PUBLIC HEALTH HAZARDS OF SOME BACTERIAL PATHOGENS ASSOCIATED WITH CONSUMPTION OF EGGS AND STUDYING THE BEST COOKING METHODS FOR THEIR DESTRUCTION

(With 4 Tables)

By:

EMAN KORASHY, A.; NAHED M. WAHBA

and R. HASSANEIN*

*Dept. of Animal Hygiene and Zoonoses, Fac. Vet. Medicine, Assiut University.

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دراسة إلى عزل بعض الميكروبات ذات الأهمية الصحية حيث تكون سبباً في تلوث البيض متسبيبة في إحداث التسمم الغذائي للإنسان مثل المكور العنقودي الذبي، الميكروب الفولوني (الإبيرةشيا كولاي)، فصائل السالمونيلا والليستريا والإريموناس وذلك بالدراسات والدراسات والدراسات والدراسات وبالгласية إبيرةشيا كولاي والإريموناس. لذا تم جمع أربع معاينة وخمسين بضعة بطريقة عشوائية من محلات البقالة ومنازل السوير ماركت ومنازل الفلاحين ببداية سبعة بواقع مناية وخمسين مهماً لكل من بيت الدجاج التجاري ونوعه من السلال البلدية ومزارع الدواجن وكذلك بيض البطة وقد تمثلت العينة الواحدة في خمس بيضات. وقد ذكرت النتائج على أن بيض الدجاج البلدي هو الأقل تلوثاً حيث لم يتم عزل الميكروب الفولوني والبايرسينبا إبيرةشيا كولاي والإريموناس. وقد عزل بعض فصائل السالمونيلا والليستريا والإريموناس بنسبة ضئيلة جداً من القرحة الخارجة والقرحة بافتقاء فقط فقط مثل المكور العنقودي الذبي، 1% هذه نسب لعزل من القرحة الخارجة والقرحة بافتقاء بعد 23%، 31% من التوالي مقارنة بنسبة العزل من المحتوى الداخلي (10%). أما بالنسبة لبيض مزرعة تعتبر فقد كان أكثر تلوثاً من بيض الدجاج البلدي حيث تم عزل المكور العنقودي الذبي، 1% هذه نسب لعزل من القرحة الخارجة والقرحة بافتقاء بنسبة 23%، 31% من التوالي مقارنة بنسبة 33%، 31% من التوالي مقارنة بنسبة 33.3%، 31%، 33.3%، على الترتيب. ونظراً لتعد طرق طهي البيض لاستهلاك فقد دهنت الدراسة إلى معرفة تأثير المعلمات الحرارية على بعض الميكروبات ذات الخصائص على صحة الإنسان. لذا تم القيام بعنق البيض بيضاً شهرياً كولاي والساسيرينا إبيرةشيا كولاي. وفيما إذا زودت هذه الميكروبات، وقد أظهرت نتائج تقسيم طرق طهي البيض أن أفضل طريقة لإعداد البيض وتناوله مناها هي طريقة الأومليت عند 10%، 5، 22 دقيقة. كما تم الحصول على نتائج عند استعمال طريقة التحمير بدون غشاء لمدة اثنتي عشر دقيقة. أما في حالة طهي البيض مسلفاً فقد تبين عند دوالي السلق المنخفضة بينما في تمام تتمزة على أنواع الميكروبات المستخدمة والمحمي عند الدقيقة الثانية عشر لم تصلح في فين في كوكب إبيرةشيا كولاي بينما تم القضاء على كل من المكور العنقودي الذبي والساسيرينا الموعودة (عدد 12 دقيقة). لذا تتضمن الدراسة بتناول البيض البلدي مع طريقتي الأومليت أو التحمير أو بطريقة السلق لمدة تزيد عن اثنتي عشر دقيقة. وقد ناشدت الدراسة الأهمية الصحية والاقتصادية لبعض الميكروبات التي تسبب الإنسان من خلال تناوله لبيض المائدة وكذلك أفضل الطرق لطهي وتسهيل الكافية لمثل تلوث البيض والحفاظ عليه أثناء تخزينه.
