

## ENTEROPATHOGENIC ESCHERICHIA COLI (EEC) IN SLAUGHTERED CATTLE AT A MODERN ABATTOIR

BY

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### INTRODUCTION

The main objectives of establishing modern abattoirs with appropriate technology are the hygienic slaughtering and handling of meat, thus preventing the spread of zoonotic and meat borne diseases in both humans and animals, whilst keeping the environment free from pathogens of animal origin, and to achieve increased and improved meat production and handling.

In Egypt, no studies till now are done on these newly built modern abattoirs to assess the effect of modernization on the presence of E.coli with special reference to enteropathogenic types. Therefore, one of the newly built abattoirs in the urban areas was selected and beef carcasses are examined for surface contaminations with such microorganisms. Moreover, some factors in the abattoir as hands, clothes and transport in open cars which can contribute to E.coli contamination were also investigated.

The native habitat for E.coli is the enteric tract of man and animals, thus its presence in foods generally indicates direct or indirect pollution of faecal origin. E.coli is the classical indicator of the possible presence of enteric pathogenes in foods. The presence of E. coli in a meat does not denote directly

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the presence of a pathogen, but only implies a certain risk that it may be present. In other words, the presence of E.coli in meat is not always closely correlated with the occurrence of salmonellae or other pathogenic microorganisms. E.coli in food have been associated with outbreaks of gastrointestinal diseases since 1903 (DELEPINE, 1903).

Definite E.coli serotypes are capable of causing various acute intestinal diseases in humans. Certain serotypes are responsible of colienteritis in children. They cause diseases in infants of the first months of life and in older infants; while others cause dysentery like diseases or cholera like diarrhoea. They produce also thermolabile and thermoresistant enterotoxine. Ecoli may also cause Colibacillosis in adults (peritonitis, meningitis, enteritis, toxoinfections, cystitis, pyelitis, pyelonephritis, angiocholitis, salpingoophoritis, appendicitis, otitis and pureperal sepsis), PYATKIN and KRIVOSHEIN (1980).

E.coli is also judged to be a significant pathogen in cases of traveller's diarrhoea and in gastrointestinal illness in developing nations and other localized areas characterized by poor individual hygiene (MEHLMAN and ROMERO, 1982).

Several identifiable strains of E.coli have been known for many years to cause infantile diarrhoea (NETER et al., 1951; TAYLOR & CHARTER, 1952 and EWING et al., 1957 & 1963). In recent years it has become increasingly evident that E.coli strains also produce illness to a significant degree in adults (SAKAZAKI et al., 1974; WHO 1974 a; ANON, 1978 and SACK et al., 1986). There are two forms of the disease which differ clinically from each other to some degree (SOJKA, 1973). The first, caused by toxigenic strains, is characterized by excessive loss of fluid from profuse diarrhoea (the cholera like syndrome). The second form, caused by invasive strains, produces a syndrome closely resembling dysentery (the dysentery like syndrome). There are also forms of the disease in which these two clinical pictures are



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intermixed. The incubation period is variable and short 6-36 hours (CDC, 1973 b), and tends to be shorter for invasive than for toxin producing strains (DUPONT et al., 1971). The duration of the disease is also generally short, 24 hours to few days, but it can be occasionally much longer. There are epidemics on record with a median duration of 9 days and a maximum of 77 days (CDC, 1973 a). Epidemics are particularly prone to occur in closed institutions for infants such as nurseries and maternity wards.

It has recently been convincingly demonstrated in volunteers that there exist both invasive and enterotoxin producing strains, and strains combining these two capacities (DUPONT et al., 1971).

GLYES & BARNUM (1969) and SMITH & GYLES (1970) stated that there are two kinds of toxins; one is thermostable and the other is thermolabile. Preliminary immunological studies furnish evidence that the heatlabile toxins from different *E.coli* strains share antigenic determinants and also cross react with the cholera toxin (HOLMGREN et al., 1973).

