SURVIVABILITY OF ESCHERICHIA COLI 0157:H7 AND NON-0157 SEROTYPES ISOLATED FROM SOME DAIRY PRODUCTS UNDER STRESS CONDITIONS

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ABSTRACT

Microbiological assay of 150 samples of dairy products for the incidence of Coliforms, E. coli, E. coli 0157:H7 and non-0157 E. coli, show the recovery of the Coliforms and E.coli from the tested products with different incidence percentage. Strains of E. coli 0157:H7 and non-0157 E. coli were recovered from 9 (6%) and 13(8.6%) of the total samples, respectively. The behaviour of these isolates were tested when exposing to low pH, salt, low holding temperature and heat treatment. The results indicate obvious survival of E. coli 0157:H7 and non-0157serotype with pH as low as 3.8 pH for 5 days. Also, survival or even multiplication in TSB containing <6% salt. Moreover, the strains remained viable at low holding temperature (5°C). So, the product which contaminated with this pathogens remain hazardous even under such stress condition. Decimal reduction times (D-values) of cells suspended in saline solution, TSB medium, reconstituted dry milk and chocolate milk were determined. The greatest survival as evidenced by highest D and Z values occurred with chocolate milk. Product composition and type of strain affected the heat lethality rates.

Keywords: Escherichia coli 0157:H7, non-0157 E. coli, pH, Salt, Heat resistance, Dairy products

INTRODUCTION

Most of Escherichia coli different strains are of special interest for its potential health hazard, as serotypes causing diarrhea or more serious forms of illness. Enterohaemorrhagic E. coli (EHEC) is the most pathogenic strain among the verotoxin (VTEC) or shiga toxin producing E. coli. The illness caused by VTEC can range from self-limited, watery and bloody diarrhoea to life threatening manifestations such as haemolytic uraemic syndrome (HUS) or thrombotic thrombocytopenic purpura, which may result in human death (Padhye and Doyle, 1992). Although, a wide variety of VTEC serogroups has been implicated in human disease E. coli 0157:H7 is the most prevalent strain.

Also, serotypes other than 0157:H7 (non-0157) such as 026, 0103, 0111 and 0145 have been identified as emergent

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(Received July 5, 2006)
(Accepted July 16, 2006)
human pathogen (McKee et al 2003). Several outbreaks were attributable to serotypes 026:H11, 0111:H8 and 0121:H19 (Large et al 2005). Non-0157 E. coli were also thought to have a low infections dose as E. coli 0157:H7 (Large et al 2005).

Survival of E. coli 0157:H7 already has been demonstrated in Cottage, Cheddar, Colby, Romano, Feta and soft cheeses, skimmilk; buttermilk; sourcream and yogurt (Arocha et al 1992; Guraya et al 1998; Reitsma and Henning 1996 and Ogwaro et al 2002). Also, non-157 strains have been isolated from raw milk, ice cream, yoghurt, kareish, cheese, Domiati cheese and Ras cheese (El-Ashmawy et al 2005 and McKee et al 2003).

Acidity is an important parameter influencing the ability of pathogen to cause disease. Since its resistance to high acid and low pHs may permit the pathogen to survive in acid foods and acidic environment of the stomach.

The common use of NaCl to salten foods also creates attendance to suppress the potential pathogens by elevating NaCl concentrations.

Keeping low -temperature of foods is still the primary mean utilized to restrict the growth of bacteria and pathogens in foods. However, a group of pathogens were capable of growing at 5°C including E. coli (Palumbo et al 1997). E. coli 0157:H7 has been shown to survive in acidic foods stored at refrigeration temperature better than those at ambient temperature (Zhao et al 1993).

Providing a successful heat-treatment is a critical point for controlling E. coli in many manufactured foods. Data on heat-resistance are therefore, essential to obtain a safe heat-treatment especially as refrigeration cannot be relied upon to prevent growth of this pathogen.

Therefore, the objective of this study is to detect the prevalence rates of E. coli 0157:H7 and non-157 E. coli strains in milk and some dairy products to assess their susceptibility to various environmental and food-related process factors such as acidity, salinity, keeping at low temperature and heat treatment.

This will be of great benefit for milk and milk products process, hygiene and keeping quality.