A total of 450 commercial eggs (Balady of farm hens and ducks) representing 150 eggs for each were collected randomly from Assiut city markets, different groceries, supermarkets and farmer's houses. Every 5 eggs represent one sample. Shell surfaces, shell surfaces mixed with shell membranes and egg contents were examined for the isolation of some pathogens of public health importance including Staph. aureus, E. coli, Salmonella spp., Listeria spp., Aeromonas spp., Yersinia enterocolitica and Erysipelothrix spp. An experimental part was applied to evaluate the best method used for cooking of eggs at different temperatures for different times to determine the safety of eggs for consumption. The obtained results of isolation revealed that Staph. aureus recorded the highest percentage of contamination among all the isolated pathogens specially from shell surfaces of all types of eggs. Commercial Balady hen eggs were the best type and advised to be consumed. Staph. aureus recovered from 23.3%, 13.3 and 10% of shell surfaces, shell mixed with shell membranes and egg contents, respectively while, E. coli, S. paratyphi, S. enteritidis, Y. enterocolitica and Erysipelothrix organisms were failed to be detected in the examined Balady hen egg samples. Commercial farm hen eggs came secondary to Balady hen eggs. Staph. aureus isolated from both shell surfaces and egg contents with percentages of 23.3% and 13.3% from the shell mixed with shell membranes. S. enteritidis recorded high rate of isolation from egg parts 16.7, 10 and 10%, respectively. E. coli, some of Aeromonas spp. and Y. enterocolitica could be isolated from some egg parts examined. S. paratyphi, S. gallinarium, Listeria spp. and Erysipelothrix spp. failed to be detected from farm hen egg samples examined. Highest rate of contamination was observed in commercial duck eggs. Staph. aureus was recoverd from shell surfaces, shell mixed with shell membranes and egg contents in 36.7, 30 and 33.3%, respectively. E. coli also recorded in high percentages of infection in shell and shell mixed with shell membranes (13.3 and 10%, respectively). Moreover, varying percentages of contamination by Salmonella, Listeria and Aeromonas spp. were recorded in different parts of duck egg samples examined, in addition to Y. enterocolitica which could be...
isolated from shell, shell mixed with shell membranes and egg contents in 10, 3.3 and 6.7 %, respectively. On the other hand, *Erysipelothrix* spp. failed to be detected in all examined duck egg samples. Concerning the experimental part, results showed that cooking of eggs by Omelet method at 163°C for 25 minutes is the best since non of the test organisms used could be detected. Secondary, was the open frying method where *S. enteritidis* destroyed after 1 minute, and complete destruction of *Staph. aureus* and *E. coli* after 12 minutes. Boiling procedure for 7 and 12 minutes were adequate to destroy *Staph. aureus* and *S. enteritidis*, respectively, while, *E. coli* still be alive. The economic and public health importance of some pathogens that affect the human health through consumption of eggs were discussed. Likewise, suggestive measures for improving the quality of produced eggs and the suitable procedure to cook eggs are given.