MATSIEVSKII et al., (1971) found that an acute outbreak of food poisoning caused by *E.coli* O 124 was observed among 198 children and 90 personnel members of a children's sanatorium. In 1982, BRYAN stated that the serogroups of *E.coli* that have caused the invasive type illness are O<sub>25</sub>, O<sub>28</sub>, O<sub>112</sub>, O<sub>124</sub>, O<sub>136</sub>, O<sub>143</sub>, O<sub>147</sub>, O<sub>144</sub> and O<sub>512</sub> while those that have been shown to elaborate enterotoxins are: O<sub>6</sub>, O<sub>15</sub>, O<sub>18</sub>, O<sub>20</sub>, O<sub>27</sub>, O<sub>44</sub>, O<sub>55</sub>, O<sub>78</sub>, O<sub>111</sub>, O<sub>114</sub>, O<sub>119</sub>, O<sub>125</sub>, O<sub>126</sub>, O<sub>127</sub>, O<sub>128</sub>, O<sub>142</sub>, O<sub>146</sub>, O<sub>148</sub>, O<sub>154</sub>, O<sub>155</sub> and O<sub>156</sub>. He stated that the incubation period of the disease (*E.coli* Diarrhoeas) was 8-24 hours, mean 11 hours for invasive type.

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The symptoms are fever, chills, headache, myalgia, abdominal cramps, profuse watery diarrhoea, it is similar to Shigellosis. In the enterotoxigenic type the incubation period was 8-44 hours with a mean 26 hours. The symptoms are diarrhoea (rice water stools), vomiting, dehydration, shock. It is similar to cholera. Recently, FOSTER (1987) stated that another type, E.coli O<sub>157</sub>:

H<sub>7</sub> cause a very serious hemorrhagic colitis, or bloody diarrhoea, that sometimes spreads into the urinary tract and causes hemolytic uremic syndrome. This organism residues in the animal population and sometimes appears in raw meat or milk.

The aim of the present study is to investigate the sanitary status of a modern abattoir by detection of EEC and its serotypes existing on the surface of beef carcasses and meat contact surfaces.

### MATERIAL AND METHODS

One hundred and fifty swabs were taken from the surface of beef carcasses and meat contact surfaces at a modern abattoir for monitoring the enteropathogenic E.coli.

The swabs were taken from the surface of twenty carcasses at two sites (shoulder and thigh) directly after skinning and after preparation as well.

Moreover, other ten carcasses were also swabbed twice at the same sites; one directly after preparation and stamping as well as after delivery in the open cars used for distribution of carcasses to butchers in the city.

To investigate contaminants on the meat contact surfaces, thirty swabs were taken; ten from each of right hand of meat handlers, clothes of the workers and inner surface of the open cars used for meat distribution.



The Enteropathogenic E.coli isolation was carried out according to ICMSF (1978). The isolated E.coli colonies were identified biochemically using the Enterotube II "Roche". The isolates were identified serologically by using Diagnostic sera, "Wellcome E.coli agglutination sera for diagnosis the Enteropathogenic types".

## RESULTS AND DISCUSSION

From the results achieved in Table (1) it was found that E.coli was isolated from 20% of shoulder samples after skinning and from 55% of samples after preparation. IT was also found in 20% of thigh samples after skinning and 30% after preparation. E.coli could be also detected in 70% of shoulder samples and 40% of thigh samples after preparation and stamping while after delivery in cars from 50% of shoulder and 40% of thigh samples. Isolated E.coli from cars were more than those from hands and clothes of workers.

Table (1): Isolated E.coli from carcasses and meat contact surfaces

Site	Sample	Isolates	
		No.	%
Shoulder	A	4	20
	B	11	55
	C	7	70
	D	5	50
Thigh	A	4	20
	B	6	30
	C	4	40
	D	4	40
Hands		1	10
Clothes		1	10
Cars		4	40

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- A = After skinning  
 B = After preparation  
 C = After preparation and stamping  
 D = After delivery in cars

Certain serotypes of *E. coli* have a primary pathogenicity in the intestine and cause gastroenteritis, mainly in infants. Most outbreaks take place in infants under 18 months, though many cases are in children up to 5 years old some infections cause diarrhoea in adults.

Table (2): Serotypes of isolated Enteropathogenic *E. coli* from surface of beef carcasses and meat contact surfaces.