MATERIAL AND METHODS

Samples collection

Samples were collected from different dairy farms, super markets, retailer shops over one year period. One hundred and fifty samples (30 each of raw milk, butter, Domiati cheese, kareish cheese and ice cream)were delivered directly to the laboratory as required by American Public Health Association (A.P.H.A., 1992).

Enumeration of Coliforms and E.coli and isolation of E. coli 0157:H7 and non-157 E. coli

Samples were enriched in MacConkey broth medium (El-Nokrashy et al 1992) and examined for incidence of total coliforms in a set of 3 fermentation tube of MacConkey broth with inverted Durham's tube for collection of gas and incubated at 37°C for 48h. according to and a loopful from the positive tubes was streaked on levine's Eosin Methylene Blue agar and incubated at 44°C for 24h and examined for typical colonies (metallic-shiney green) of E.coli. Also, 0.1 ml was spread onto dried surface of Ce-
Effect of pH on survival of Escherichia coli

Identification methods

Identification methods were carried out according to Kreig and Holt (1991). The immunological detection system was used, which include E. coli 0157 latex agglutination test (Oxoid) and latex slide agglutination test for the detection of non-0157 serogroups (026, 091, 0103, 0111, 0128 and 0145) (Dry spot E. coli se roscreen (Oxoid).

Preparation of inoculum

Isolates of E. coli 0157:H7 and non-157 E. coli were grown separately in TSB and incubated at 37°C. Equal volumes of 18h cultures of the isolated strain from the same source of dairy products were combined to serve as the inoculum for each experiment.

pH tolerance

Tryptone soy broth (TSB) was adjusted aseptically to pH values (3.8, 4.1, 4.7, 5 and 5.5) with sterile 85% lactic acid. TSB in different pHs were inoculated with 10^5 CFU/ml, kept at 10°C and analyzed after 2 and 5 days onto Violet Red Bile Agar (VRBA) (Oxoid). The experiment was carried out in doublicate.

NaCl tolerance

The experimental was similar to the pH study, but TSB medium was adjusted to pH 7 and each containing amounts of NaCl to yield 0.2, 4, 6 and 8%.

Minimum growth temperature

The minimum growth temperature was determined by testing the isolates of E. coli 0157:H7 and non-157 serogroups in which grown as described before in TSB at temperature 10, 8 and 5°C for 10 days at intervals of 0, 3, 5, 7 and 10 days. Aliquots of E. coli strains were determined for viable cell counts by plating on VRBA for determination of maximum population at the minimum temperature.

Heat Resistance

a- Strain selection

Isolates of E. coli 0157:H7 and non-157 serogroups were examined for their heat resistance in TSB.

Preliminary experiment were done by exposing all isolates (24h-old) to different heat treatments (73°C/15 sec. and 60°C/30 min.). The preferable heat treatment to determine the heat-resistance parameters for the isolates was 60°C 10 min. The most resistant 2 strains of each of E. coli 0157:H7 and non-157 serogroups were chosen to determine D and Z-values.

Using the test tube method (Donnelly and Briggs, 1987), the two strains (24h-old) were inoculated (0.1ml) into screw-capped test tubes containing 10 ml of sterilized saline solution, TSB, reconstituted milk or chocolate milk, and heated at 55, 60 and 65°C in a water bath began at the end of the come-up period, with dwell times at each temperature. Time/ Temperature treatments were carried out as follow:

55°C: 10, 20, 30, 40 and 50 min.
60°C: 0.5, 1, 2, 3, 4, 5, 6 and 10 min.
RESULT AND DISCUSSION

Incidence of VTEC0157 and non-0157 VTEC in dairy products

Results of the 150 tested samples of dairy products are listed in Table (1) for the presence of Coliforms, 

E. coli, verocytotoxigenic E. coli (VTEC) 0157:H7 and non-0157 serotypes. Results indicated the high levels of contamination with Coliforms (100%) in raw milk samples, which consequently indicates a probable sanitation problems in farms, marketing and handling of raw milk.