**Key words:** *Eggs, Staph. aureus, E. coli, Salmonella, Listeria, Yersinia, Coocking.*

**INTRODUCTION**

Eggs are one of the few foods that are used among the popular dishes consumed by people at home, restaurants and convenience stores in their natural states with no artificial additives. Eggs are considered a unique, well balanced source of nutrients and essential food elements for growth and maintenance of health in the human body of all persons of all ages. Beside, the high nutrient contents of eggs, their low caloric values and ease of digestibility make them also valuable in many therapeutic diets for adults. Eggs and egg products are used in a wide variety of foods including whole egg custard, mayonnaise, egg salad, eggnog and all types of bakery products. Also, there are many food uses of eggs as pet foods.
for domestic animals, soil fertilization, culture media, artificial insemination
and industrial uses include, leather, cosmetics, shampoos and adhesives.

Most freshly laid eggs are sterile, at least from inside in case of good
flock management and absence of vertical transmission also by the presence
of cuticle, shell membranes and the antimicrobial properties of eggs (Yadava
and Vadehra, 1977). But, eggs may constitute, if contaminated, a public health
hazard as laying hens can sequester different types of microorganisms in their
eggs.

Eggs are liable to contamination either before laying (congenitally) or
after laying when the microorganisms reach the egg contents through
penetration the shell and cause low egg quality, low shelf life and safety
inducing public health hazards (Board and Fuller, 1994), in addition, fecal
matter, improper washing, using of contaminated water and bad handling are
the common sources of contamination. With attention to duck's eggs, they are
highly contaminated than hen's eggs as they are laid near the damp places
and due to the rapid deterioration of the antibacterial activity of albumen by
the unfavorable surroundings. Bahout (2001) studied the public health
importance resulting from consumption of duck's and hen's eggs.

Furthermore, among the pathogenic food poisoning organisms that
affect the public health of humans due to consumption of eggs is Staph.
aureus which is of serious concern to public health (Wyah, 1992). Its
thermostable enterotoxins elaborated in large numbers of foods and animal
products including eggs causing rapid onest of nausea, vomiting and diarrhea
within 6 hours of ingestion of food. Several outbreaks of Staph. aureus food
poisoning have been recorded, involving large number of individuals
throughout the world (Ko and Chang, 1995). Also, there have been many
research works that dealt with Staph. aureus in and on hen's and duck's eggs
(Sabreen, 2001 and Bastawrows et al., 2002).

E. coli constitutes a major economic menace to poultry industry and
consequently is of public health importance for human causing profuse watery
diarrhea which is varying in its severity and persistence due to inflammation of
the intestinal mucosa (Schiavoni and Vergora, 2000). The organism is taken as index of recent fecal contamination. Quiroga et al., (2000) stated that diarrhoeagenic E. coli is the major agent involved in diarrhoeal disease in developing countries. Keshimaki et al. (2001) could isolate E. coli from 35% of diarrhoeal and 26% of non diarrhoeal cases.

E. coli can multiply in egg content and cause infection when the number of the organism reaches $10^5 - 10^7$ organisms/g (Eley, 1996). Numerous cases of food poisoning outbreaks were traced to the members of the family Enterobacteriaceae (Brooks et al., 1995). Likewise, several investigators screened eggs for members of the family Enterobacteriaceae in shell, shell membranes and whole egg contents (Lambiri et al., 1995; Bastawrows et al., 2001 and 2002).

Moreover, Salmonella spp. remains a potential threat to human health, as well as, broiler chickens. The public health importance of avian salmonellosis has for long been appreciated, particularly the association of gastroenteritis in man resulting from consumption of infected hen's and duck's eggs (Abouzeed et al., 2000). Different Salmonella spp. could be isolated from human diarrhoeal swaps by several authers (Urio et al., 2001 and Biendo et al., 2003).

Cold tolerant pathogens like Listeria, Aeromonas and Yersinia have assumed increased importance recently in shell eggs and egg products. While, there have been no documented outbreaks of listeriosis associated with eggs, L. monocytogenes is of concern because of its ability to grow in refrigerated whole egg and egg yolk (Sionkowski and Shelef, 1990). Moreover, it was isolated from commercial raw liquid whole eggs (Moore and Madden, 1993).

A. hydrophila can provoke extra intestinal and gastrointestinal disease in humans. It has been recovered as the primary or single gastrointestinal pathogen in children (Janda et al., 1984). Isolation of Aeromonas from eggs has been reported by Varnam and Evans (1991), as well as, Kumar et al. (2000).
Production of a heat stable enterotoxin is a feature of both virulent and non virulent strains of *Y. enterocolitica*, and other non pathogenic yersinias. The ability of some strains of *Y. enterocolitica* to produce toxin has been demonstrated at 25°C, but not at refrigerated temperature (Walker, 1986).

*Erysipelothrix* infection is most commonly associated with diseases of animals and infrequently in humans (Hassanein *et al.*, 2001).

Because, there is considerable demand for precooked egg products, it is important to determine the safety of these products with respect to *Staph. aureus, E. coli* and *S. enteritidis*. Survival behaviors of heat shocked cells of these pathogens by applying different temperatures were studied by several investigators (Baker *et al.*, 1983; Bradshaw *et al.*, 1985).