Samples	Serotypes		No. of
	poly valent	monovalent	+ ve samples
<b>Shoulder</b>			
-After skinning	2	0 <sub>55</sub> : K <sub>59</sub> (B 5)	12
-After preparation	2	0 <sub>111</sub> : K <sub>58</sub> (B 4)	2
-After preparation and stamping	2	0 <sub>119</sub> : K <sub>69</sub> (B14)	1
-After delivery in car	-		Nil
<b>Thigh</b>			
-After skinning	-	-	Nil
-After preparation	-	-	Nil
-After preparation and stamping	-	-	Nil
-After delivery in car	2	0 <sub>119</sub> : K <sub>69</sub> (B14)	5
<b>Hands</b>			
<b>Clothes</b>			
<b>Cars</b>			
	2	0 <sub>26</sub> : K <sub>60</sub> (B 6)	1
	-		Nil
	2	0 <sub>55</sub> : K <sub>59</sub> (B 5)	9,10



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The two serotypes, alpha (BRAY, 1945) and beta (SMITH, 1949), first shown to be the cause of outbreaks of infantile diarrhoea were later typed as  $O_{111}:K_{58}$  (B 4) and  $O_{55}:K_{59}$  (B 5). The biotype Dyspepsikoli A IV and Dyspepsikoli A I which were identified as cause of infantile gastroenteritis by ADAM (1927) were also later typed as  $O_{111}:K_{58}$  and  $O_{55}:K_{59}$  respectively. Such serotypes were isolated from the shoulder of beef carcasses after skinning and after preparation and from cars used for transport of meat from the abattoir to butcher's shops.

Further serotypes have since been found in cases and outbreaks of infection, e.g. in O-group 26, 44, 86, 112, 119, 124, 125, 126, 127, 128, 142 and 158 (ROWE et al., 1974) and  $O_{157}$  (FOSTER, 1987). Not all strains in these enteropathogenic serotypes are able to cause gastroenteritis. The particular strains that cause gastroenteritis are distinguished from others in the same serotype by their ability to form an enterotoxin demonstrable by the production of fluid secretion and distension in ligated loops of intestine in rabbits; most strains of the same serotypes found in symptomless excretors do not form enterotoxin (TAYLOR et al., 1961; SMITH & HALLS, 1967 and SACK et al., 1971). The power to produce enterotoxin can be acquired by a non toxigenic strain by the receipt of a plasmid transmitted on conjugation from a toxigenic strain (SMITH and HALLS, 1968).

The enteropathogenic *E.coli* strains produce disease not only in man but also in a number of domesticated animals, such as calves, pigs, poultry and lambs (COOKE, 1974). A variety of foods have been implicated in outbreaks: stewed meat and gravy (KORETSKAIA and KOVALEVSKAIA, 1958); roast mutton (COSTIN et al., 1964); pork and chicken (SMITH et al., 1965) and ham and pie (WHO, 1974 b). The detection of even low numbers of Enteropathogenic *E.coli* in food, particularly in baby foods, reveals a public health hazard as significant as the demonstration

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of Salmonellae in such foods (ICMSE, 1978).

The sanitary importance of Enteropathogenic *E. coli* has been emphasized by many other authors as it has been implicated in human cases of gastroenteritis, epidemic diarrhoea in infants, sporadic summer diarrhoea in children as well as in cases of food poisoning (FERGUSON & JUNE, 1952; JUNE et al., 1953; ROGERS & CARACKELL, 1956; EWING & DAIRS, 1961; MACKIE & MACCARTNEY, 1962; EWING, 1963; BODILY et al., 1970; ETKIN & GORBACH, 1971; MATSIEVSKII et al., 1971; LOVE et al., 1972; CRUICKSHANK et al., 1975; MARIER et al., 1973; SINGH & RANGNATHAN, 1974 & 1977; MOSSEL, 1975; KORNACKI & MARTH, 1982; KRIEG & HOLT, 1984 and FOSTER, 1987). Moreover, organism was the most frequent cause cystitis, pyelitis, pyelonephritis, appendicitis and peritonitis (GRONROSS et al., 1955; LEPPANEN, 1958 & 1959; SMITH & CONANT, 1960; RYATKIN, 1967 and MOSSEL, 1975).