Table 1. Incidence of coliforms and E. coli, VTEC-0157 and Non-0157 VTEC isolates in milk and some milk products.

| Tested samples   | Total No. of samples | Total coliforms | E. coli | VTEC-0157 | Non-0157 VTEC |
|------------------|----------------------|-----------------|---------|------------|---------------|
|                  | No. of positive samples | %               | No. of positive samples | %          | No. of positive samples | %          | No. of positive samples | %          |
| Raw milk         | 30                    | 30              | 100     | 24         | 80            | 3            | 10                     | 2           | 6.6         |
| Butter           | 30                    | 13              | 43.3    | 5          | 16.6          | 0            | 0                      | 0           | 0           |
| Domiati cheese   | 30                    | 20              | 66.6    | 8          | 26.6          | 2            | 6.6                    | 2           | 6.6         |
| Kareish cheese   | 30                    | 25              | 83.3    | 19         | 63.3          | 3            | 10                     | 6           | 20          |
| Ice cream        | 30                    | 9               | 30      | 6          | 20            | 1            | 3.3                    | 3           | 6.6         |
| Total            | 150                   | 97              | 64.6    | 62         | 41.3          | 9            | 6                      | 13          | 8.6         |

Total No. of E. coli 0157:H7 isolates = 14
Total No. of non-E. coli 0157:H7 isolates = 20
Also, raw milk samples showed high incidence of VTEC 0157 (10%) and non-157 VTEC (6.6%). Similar results were obtained by Abdul-Rouuf et al. (1996) who reported that 6% of raw cows’ milk samples examined in Egypt were contaminated with *E. coli* 0157:H7. Moreover, Massa et al. (1999) recorded a good survival or even multiplication of *E. coli* 0157:H7 in raw milk when stored at 8°C.

Although these organisms would not be expected to survive pasteurization of raw milk the cheeses made from this milk might represent a health hazard if the pathogen was there and survived the cheese making process. Hereupon the prevalence rates of coliforms, *E. coli* 0157:H7 and non 0157 type were high in Kareish cheese (83, 10 and 20%, respectively). While in Domiati cheese the incidence percent was 66.6% coliforms and 6.6% for each of VTEC-0157 but three samples (10%) were positive for non-0157 VTEC. The non-0157 VTEC are more frequently present in food of animal origin than serotype 0157 (Neill, 1997). El-Ashmawy et al. (2005) could isolate VTEC 0157:H7 and non-0157 from ice cream samples in lower percentages (2% for each strain).

### Acidity tolerance

The survival and growth responses of isolates of *E. coli* 157:H7 to different pHs (3.8-5.5) were illustrated in Figs. (1 & 2), as indicator for acidity tolerance. At pH 3.8, the isolated strains of *E. coli* 0157:H7 tolerated such a low pH in 2 days incubation and survived but with sharp rate of decline at the 5th day of incubation.

The bacteria count at pH 4.1 exhibited ~2-log reduction after 5 days of incubation of the isolated strains from different tested dairy products. Survival with no growth was observed at PH 4.4 after 2 and 5 days of incubation of all of the tested strains of *E. coli* 0157:H7. Therefore, the results indicated that the tested strains may grow and increase in counts between pH 5 and 5.5 as low acid to neutral medium. While, these were decline in number below pH 5 in the high acid medium across 2-days. Difference in cell densities at different pH level were observed between the strains isolated from different samples of tested dairy products. In this respect, Zhao et al. (1993) reported that this pathogen grew slightly in apple cider at pH 3.8 to 4, indicating more acid...
Fig. 1. Growth response of isolated strains of *E. coli* 0157:H7 in TBS at varying pH levels at 10°C for 48 h.

Fig. 2. Growth response of isolated strains of *E. coli* 0157:H7 in TBS at varying pH levels at 10°C for 48 h.
Survivability of Escherichia coli

tolerance than observed in this study. Also, Bessecr et al (1993) noticed survival of E. coli 0157:H7 at 8°C for 20 days in freshly pressed apple cider with pH below 4. Moreover, Guraya et al (1998) found that E. coli 0157:H7 was survived at pH 3.8 in skin milk for 7 days and was not detected at pH 4.4 after 35 days and in butter milk, sour cream, and yogurt, E. coli 0157:H7 was inactivated at rates similar to or greater than those for skim milk. Moreover, Hussein and Sakuma (2005) reported that E. coli 0157:H7 survived in yogurt and sour cream at low pH values (4.17 and 4.3, respectively). In contrarily, Guraya et al (1998) reported that E. coli 0157:H7 did not survive in skim milk at pH 3.8 and was reduced by 3-log cycles at pH 4.1.

On the other hand, strains of E. coli 0157:H7 isolated from Kariesh cheese achieved higher densities compared with the other studied strains for the both 2 and 5-day incubation period in all pH values.

The survival and or growth of isolated E. coli non157 in TBS adjusted to various pH values for 2 and 5-days incubation at 10°C are shown in Figs. (3 & 4).

There is a decrease in the viable courts of all of the isolated strains at pH values 4 and 3.8. While, viable courts increased in TBS at pHs 5.5 and 5, whereas, the organism grew up to ~2-log cycles at pH5 after 2-days incubation and more after 5-days. Slight differences were observed in rates of inactivation, survival and growth at different pH values between the strains isolated from different samples of dairy products. In general, strains of E. coli 0157:H7 vary widely in their acid tolerance (Miller and Kasper, 1994 and Massa et al 1997).

It should be pointed out that the isolated strain of non-0157 E. coli have less ability to survive in acidic media than isolated strains of E. coli 0157:H7. In this respect, Large et al (2005) reported out breaks associated with non-157 E. coli was much less frequently than E. coli 0157:H7 and the reason for this disparity in prevalence may result from the differences in the inherent acid resistance and survival in acidic food between the two types. Also, Eblen et al (2005) reported that strains other than E. coli 0157:H7 do not have the high acid resistance reported for E. coli 0157:H7.

Generally, acid survival plays an important role in bacterial enteric infections. Food borne pathogens must survive in the stomach (pH<3). The data indicate that products at or below pH 4 could be good vehicles of E. coli 0157:H7 and non 157 strains.

Salt tolerance

In the presence of NaCl, the range of growth of E. coli 0157:H7 was between 2-4% NaCl, and this rate was decline with 6% NaCl during 2 and 5-days incubation in TSB at 10°C (Fig. 5). Where as at 8% NaCl, counts of the pathogen decreased. Differant isolated strains exhibited varying growth rates and tolerance ranges over the two periods of incubation. Optimum NaCl levels seems to be 0-2 NaCl for the different isolated strains of E. coli 0157:H7 on the basis of the maximum counts that was observed at these levels. Other investigations indicated that E. coli 0157:H7 was moderately salt tolerant and survives at 6.5% NaCl (Glass et al 1992 & Gibson and Roberts, 1986). Also, Guraya et al (1998) observed E. coli population reduction in 6% salted
Fig. 3. Growth response of isolated strains of non-0157:H7 *E. coli* in TBS at varying pH levels at 10°C for 2 days.

Fig. 4. Growth response of isolated strains of non-0157:H7 *E. coli* in TBS at varying pH levels at 10°C for 2 days.
Fig. 5. Behavior of isolated strains of *E. coli* 0157:H7 in TSB at varying concentration of NaCl for 2 and 5 days at 10°C.
dairy food samples at pH 5 and 5.4. They reported that there was greater survival at lower salt levels of 2 and 4%.

The isolated strains of non-157 E. coli behaved similarly with different concentrations of NaCl to TSB during the incubation periods of 2 and 5 days at 10°C strains grew in NaCl different concentrations up to 6%, but a reduction of viable counts was appeared at 8% NaCl, as shown in Fig. (6). These results are in agreement with those obtained by Conner and Hall (1996) who reported that 6 or 8% NaCl in TSB showed a pronounced effect on growth of the pathogenic E. coli during storage at 10°C.