The present study aims to:

Isolation of some pathogenic microorganisms of public health importance from shell surfaces, shell mixed with shell membranes and egg contents of different types of consumed eggs.

Study growth and survival behavior of some pathogens by applying different temperatures during its preparation for consumption.

**MATERIALS and METHODS**

A- Collection of samples:

300 of fresh commercial hen eggs of native breeds (Balady) and poultry farms and 150 of commercial duck eggs bought from farmer's houses, different groceries and Assiut city markets. Every 5 eggs constitute one group.

B- Preparation of samples:
Egg shells were tested by two methods a surface rinse for shell surfaces and by blending method for shell and shell membranes as described by Moats (1980). Egg contents were prepared and evacuated according to Speck (1976).

C- Isolation of some pathogens of public health importance:

- **Staph. aureus**: Using sodium chloride broth and Baird-Parker agar (Biolife) (Finegold and Martin, 1982).
- **E. coli**: Using MaConkey's broth and agar. The technique recommended by Quinn *et al.* (1994) was used for identification.
- **Salmonella** spp.: By using selenite F broth and SS agar and identification was done according to Quinn *et al.* (1994).
- **Listeria** spp.: were isolated on Oxford agar plates (Curtis *et al.*, 1989) after enriched in *Listeria* enrichment broth and identification was performed according to Hitchins (1995).
- **Aeromonas** spp.: Using trypticase soy broth with Ampicillin and trypticase soy Ampicilline agar (FAO, 1979) and identification was applied according to Popoff and Veron (1976).
- **Y. enterocolitica**: Isolated on agar plates of Cefsulodin Irgasan Novobiocin by Oxoid antibiotic (CR log) (Schiemann, 1979) after enrichment in phosphate buffer saline and identified according to Speck (1984).
- **Erysipelothrix** spp.: Isolation of *Erysipelothrix* spp. were performed according to selective method (Hassanein *et al.*, 2001) using brain heart infusion (BHI) broth containing 0.1% Tween 80, 5% horse serum, 50 μg/ml gentamicin, 0.1% sodium azide, and 0.001% crystal violet and BHI agar containing 0.1% Tween 80, 50 μg/ml gentamicin, and 0.1% sodium azide.

D- Evaluation of different methods used for egg cooking to destruct some pathogens (Baker *et al.*, 1983; Chantarapanont *et al.*, 2000):

- Test organisms used: Staph. aureus, E. coli and S. enteritidis were grown in brain heart infusion broth at 37°C.
- Preparation of an egg for inoculation by the test organisms:
  - A small hole was made at the blunt end of an egg with a sterile drill.
  - Aseptically injection of an inoculum (0.5 ml) containing $1 \times 10^8$ c.f.u of the tested organism into the egg yolk by a sterile needle. Then the
hole is covered after injection by Ducocement. The egg was ready for cooking by one of the following methods:

1- **Boiling**: The inoculated eggs with test organisms were immersed in boiling water bath for 3, 5, 7 and 12 minutes then cooled and examined.

2- **Frying**: The contents of the inoculated eggs were poured into a sterile frying pan containing a small amount of oil and cooking still for 1, 4 and 12 minutes. Then cooled and examined.

3- **Omelets**: In a sterile greased aluminum pan the contents of inoculated eggs were baked in an oven at 163°C for 25 minutes then samples were taken for detection of the test organisms.

**RESULTS**

The results were shown in Tables 1-4
Table 1: Incidence of some pathogens of public health significance isolated from commercial Balady hen eggs.

<table>
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<tbody>
<tr>
<td></td>
<td></td>
<td>S. typhi</td>
<td>S. gallinarum</td>
<td>L. innocua</td>
</tr>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Shell 7</td>
<td>23.3</td>
<td>1</td>
<td>3.3</td>
<td>-</td>
</tr>
<tr>
<td>Shell mixed with membranes 4</td>
<td>13.3</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Content 3</td>
<td>10.0</td>
<td>1</td>
<td>3.3</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2: Incidence of some pathogens of public health significance isolated from commercial farm hen eggs.