### SUMMARY

One hundred and fifty swabs were taken from the surface of beef carcasses and meat contact surfaces at a modern abattoir for monitoring the EEC. Moreover, other swabs were taken from hands of meat handlers, clothes and inner surfaces of open cars used for meat distribution.

*E. coli* was isolated more oftenly from the shoulder than from the thigh and from cars more than from hands and clothes of workers.

Serotypes of EEC from surface of beef carcasses were 055: K 59 (B 5) from shoulder after skinning and 0111: K 58 (B 4) after preparation and 0119: K 69 (B 14) from shoulder after preparation and stamping and from thigh after delivery in cars. EEC serotype 026 : K 60 (B 6) was isolated from hands and 055: K 59 (B 5) from cars.



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Public health significance of *E. coli* and isolated serotypes was discussed.

## REFERENCES

1. Adam, A. (1927): Dyspepsie-koli zur frage der-terii-ellen Aetiologie der sogenannten alimentarenintox-ikation. Jahresbericht Rinderheilkunde Berlin, 116, 8.
2. Anon, (1978): Food borne disease bacteria. In Inter-national Commission on Microbiological Specificat-ions for Food, Microorganisms in Foods. 1. Their significance and Enumeration, 2nd Ed. P. 22. Univer-sity of Toronto Press., Toronto.
3. Bodily, H.L. Updyke, E.L. and Mason, J.O. (1970): Diagnostic procedures for bacterial, mycotic and parasitic infections. 5thEd., Amer. Publ. Hith. Assoc., New. York.
4. Bray, J. (1945): Isolation of antigenically homoge-nous strains of *Bact. coli* Neopolitanum from summer diarrhoea of infants. *J. Path. and Bact.*, 57. 239.
5. Bryan, F.L. (1982): Diseases transmitted by foods. 2 nd Ed. HHS Pub. No. (CDC) 83-8237, US Dept. of Health and Human Services, Public Health Service, Centers for disease control, Atlanta, Georgia 30 333 USA.
6. Center for Disease Control (1973 a): Nosocomial ga-stroenteritis Arizona Morbidity and Mortality Week-ly Report 22, 225. Atlanta, Ga, US. Dept. Health Education & Welfare.
7. Center for Disease Control (1973 b): Foodborne and waterborne disease outbreaks. Annual Summary, 1972, P. 30, Atlanta, Ga, US, Dept. Health Education and Welfare.

*Enteropathogenic Escherichia coli (EEC) in.....*

- 8 . Cooke, E.M. (1974): E.coli and diseases of the gastrointestinal tract. In E.coli & man, Ch. 4, Edinburgh Churchill Livingstone.
- 9 . Costin, I. Voiculescu, Q. and Gorcea, V. (1964): An outbreak of food poisoning in adults associated with E.coli serotype 86 : B<sub>7</sub>: H<sub>34</sub>. Path. Microb., 27, 68.
10. Cruickshank, R. Duguid, J. Marmion, B. and Swain, R. (1975): Medical Microbiology, 12th Ed. Vol. 1 E. Livingstone Ltd, Edinburgh.
11. Delepine, S. (1903): Food poisoning and epidemic diarrhoea. J.A.M.A. 40, 657.
12. Dulont, H. Formal, S. Hornick, R. Syder, M. Libonati, J. Sheahan, D. La Brec, E. and Kalas, J. (1971): Pathogenesis of E.coli diarrhoea. N. Engl. J. Med. 285, 1.
13. Ethin, S. and Gorbach, S. (1971): Studies on enterotoxin from E.coli associated with acute diarrhoea in man. J. Lab. Clin. Med., 78, 81.
14. Ewing, W.H. (1963): Isolation and identification of E.coli serotypes associated with diarrhoeal diseases. US. Dept. of Health Education and Welfare, Public Health Service, Atlanta, Georgia.
15. Ewing, W.H. and Dairs, B.R. (1961): The O antigen group of E.coli culture from various sources. US. Dept. of Health Education and Welfare. Public Health Service, Atlanta, Georgia.
16. Ewing, W.H. Davis, B.R. and Montague, T.S. (1963): Studies on the occurrence of E.coli serotypes associated with diarrhoeal diseases. Atlanta, Ge., Center for Disease Control, US. Dept. of Health Education and Welfare.



17. Ewing, W.H. Tatum, N.W. and Davis, B.R. (1957): The occurrence of *E.coli* serotypes associated with diarrhoeal disease in the United States. Public Health Lab., 15, 118.
18. Ferguson, W.W. and June, R.C. (1952): Experiments on feeding adult volunteers with *E.coli* O<sub>111</sub>: B<sub>4</sub> a Coliform organism associated with infant diarrhoea. Amer. J. Hyg., 55, 155.
19. Foster, E.M. (1987): Future direction of food microbiology and food safety from the food industry's perspective. Proc. of 21<sup>th</sup> general Conference of ICMSF 25<sup>th</sup> Anniversany (1962-1987) Sept. 9-18, Toronto, Ontario, Canada.
20. Gronross, J. Mustakllio, E. and Virtanen, S. (1955): Serological identification of *E.coli* strains from urinary infection and suppurative conditions. Ann. Med. Exper. Fenn, 33, 133.
21. Gyles, C.L. and Barnum, D.A. (1969): A heat labile enterotoxin from strains of *E.coli* enteropathogenic for pigs. J. Infect. Dis. 120,419.
22. Holmgren, J. Soderlind, O. and Wadstron, T. (1973): Cross reaction between heat labile enterotoxins of *Vibrio cholera* and *E.coli* in neutralization test in rabbit ileum and skin. Acta Pathol. Microbiol. Scand, Sect, B. 81, 757.
23. ICMSF (1978): Microbial ecology of foods. University of Toronto Press, Toronto, Ontario, Canada.
24. ICMSF (1978): Microorganisms in foods, their significance and methods of enumeration. 2<sup>nd</sup> Ed. Univ. of Tornto Press, Toronto.

*Enteropathogenic Escherichia coli (EEC) in.....*

25. June, R. Ferguson, W. and Worfel, M. (1953): Experiments on feeding adult volunteers with E.coli O<sub>55</sub> B<sub>5</sub>, a Coliform organism with infant diarrhoea. Amer. J. Hyg., 57, 222.
26. Koretskaia, L.S. and Kovalevskaia, A.N. (1958): Food poisoning produced by E.coli serotype O<sub>26</sub>: B<sub>6</sub>. zh. Mikrobiol., Epidemiol. i Immunobiol, 4, 58.
27. Kornacki, J.L. and Marth, E.H. (1982): Food borne illness caused by E.coli. A review. J. Food. Prot. 45, 1051.
28. Krieg, N.R. and Holt, J.G. (1984): Manual of systematic Bacteriology, Vol. I. Williams and Wilkins, Baltimore, USA.
29. Leppanen, M.K. (1958): The occurrence of E.coli serotypes O<sub>26</sub>: B<sub>6</sub>; O<sub>55</sub>: B<sub>5</sub>; O<sub>86</sub>: B<sub>7</sub>; O<sub>124</sub>: B<sub>15</sub>; O<sub>126</sub>: B<sub>16</sub>; O<sub>44</sub> and O<sub>78</sub> in inflamed appendicitis and faeces, Ann. Med. Exper, Et. Biol. feun., 37, 105.
30. Love, W. Gorden, A. Gross, R. and Rowe, B. (1972): Infantile gastroenteritis due to E.coli O<sub>124</sub>. Lancet, 11, 355.
31. Mackie, K.J. and MacCartney, J.E. (1962): Handbook of practical bacteriology. 10<sup>th</sup> Ed. E & S Livingstone Ltd. London.
32. Marier, R. Wels J. Swanson, R. Callahan, W. and Mehlamn, I (1973): An outbreak, of EE. coli. foodborne disease traced to imported French cheese. Lancet, 2, 1376.



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33. Matsievskii, V., Logachev, A. Fedorina, A. and Pisklova, A (1971): Outbreak of food poisoning caused by E.coli O<sub>124</sub>: K<sub>72</sub> (B 17). Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii 48, 137. Dairy Sci. Abst., 35, 388 (1973).
34. Mehlman, I. and Romervo, A. (1982): Enteropathogenic E.coli, Methods for recovery from foods. Food Tech., 36, 3, 73.
35. Mossel, A.A. (1975): Microbiology of foods and dairy products. Univ. of Utrecht, Fact. Vet. Med.
36. Neter, E. Webb, C. Shumway, C. and Murdock, M (1951): Study on etiology, epidemiology and antibiotic therapy of infantile diarrhoea, with a particular reference to certain serotypes of E.coli. Amer. J. Puble. Health, 41, 1490.
37. Pyathin, K. (1967): Microbiology. MIR Publ., Moscow, USSR.
38. Pyathin, K. and Kriivoshein, Y. (1980): Microbiology with Virology, 2<sup>nd</sup> Ed. MIR Publ., Moscow, USSR.
39. Rogers, K.B. and Caracknell, V.M. (1956): Epidemic infantile gastroenteritis due to E.coli type O<sub>114</sub>. J. Path. Bact., 72, 27.
40. Rowe, B. Gross, R. Lindop, R. and Baird, R. (1974): A new E.coli O group O<sub>158</sub> associated with an outbreak of infantile enteritis. J. Clin. Path. 27, 832.
41. Sack, R. Corbach, S. Bauwell, J. Jacobe, B. chatterjee, B. and Mitra, R. (1971): EEC isolated from patients with severe cholera like disease. J. Infect. Dis. 123, 378.

*Enteropathogenic Escherichia coli (EEC) in.....*

42. Sack, R. Sack, D. and Orskov, I. (1986): EEC isolated from food. J. Infect. Dis, 135, 313.
43. Sakazaki, R. Tamura, K. and Nakamura, A (1974): Further studies on EEC associated with diarrhoeal diseases in children and adults. Japan J. Med. Sci. Biol. 27, 7.
44. Singh, R. and Ranganathan, B. (1974): Occurrence of EEC serotypes in milk and milk products. Milchwissenschaft, 29, 529.
45. Singh, R. and Ranganathan, B. (1977): Public health significance of E.coli in milk and milk products. Dairy Sci. Abst. 40, 227, (1978).
46. Smith, J. (1949): The association of ceratin types of E.coli with infantile gastroenteritis. J. Hyg. Camb, 47, 221.
47. Smith, D.T. and Conant, N.F. (1960): Zinsor Microbiology, 12 th Ed. Appleton Century Craft, INC., New York.
48. Smith, H.W. and Gyles, C.L. (1970): The relationship between two apparently different enterotoxins produced by enteropathogenic strains of E.coli of porcine origin. J. Med. Microbiol, 3, 387.
49. Smith, H.W. and Halls, S. (1967): Studies on E.coli enterotoxin. J. Path. Bact, 93, 531.
50. Smith, H.W. and Halls, S. (1968): The transmissible nature of genetic factor in E.coli that controls enterotoxin production. J. General Microb. 52, 319.
51. Smith, M. Newell, K. and Sulianti, J. (1965): Epidemiology of EEC infections in non hospitalized children. In: Antimicrobiological agents & chromatography. P.77, Amer. Soc. Microb, Waverly Press Inc. Baltimore, The Williams and Wilkins Comp.



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52. Sojka, W.J. (1973): EEC in man and farm animals. Can. Inst. Food Sci. Technol. J. 6, 52.
53. Taylor, J. and Charter, R. (1952): The isolation of serological types of B. coli in two residential nurseries and their relation to infantile gastroenteritis. J. Path. Bact. 64, 715.
54. Taylor, J. Wilkins, M. and Poyne, J. (1961): Relation of rabbit gut reaction to EEC. Brit. J. Exp. Path. 42, 43.
55. World Health Organization (1974 a): Gastroenteritis from cheese. WHO Weekly Epidemiol. Rec. 49, 200.
56. World Health Organization (1974 b): Food borne disease, methods of sampling and examination in surveillance programmes. WHO Technical Report Series No. 543.