Low temperature effects

The ability of the isolated strains of E. coli 0157:H7 and non-157 E. coli to grow at low temperature in TSB as maximum populations counts at the lowest temperature are shown in Table (2). All of the tested strains grew well at 10°C and increased in numbers in average more than 3 log cycles of the four strains of E. coli 0157:H7 and non-157 E. coli in a holding period of 10-days. At 8°C, all of the four strains of E. coli 0157:H7 were able to grow and attain maximum counts in 5-7 days. While isolates of non-157 E. coli attained maximum counts after 7-10 days of holding period; except the E. coli strains isolated from ice cream which reached maximum populations after 5 days. This is may be attributed to the adaptation of these strains to grow of low temperatures. In this concern, it has been reported that certain sub-optimum environmental condition may result in protection from subsequent stresses (Semanchek and Golden, 1998). However, all of the tested isolates survived during the holding period of 10-days (Table 2). Thus a problem might come up since some strains of enterohemorrhagic E.coli could grow at low temperature (8°C) and produce verotoxin (Palumbo et al 1997). There is no conflict with the finding of Guraya et al (1998) who noticed better survival at 4 °C than at 12 °C in acidic media. Also, Massa et al (1999) and Jones et al (2006) who obtained good survival of E. coli 0157:H7 in raw milk stored at 6 and 8°C.

Hereupon, the milk products contaminated with E. coli 0157:H7 and non-157 E. coli would remain hazard for consumption even if held at 5°C.

Table 2. Growth responses and lowest temperature for growth and survival of E. coli 0157:H7 and non- 0157 E. coli isolates.

| Isolates       | Lowest temperature (°C) at which growth occurred | Time (days) to attain maximum population |
|----------------|--------------------------------------------------|----------------------------------------|
|                | E. coli 0157:H7  Non -0157 E. coli  E. coli 0157:H7  Non -0157 E. coli |
| Milk           | 8       | 8       | 5       | 7       |
| Domiati cheese | 8       | 8       | 7       | 10      |
| Kareish cheese | 8       | 8       | 7       | 7       |
| Ice cream      | 8       | 8       | 5       | 5       |

* No growth but survived at 5°C

Arab Univ. J. Agric. Sci., 14(2), 2006
Fig. 6. Behavior of isolated strains of non-0157:H7 *E. coli* in TSB at varying concentration of NaCl for 2 and 5 days at 10°C.
Thermal inactivation studies

Determination of heat resistance revealed that all of the tested isolates showed no heat resistance to the pasteurization temperature (65°C/30 min and 72°C for 15 sec.) which were sufficient to kill either of the E. coli 0157:H7 and non-0157 E. coli. These results were in agreement with those obtained by Massa et al (1999) who reported that high temperature short time (71.7°C, 15 sec), was sufficient to kill approximately 1 x10³ E. coli 0157:H7 ml⁻¹.

Also the different strains of E. coli 0157:H7 and also non-157 E. coli vary in their tolerance to heat inactivation (Fig. 7 & 8).

The results obtained for D and Z values of the two selected strains belonging to E. coli 0157:H7 and non-157 E. coli are shown in Table (3). The recorded D-value at 55°C of E. coli 0157:H7 ranged from 16.8 min, in saline solution to 26.5min in milk chocolate. While, D-value at 60°C ranged from 3.7 to 5.2 min. for saline solution and chocolate milk, respectively. Also, D₅₀ values ranged from 1.0 min. in saline solution to 1.5 min. in reconstituted dry milk and chocolate milk (Table 3). Thus, the resultant D values were high order in chocolate milk >milk> TSB medium> saline. This may be due to the presence of NaCl 9% in saline solution, the nutrient factors in TSB medium and the carbohydrates, protein, fat contents in milk and milk products (Semanchek and Golden, 1998; Ahmed et al 1995 and Duffy et al 2006).

D-values obtained were close, but not identical to those reported by Line et al (1991); Ahmed et al (1995); Kotrola and Conner (1997) and Huang & Juneja (2003). This is due to the ecological difference between the strains or isolates, the methodology and different recovery media or different products concerning the heat resistance of selected strain of E. coli, non-0157 serotypes, result D-values were shown in Table (3).

The D₅₀ values ranged from 19.5 to 24 min.; in saline solution and chocolate milk, respectively.

At 60°C, the D values were 5.9, 6.2, 7.2 and 7.5 min. for saline solution, TSB, reconstituted milk and chocolate milk, respectively. While, increasing the heat treatment to 65°C resulted in reduction in all of the D-values when the D₅₀ values ranged from 1.2 min in saline solution to 1.6 min in chocolate milk comparing.

The obtained results D-values for the different selected strains of E. coli 0157:H7 and non-0157 E. coli are shown in (Table 3).

It was observed that the different strains varied in their sensitivity to lethal effecty of different heating temperatures, the same heating temp/time and heating media.

This might reflect difference in the heat resistance of strains of 0157 and non 0157 serogroups under the same condition. Clavero and Beuchat (1996) found that non-0157:H7 E. coli strains were less heat resistant than E. coli 0157:H7 strains. Williams and Ingham (1997) obtained D-value at 54°C for E. coli FRIK-124 was fivefold lower than the D-value of E. coli 0157:H7.

The Z-values were estimated by the linear regression between Log (D) and temp. were ranged from 7.8 to 8°C for E.coli 0157:H7, and were ranged from 8.1 to 8.7°C for non-0157 serotypes in different media. These values were similar to the value obtained by Huang and
Survivability of *Escherichia coli*

**Fig. 7.** Representative survivor curves of the chosen isolated E.coli 0157:H7 at different temperatures

- ■ 55 °C
- ▲ 60 °C
- ● 65 °C

Arab Univ. J. Agric. Sci., 14(2), 2006
Fig. 8. Representative survivor curves of the chosen isolated non-*E. coli* 0157:H7 at different temperatures.
Table 3. D-values (minutes) and Z-values (°C) of *E. coli* 0157:H7 and non–0157 Serogroups in different media.

| Temp. |  |  |  |  |  |  |  |
|-------|---|---|---|---|---|---|---|
|       | *E. coli* 0157 |  |  |  |  |  |  |
|       | Saline | TSB | Milk | Chocolate milk | Saline | TSB | Milk | Chocolate milk |
| 55°C  | 16.8 | 19.2 | 22.4 | 26.4 | 19.5 | 20 | 22 | 24 |
| 60°C  | 3.7 | 4.0 | 4.3 | 5.2 | 5.9 | 6.2 | 7.2 | 7.5 |
| 65°C  | 1.0 | 1.1 | 1.1 | 1.5 | 1.2 | 1.5 | 1.6 | 1.6 |

| Z-values (°C) | 7.8 | 7.9 | 7.9 | 8.0 | 8.1 | 8.6 | 8.7 | 8.7 |

Juneja (2003), but higher than values (6°C) obtained by Juneja *et al* (1997) and (4.34-4.78°C) obtained by Ahmed *et al* (1995).

In conclusion, it is worthy to announce the survival and growth patterns of *E. coli* 0157:H7 and non-0157 serotypes to reduce its hazardous in milk and milk products. Milk pasteurization is quiet enough to destroy these microbes and secure the customers's heath.

REFERENCES

Abd-El-Hady, H.M.; M.A. Halawa and S.H. EL-Shenawy (1995). Surveillance of enterohemorrhagic *E. coli* in milks and Kareish cheese. *Assiut Vet. Med. J.* 33: 110-112.

Abdul-Raouf, U.M.; M.S. Ammar and L.R. Beuchat (1996). Isolation of *Escherichia coli* 0157: H7 from some Egyptian foods. *Int. J. Food Microbiol.* 29:423-426.

Ahmed, A.A.H.; S.H. Ahmed and M.K. Moustafa (1988). Occurrence of fecal coliforms and *enteropathogenic Escherichia* in Egyptian salt cheese. *J. Food Prot.* 51: 442-444.

Ahmed, N.H.; D.E. Conner and D.L. Huffman (1995) .Heat-resistance of *Escherichia coli* 0157:H7 in Meat and poultry as affected by product composition. *J. Food Sci., 60: 606-610.*

American Public Health Association (A.P.H.A.) (1992). *Compendium of Methods for the Microbiological Examination of Food.* Third Ed. pp.843-845, American Public Health Association, Washington D.C., USA.

Arocha, M.M.; M. Mcvey; S.D. Londer; J.H. Rupnow and L. Bullerman (1992). Behavior of hemorrhagic *Escherichia coli* 0157:H7 during the manufacture of Cottage cheese. *J. Food Prot., 55: 379-381.*

Besser, R.E.; S.M. Lett; J.T. Weber; M.P. Doyle; T.J. Barrett and J.G. Wells (1993). An outbreak of Diarrhea and hemolytic uremic syndrome from fresh-pressed apple cider. *JAMA 296: 2217.*
Clavero, M.R. and L.R. Beuchat (1996). Survival of Escherichia coli 0157:H7 in broth and processed Salami as influenced by pH, water activity, and temperature and suitability of media for its recovery. *Appl. Environ. Microbiol.* 62: 2735-2740.

Conner, D.E. and G.S. Hall (1996). Temperature and food additives affect growth and survival of *Escherichia coli* 0157:H7 in poultry meat. *Dairy, Food and Environmental Sanitation* 16: 150-153.

Donnelly, C.W. and E.H. Briggs (1987). Comparison of heat resistance of *Listeria monocytogenes* in milk by two methods. *J. Food Prot.* 50: 14-19.

Duffy, G.; C. Walsh; L.S. Blair and D.A.M.C. Dowell (2006). Survival of antibiotic resistant an antibiotic sensitive strains of *E. coli* 0157 and *E. coli* 026 in food matrices. *Int. J. Food Microbiol* 109: 179-186.

Ebben, D.R.; B.A. Annous and G.M. Sapers (2005). Studies to select appropriate nonpathogenic surrogate *Escherichia coli* strains for potential use in place of *Escherichia coli* 0157:H7 and salmonella in pilot plant studies. *J. Food Prot.*, 68: 282-291.

El-Ashmawy, M.A.M.; M. El-Sherbini and A. Abd El-Khalak (2005). The prevalence of verocytotoxigenic *Escherichia coli* and its significance in milk and some diary products. *4th Int. Sci. Conf. Mansoura*, 1187-1197.

El-Nokrashy, S.; A.G. Hegazi; N.F. Tawfeek; L. Aly; M.A. El-Shenawy; B.A. Effat and R.K. El-Dairouty (1992). Comparative study on selective media used in recovering enteropathogenic *E. coli*. *J. Egypt Vet. Med. Ass.* 52: 483-492.

Gibson, A.M. and T.A. Roberts (1986). The effect of pH, Water activity, sodium nitrate and storage temperature on the growth of Enteropathogenic *Escherichia coli* and salmonella in a laboratory medium. *Int. J. Food Microbiol.*, 6: 155-178.

Glass, K.A.; J.M. Loefelholz; J.P. Ford and M.P. Doyle (1992). Fate of *Escherichia coli* 0157:H7 as affected by pH or sodium chloride and in fermented dry sausage. *Appl. Environ. Microbiol.* 58: 2513-2516.

Glatz, B.A. and S.A. Brudvig (1980). Survey of commercially available cheese for Enterotoxigenic *Escherichia coli*. *J. Food Prot.*, 43: 395-398.

Guraya, R.; J.F. Frank and A.N. Hassan (1998). Effectiveness of Salt, pH and Diacetylene as inhibitors for *Escherichia coli* in dairy foods stored at refrigeration temperature. *J. Food Prot.*, 61: 1098-1102.

Huang, L. and V.K. Juneja (2003). Thermal Inactivation of *Escherichia coli* 0157:H7 in Ground Beef supplemented with sodium lactate. *J. Food Prot.* 60: 664-667.

Hussein, S.H. and T. Sakuma (2005). Shiga toxin – producing *Escherichia coli*: pre and postharvest control measures to ensure safety of Dairy cattle products. *J. Food Prot.*, 68: 199-207.

Jones, T.H.; A. Murray; M. Johns; C.O. Gill and L.M. McMullen (2006). Differential expression of proteins in cold-adapted log-phase cultures of *Escherichia coli* incubated at 8, 6 or 2°C. *Int. J. Food Microbiol.*, 107: 12-19.

Juneja, V.K.; O.P. Snyder and B.S. Marmer (1997). Thermal destruction of *Escherichia coli* 0157:H7 in beef and chicken: determination of D- and Z-values. *Int. J. Food Microbiol.*, 35: 231-237.
Survivability of *Escherichia coli* 677

Kotrola J.S. and D.E. Conner (1997). Heat Inactivation of *Escherichia coli* 0157:H7 in Turkey Meat as Affected by Sodium chloride, Sodium lactate, polyphosphate, and Fat content. *J. Food Prot.*, 60: 898-902.

Krieg, N.R. and J.G. Holt (1991). Berges Manual of Systematic Bacteriology. *Volume II*, pp. 420–423. Williams and Wilkins, Baltimore, USA.

Large, T.M.; S.T. Walk and T.S. Whittan (2005). Variation in Acid Resistance among shiga toxin-producing clones of pathogenic *Escherichia coli*. *Appl. and Environ. Microbiol.* 71:2493-2500.

Line, J.E.; A.R Fain; A.B. Moran; L.M. Martin; R.V. Lechowich; J.M. Carosella and W.L. Brown (1991). Lethality of heat to *Escherichia coli* 0157:H7: D-value and z-value determination in ground beef. *J. Food Prot.* 54: 762-766.

Massa, S.; C. Attieri; V. Quaranta and R. De Pace (1997). Survival of *E. coli* 0157:H7 in yoghurt during preparation and storage at 4°C. *Lett. Appl. Microbiol.*, 24: 347-350.

Massa, S.; E. Goffredo; C. Attier and K. Natola (1999). Fate of *Escherichia coli* 0157:H7 in unpasteurized milk stored at 8°C. *Lett. Appl. Microbiol.*, 28: 89-92.

Mckee, R.; R.H. Madden and A. Gilmour (2003). Occurrence of verocytotoxin-producing *Escherichia coli* in Dairy and Meat processing environments. *J. Food Prot.*, 66: 1576-1580.

Miller, L.G. and C.W. Kaspar (1994). *Escherichia coli* 0157:H7 acid tolerance and survival in apple cider. *J. Food Prot.* 57: 460-464.

Neill, M.A. (1997). Overview of verotoxigenic *Escherichia coli*. *J. Food Prot.*, 60:1444-1446.

Ogwaro, B.A.; H. Gibson; M. Whitehead and D.J. Hill (2002). Survival of *Escherichia coli* 0157:H7 in traditional African yoghurt fermentation. *Int. J. Food Microbiol.*, 79:105-112.

Padhye, N.V. and M.P. Doyle (1992). *Escherichia coli* 0157:H7 epidemiology, pathogenesis and methods for detection in Foods. *J. Food Prot.*, 55: 555-565.

Palumbo, S.A.; A. Pickard and J.E. Call (1997). Population changes and verotoxin production of Enterohemorrhagic *E. coli* strains inoculated in milk and ground beef held at low temperature. *J. Food Prot.*, 60: 746-750.

Reitsma, C.J. and D.R. Henning (1996). Survival of Enterohemorrhagic *Escherichia coli* 0157:H7 during manufacture and curing of Cheddar *J. Food Prot.*, 59: 460-464.

Semanchek, J.J. and D.A. Golden (1998). Influence of growth temperature on inactivation and injury of *Escherichia coli* 0157:H7 by heat, acid and freezing. *J. Food Prot.*, 61: 395-401.

Williams, N.C. and S.C. Ingham (1997). Changes in heat resistance of *Escherichia coli* 0157:H7 following heat shock. *J. Food Prot.*, 60: 1128-1131.

Zhao, T.M.; M.P. Doyle and R. Besser (1993). Fate of Enterohaemorrhagic *Escherichia coli* 0157:H7 in apple cider with and without preservatives. *Appl. Environ. Microbiol.*, 59: 252-2530.

Zadik, P.M.; P.A. Chapmanand; C.A. Siddons (1993). Use of tellurite for the selection of verocytotoxigenic *Escherichia coli* 0157. *J. Medical Microbiol.* 39: 155-158.
Capacity of some Escherichia coli strains isolated from dairy products to survive under unfavorable growth conditions

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Abstract

The purpose of this study was to examine the survival capacity of some strains of Escherichia coli isolated from dairy products under unfavorable growth conditions. A total of 150 milk samples were examined for the presence of a group of coliforms and E. coli, with particular emphasis on the E. coli O157:H7 strain and non-O157 strains, which are known to cause foodborne diseases. The study found that the isolated strains were able to survive at pH 3.8, with the ability to grow at pH 4.5, indicating the potential for contamination of dairy products under unfavorable conditions.