<table>
<thead>
<tr>
<th>Egg samples</th>
<th>Staph. aureus</th>
<th>E. coli</th>
<th>Salmonella spp.</th>
<th>Aeromonas spp.</th>
<th>Yersinia enterocolitica</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. typhi</td>
<td>S. enteritidis</td>
<td>A. hydrophila</td>
</tr>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
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<tr>
<td>Shell 7</td>
<td>23.3</td>
<td>1</td>
<td>3.3</td>
<td>1</td>
<td>3.3</td>
</tr>
<tr>
<td>Shell mixed with 4</td>
<td>13.3</td>
<td>1</td>
<td>3.3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3: Incidence of some pathogens of public health significance isolated from commercial duck eggs.

<table>
<thead>
<tr>
<th>Egg samples</th>
<th>Staph. aureus</th>
<th>E. coli</th>
<th>Salmonella spp.</th>
<th>Listeria spp.</th>
<th>Aeromonas spp.</th>
<th>Y. enterocolitica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell</td>
<td>1 3 6 . 7</td>
<td>. . 1 3 1 . 3</td>
<td>- - 3 . 1 . 3 0</td>
<td>- - 3 . 1 . 3 0</td>
<td>- - 3 . 1 . 3 0</td>
<td>- - 3 . 1 . 3 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 3</td>
<td>S. typhi</td>
<td>S. paratyphi</td>
<td>S. enteritidis</td>
<td>L. ivanovi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 . 1</td>
<td>S. paratyphi</td>
<td>S. paratyphi</td>
<td>S. enteritidis</td>
<td>L. ivanovi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>. 1 . 3</td>
<td>. 1 . 3 . 1 . 3</td>
<td>. 1 . 3 . 1 . 3</td>
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<td>3 . 1</td>
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</table>

| Content 7 23.3 1 3.3 - - 3 10.0 3 10.0 - - - - 3 10.0 | | | | | | |
**Table 4:** Temperature - time relationship for destruction of some pathogens in eggs cooked by different methods.

<table>
<thead>
<tr>
<th>Method of cooking</th>
<th>Time of cooking / minutes</th>
<th>Survival of some pathogens after cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Staph. aureus</td>
</tr>
<tr>
<td><strong>Boiling</strong></td>
<td>3</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td><strong>Frying</strong></td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td><strong>Omelet (163 °C)</strong></td>
<td>25</td>
<td>-</td>
</tr>
</tbody>
</table>
DISCUSSION

Human infection due to consumption of infected eggs has now been reported in numerous countries all over the world. There has been a steady increase in the recorded incidence of infection and the number of countries which reported this infection (Wieneke et al., 1993; Ko and Chang, 1995). Worthily to mention that a single contaminated egg may result in the infection of a large number of people (Varnam and Evans, 1991).

The present study showed that Staph. aureus scored highest percentages of contamination among all pathogenic organisms isolated from the shell surfaces and shell mixed with shell membranes of all type of eggs examined (Tables 1, 2 and 3).

In case of commercial Balady hen eggs, Staph. aureus recorded 23.3 and 13.3% in the shell surfaces and shell mixed with shell membranes, respectively (Table 1). The obtained results were higher than data were recorded by Alaboudi et al. (1988) and El – Essawy et al. (1989). While, they were lower than those observed by Ahmed et al. (1985) and Bastawrows et al. (2002). The variability in these results may be referred to the health status of hens as the transovarian transmission of Staph. aureus to eggs which recorded by Mathes and Hanscke (1977) or accidental transmission from shell (Mathes, 1984). Additional evidence in Table 1 indicating that low rate of contamination by Staph. aureus in egg contents of Balady eggs (10%) and this may related to the presence of lyzosome in the inner shell membranes which acts as an effective agent against Gram-positive bacteria minimizing the chance of interance of the organism to the egg content which constitutes a great threat to the human health specially children (Baker, 1974). It is apparent from Table 1, failed detection of E. coli, S. paratyphi, S. enteritidis, Y. enterocolitica and Erysipelothrix spp. from parts of commercial Balady hen eggs. Consequently, Balady eggs proved to be the best for consumption if compared by farm hen and duck eggs. Even the other Salmonellae, Listeria spp. and A. hydrophila could be isolated in low percentages, one sample for each (3.3%).

Data reported in Table 1 revealed failed detection of L. monocytogenes from the egg shells of all samples examined and this contrasted the results of Saad and El–Prince (1995) and Bastawrows et al. (2001) while, absence of L. monocytogenes from egg contents came in line with the same last investigators and contradictory to Leasor and Foegeding (1989). The obtained results may attribute to the unsuitability of pH of raw egg albumen for growth of L. monocytogenes. Furthermore, the presences of the antibacterial properties of the eggs which hydrolyse the polysaccharide bacterial cell wall causing cell lysis (Yadava and Vadehra, 1977). In addition, presence of L. innocua with significant level may competeat isolation of L. monocytogenes (Pateran and Swanson, 1993).

L. innocua revealed 3.3 and 3.3% from egg shells and shell mixed with membranes (Table 1). It was more present than L. monocytogenes and other species of Listeria as reported by Pateran and Swanson (1993). Presence of Listeria spp. in eggs most likely is due to contamination from shells during the breaking process or from the environment (Foegeding and Leasor, 1989).

In case of commercial farm hen eggs, Table 2 showed that Staph. aureus could be isolated from shell surfaces and egg contents with incidence of 23.3% for each, while shell mixed with shell membranes revealed 13.3%. The present study clearly demonstrated that highly contaminated egg contents of farm eggs than Balady ones. Table 2 revealed the percentage of 3.3% contamination by E. coli in each of shells, shells mixed with shell membranes and egg contents of farm hen eggs. The obtained results were lower than that recorded by El–Essawy et al., (1989). E. coli is a normal inhabitant of the intestinal tract of both man and animals and may contaminate
manure and this explains its presence in egg content and shell surface since the organism can grow and penetrate the shells contaminating the contents (Mayes and Takeballi, 1983) so, the organism is taken as index of recent fecal contamination (Garrad, 1946).

Certain strains of *E. coli* are responsible for egg deterioration and fishy flavors (Frazier and Westhoff, 1986). Likewise, high rate of contamination by *S. enteritidis* was recorded in commercial farm hen egg samples in shell surfaces, shell mixed with shell membranes and egg contents in percentages of 16.7, 10 and 10%, respectively. These results were in agreement with those reported by Shirota et al. (2001) who suggested that *S. enteritidis* was more associated with human food borne disease outbreaks than other *Salmonella* serotypes particularly those associated with eggs and egg products. Contamination of eggs by the organism occurs before the egg is laid before the formation of the shell (Humphrey, 1999). 90% of food borne Salmonellosis caused by *S. enteritidis* is through the shell of eggs (Schroeder et al., 2005). *A. hydrophila* and *Y. enterocolitica* revealed high incidence (10%) from egg contents of farm eggs (Table 2). *Y. enterocolitica* could not be detected from egg contents by Favier et al. (2000) and Bastawrows (2002) while 3.3% could be isolated from shells and shells mixed with shell membranes in the present study. However, high incidence of *Y. enterocolitica* was recorded by Favier et al. (2000) and Bastawrows et al. (2001) from shell surfaces of eggs.

*Y. enterocolitica* is found in the chicken faeces and the shell can be contaminated with faeces in the nest or during subsequent manipulation (Berrang et al., 1999). The variation in results could be attributed to the enrichment procedures and the selective media used which fail to recover low levels of clinical strains (Chester and Stotzky, 1976), beside the competition of other contaminants. *Listeria* spp. and *Erysipelothrix* spp. could not be isolated from all examined parts of commercial farm hen egg samples. From the public health point of view, farm hen eggs came secondary to Balady hen eggs for consumption.

The summarized results in Table 3 proved that commercial duck eggs were the worst for consumption. *A. hydrophila* and *Staph. aureus* were the predominant pathogens isolated from shell surfaces and egg contents of duck eggs in percentages of 43.3 and 40%, 36.7 and 33.3%, respectively. The obtained results were in accordance to Kumar et al. (2000) who detected that *A. hydrophila* was the predominant species isolated from poultry eggs in 51.52%, followed by *A. sobria* (39.39%) and *A. caviae*.

Shell surfaces can be contaminated congenitally from the carrier ducks which disseminate the organisms to widely distributed areas which receive the infected eggs for hatchability. Duck shell surfaces can be contaminated also from the excreta of farm animals live with ducks in the same place as a bad habit of the Egyptian farmer. Dhillon et al. (1974) stated that contaminated water, environment and intestinal tract are the main sources of shell contamination. Shell mixed with shell membranes of commercial duck eggs also recorded high incidence of infection by *Staph. aureus* in incidence of 30%, *E. coli* in 10% and 13.3% by *S. enteritidis* and *A. hydrophila* (for each). *S. typhi*, *S. paratyphi*, *A. caviae* and *Y. enterocolitica* recorded 3.3% for each (Table 3). Bad habits of ducks as laying eggs near dirty and damp places, in addition to the rapid deterioration of the antibacterial activity of albumen on storage give the chance to raise the rate of contamination in duck eggs.

Eggs are one among the major animals foods mostly marketed raw and frequently consumed raw, semi-raw in many dishes and form an important part of meals contain raw eggs as an essential ingredient (home made ice cream, mayonnaise, eggnog etc.). These dishes are not heated up to the (FAO, 1979) recommended temperatures, 155°F for at least 15 seconds (Mermelstein, 2001) and this is not enough to render an egg free from pathogenic organisms as yolk is high nutritive medium permits multiplication of the organisms. Several methods of microbial destruction were discussed by Serrano et al. (1997) and Brackett et al. (2001). Table 4
clarified that boiling procedure used for destruction of the inoculated test organisms is not enough at 3 and 5 minutes. While, boiling for 7 minutes was enough to destroy Staph. aureus only. By elongation the time of cooking for 12 minutes, destruction of S. enteritidis was obvious, while E. coli still be alive.

The results came in line with Baker et al., (1983); Schuman et al., (1997) and Soliman and El-Tabiy (2007). The present study demonstrated a combined relationship between destruction of the test organism and the time-temperature used during the method of eggs cooking. Following up Table 4 it clarified that by applying the open frying on one side all the test organisms destroyed at 12 minutes. Staph. aureus and E. coli could be isolated when fried for 1 and 4 minutes. However, S. enteritidis was completely destroyed and could not be isolated. The results were in contrast to Baker et al. (1983).

Table 4 illustrated that all the test organisms were completely destroyed in the omelets at 163°C for 25 minutes. This evidence due to high temperature and long time during omelet cooking procedure. The same results were recorded by Baker et al. (1983). The obtained results recommended that omelet procedure is the best for consuming safe eggs while, frying and boiling methods were inadequately to destroy some of the test organisms. Boiling must be adopted for more than 12 minutes to ensure complete destruction of pathogens may contaminate eggs. Heat treatment – time temperature conditions aims to achieve a decrease in the number of viable organisms (Stadelman et al., 1996 and Schuman et al., 1997).

There is a considerable demand for using high temperatures during cooking of eggs to destroy the present pathogens. Gossett and Baker (1981) studied the textural problems and greenish discoloration which affected eggs due to high temperatures used and suggested the addition of citric acid which gives favorable effects due to thermal destruction of microorganisms.

So, in order to remove or reduce the risk of some of pathogenic organisms of public health importance contaminate eggs, there are several points must be adopted. Chosen of healthy mother’s hens are necessary to obtain eggs of free pathogens. Hygienic measures applied in the farms during handling and storage. Using of hot soapy water with those come in contact with eggs and egg containing foods in work areas. Eggs must be held at low temperature (5 °C) to prevent proliferation of the pathogens. Cleaning with sanitizer minimizes the contamination of the shells, beside pasteurization of egg products as statutory requirements in many countries. