses and super coiling. ⁽³⁴⁾ Reported result Resistance for Co-trimoxazole (75%) ,Augmentin (73.3%) this study agreed with the work of Drawz and Bonomo(2010). ⁽³⁵⁾Furthermore, Resistance result of Nitrofourantion higher (86.66%) this result agreed with study by Gums (2005). ⁽³⁶⁾ While imipenem sensitive higher 100% this result agreed with Livadariu *etal.*(2006).⁽³⁷⁾ In general the resistance to different antibiotics may be due to the type of antibiotics and how much that used among the patients in the community. In addition to that the resistance to ward any antibiotics was depended on the amount of PBP2a or β -Lactamase enzyme that produced by each strain of *Ecoli* . All these reasons could create variations in the rate of resistance.

Table (3): Some of virulence factors of *Ecoli* results

Virulence factor	Isolate NO.	<i>Ecoli</i> positive (%)	<i>Ecoli</i> negative (%)
Extended-spectrum β -lactamases	2	10%	90%
Metallo- β -lactamases	4	20%	80%
Bacteriocin(colicin)	6	30%	70%

The results in table (3) showed that 2 (10%) isolates were production for Extended-spectrum β -lactamases , in this study also agreed with the findinds of Babypadmini, and Appalaraju (2004).⁽³⁸⁾ Who reported 41% ESBL positivity *E. coli* and 40% was reported by Jayapradha *etal.*(2007) .⁽³⁹⁾ Isolates can be explained in most cases to production of β - Lactamase enzyme that destroyed the β - Lactam ring and inactivated the penicillin and this enzyme was encoded by plasmid that easy to transfer among strain. While 4(20%) isolated nac be produced of " Metallo β -lactamase"s,this product agreed with numerous recent studies from eroth parts of Asia such sa (18.98%) about this" study Khanal *etal.*(2013)" ⁽⁴⁰⁾ Also demonstrated rising incidence fo M.B.L invention ni Enterobacteriaceae isolate. ^{(41).}(42)

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Production of M.B.L ni Enterobacteriaceae isolates at present follows an rising "prevalence pattern and the prevalence pace may diverge greatly in different geographical areas and as of institute to institution". ⁽⁴³⁾ 6 (30%) isolated can be produced Bacteriocin (colicin) , As noted previously, variable levels of susceptibility to colicins could be due to variability in the number of colicin receptors per cell or due to shielding of receptors by the lipopolysaccharide O-antigenic. ⁽⁴⁴⁾

References

1. Hudault S, Guignot J, Servin AL (Jul 2001). "Escherichia coli strains colonising the gastrointestinal tract protect germfree mice against Salmonella typhimurium infection". Gut. 49 (1): 47–55. doi:10.1136/gut.49.1.47. PMC 1728375. PMID 11413110 .
2. Nataro, J. P., Bopp, C. A., Fields, P. I., Kaper, J. B., & Strockbine, N. A. (2007). Escherichia, Shigella and Salmonella. In P. R. Murray, E. J. Baron, J. H. Jorgensen, M. L. Landry & M. A. Pfaller (Eds.), Manual of Clinical Microbiology (9th ed., pp. 670-687). Washington, DC, USA: ASM press.
3. cookes1985, Feng, Peter, et al., "Enumeration of Escherichia coli and the Coliform Bacteria," in BACTERIOLOGICAL ANALYTICAL MANUAL (8th Ed. 2002), available online at <http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/BacteriologicalAnalyticalManualBAM/ucm064948.ht> .
4. "Escherichia coli". CDC National Center for Emerging and Zoonotic Infectious Diseases. Retrieved 2012-10-02.
5. Wilson, W. R., Sande, M. A., & Drew, W. L. (2001). Current diagnosis & treatment in infectious diseases. New York: Lange Medical Books/McGraw-Hill.
6. Reed, Jennifer Leanne. "Model Driven Analysis of Escherichia coli Metabolism." 2005.
7. Nataro, J. P., Bopp, C. A., Fields, P. I., Kaper, J. B., & Strockbine, N. A. (2007). Escherichia, Shigella and Salmonella. In P. R. Murray, E. J. Baron, J. H. Jorgensen, M. L. Landry & M. A. Pfaller (Eds.), Manual of Clinical Microbiology (9th ed., pp. 670-687). Washington, DC, USA: ASM press.

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8. Lachmayr KL, Lee J, Kerkhof LJ, DiRienzo AG, Cavanaugh CM, Ford T E. Quantifying Nonspecific TEM β -Lactamase (*bla*TEM) Genes in a Wastewater Stream Appl. Environ. Microbiol, 2009; 75(1): 203-211.
9. Philippon A, Labia R, Jacoby G. Extended-spectrum beta-lactamases. Antimicrob Agents Chemother. 1989;33:1131–6.
10. Paterson DL, Bonomo RA. Extended-spectrum β -lactamases: A clinical update. Clin Microbiol Rev. 2005;18:657–86.
11. Bebrone C: Metallo-beta-lactamases (classification, activity, genetic organization, structure, zinc coordination) and their superfamily. Biochem Pharmacol. 2007, 74: 1686-1701.
12. Cornaglia G, Giamarellou H, Rossolini GM: Metallo- β -lactamases: a last frontier for β -lactams. Lancet Infect Dis. 2011, 11: 381-393 .
13. Cotter PD, Hill C, Ross RP. 2005. Bacteriocins: developing innate immunity for food. Nat. Rev. Microbiol. 3:777–788. Cross .
14. Klaenhammer TR. 1993. Genetics of bacteriocins produced by lactic acid bacteria. FEMS Microbiol. Rev. 12:39–85.
15. Holt, J.G.; N.R. Krieg; P.H.A. Sneath; J.T. Staley; and S.T. Williams. 1995. Bergy's Manual of Determinative Bacteriology. 9th.ed. Williams &Wilkins, USA. P.532-551.
16. MacFaddin J F. Biochemical tests for identification of medical bacteria. 1st Ed. Williams and Wilkins. Baltimore, USA, 2000.
17. Clinical and Laboratory Standards Institute (CLSI). (2013). Performance Standards for Antimicrobial Susceptibility Testing; twenty- second information supplement; CLSI Document M100-S22. Clinical and Laboratory Standards Institute: Wayne, PA, USA.
18. ALan MD, Partin PH, McConnell DH. Campbell-Walsh urology. 9th ed. Saunders, 2006, pp. 1119-1125.
19. Jorgensen JH and JD Turnidge. Susceptibility test methods: dilution and disk diffusion methods, p. 1152–1172. In PR Murray, E J Baron, JH Jorgensen, M L Landry, and M.A Pfaller (ed.), Manual of clinical microbiology, 9th ed. ASM Press, Washington, DC , 2007.

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20. Collee, J.G.; R.S. Miles; and B. Watt. 1996. Test for The Identification of Bacteria. P.131-149. In, J.G. Collee; A.G. Fraser; B.P. Marmion; and A. Simmons (eds.). Mackie and McCartney Practical Medical Microbiology. 14th.ed. Churchill Livingstone, New York .
21. Jarlier, V.; Nicolas, M.; Fournier, G.; and Philippon, A. (1988). Extended broad-spectrum β -Lactamases conferring transferable resistance to newer β -lactam agents in *Enterobacteriaceae*: Hospital prevalence and susceptibility patterns. *Rev. Infect. Dis.* Vol.10, No. 4 :pp. 867-78.
22. Franklin C, Liolios L, Peleg AY: Phenotypic detection of carbapenem susceptible metallo-beta-lactamase-producing gram-negative bacilli in the clinical laboratory. *J Clin Microbiol.* 2006, 44: 3139-3144.
23. Pugsley AP (1985) *Escherichia coli* K12 strains for use in the identification and characterization of colicins. *J Gen Microbiol* 131: 369–376.
24. Holt ,J.G.; Krieg, N.R.; Sneath, P.H.A.; Staley, J.A.; & Williams, S.T.(1994). *Bergey's Manual Of Determinative Bacteriology*. (9th) ed. Williams & Wilkins.
25. Friedrich , A.W.; Koch , R.; Bielaszewska , M.; Zhang , W.; Karch , H. and Mathys , W. (2005) . Distribution of the urease gene cluster among and urea activity of enterohemorrhagic *Escherichia coli* O157 isolated from humans . *J. of Clinical Microbiology* .Vol.43, No. 2 : pp.546-50 .
26. Dhakal ,B . K. and Mulvey . M . A.(2012). The UPEC Pore-Formin Toxin α -Hemolysin Triggers Proteolysis of Host Proteins to Disrupt Cell Adhesion, Inflammatory, and Survival Pathways. *Cell Host & Microbe*, Vol.11, No. 1, pp.58-69
27. Olowe OA, Eniola KIT, Olowe RA, Olayemi AB. Starch paper technique is easy to detect beta lactamase detection from cases of diarrheagenic *Escherichia coli* in Osogbo. *Life Sci J.* 2007;4.
28. Al-Chalabi, R .; Al- Ibadi, M. and Al –Ubaidy, A .(2010). Detection of Urovirulence Genes (*eae, E-hly, α -hly*) of Uropathogenic *Escherichia coli* by Specific PCR. *Journal of Biotechnology Research Center* (special edition). Vol.4, No.1.pp.

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29. Bonomo , R.A.; Donskey , C.J.; Blumer , I.L; Hujer , A.M.; Høyenm , C.K.; Jacob , M.R.; Whalen , G.G. and Salata, R.A. (2003) . Cefotaxime resistant bacteria colonizing older people admitted to an acute care hospital . (2003) *J. AM. Geriatr Soc* . Vol. 51 ,No. 4 : 519 –22 .
30. Spanu, T.; Luzzaro, F.; Perilli, M.; Amicosanti, G.; Toniolo, A.; Fadda, G. and the Italian ESBL study group .(2002). Occurrence of extended-spectrum- β -lactams and other antimicrobial drug. *Antimicrobial Agent and Chemotherapy*. Jun. Vol .46 ,No. 1 :pp. 196-202.
31. Tesfaye G, Asrat D, Woldeamanuel Y, Gizaw M. Microbiology of discharging ears in Ethiopia. *Asian Pac J Trop Med*. 2009;2(91):60–67.
32. Heritage, J. (2003). Antibiotics. University of Leeds.
33. Mavroidi A, Miriagou V, Liakopoulos A, Tzelepi E, Stefos A, Dalekos GN, et al. Ciprofloxacin-resistant *Escherichia coli* in Central Greece: mechanisms of resistance and molecular identification. *BMC Infect Dis*.2012;12 [[PMC free article](#)] [[PubMed](#)]
34. (Hardy et al., (2009). Virulence factors of avian pathogenic *Escherichia coli* (APEC)) *Pesq. Vet. Bras*. vol.29 no.7 Rio de Janeiro July
35. Drawz SM, Bonomo RA. Three decades of beta-lactamase inhibitors. *Clin Microbiol Rev*.2010;23(1):160–201. [[PMC free article](#)] [[PubMed](#)]
36. Gums J.G., Comparison of National and Regional Non Susceptibilities of *S. aureus*, *E. coli* and *P. aeruginosa* to commonly prescribed antibiotics: results of the antimicrobial resistance management program 1997-2004, 434, 43rd IDSA, San Francisco, 6-9 oct. 2005.
37. Livadariu M., Cristea V., Frunzoi M., Studiul infecțiilor cutanate în cazuistica laboratorului Synevo București, Zilele Medicale Medcover-Synevo, București, 2006.
38. Babypadmini, S. and Appalaraju, B. (2004). Extended spectrum β -lactamases in urinary isolates of *Escherichia coli* and *Klebsiella pneumoniae* –Prevalence and susceptibility

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- pattern in a tertiary care hospital. Indian Journal of Medical Microbiology. 22(3):172-174.
39. (Jayapradha, R., Muruges, S., Mahesh, N and Brahatheeswaran, D. (2007). Prevalence of ESBL Producing Strains in Tuberculosis Patients. Research(Journal of microbiology, 2:491-495).
 40. Khanal S, Joshi DR, Bhatta DR, Devkota U, Pokhrel BM: β -lactamase-producing multidrug-resistant bacterial pathogens from tracheal aspirates of intensive care unit patients at national institute of neurological and allied sciences. Nepal ISRN Microbiol. 2013, 2013: 847569.
 41. Kumar S, Bandyopadhyay M, Mondal S, Pal N, Ghosh T, Bandyopadhyay M, Banerjee P: Tigecycline activity against metallo- β -lactamase-producing bacteria. Avicenna J Med. 2013, 3: 92-96.
 42. Datta S, Wattal C, Goel N, Oberoi JK, Raveendran R, Prasad KJ: A ten year analysis of multi-drug resistant blood stream infections caused by *Escherichia coli* & *Klebsiella pneumoniae* in a tertiary care hospital. Indian J Med Res. 2012, 135: 907-912.
 43. Yong D, Choi YS, Roh KH, Kim CK, Park YH, Yum JH, Lee K, Chong Y: Increasing prevalence and diversity of metallo-beta-lactamases in *Pseudomonas* spp., *Acinetobacter* spp., and *Enterobacteriaceae* from Korea. Antimicrob Agents Chemother. 2006, 50: 1884-1886.
 44. Bradley DE, Howard SP, Lior H (1991) Colicinogeny of O15 enterohemorrhagic *Escherichia coli* and the shielding of colicin and phage receptors by their O-antigenic side chains. Can J Microbiol 37: 97–104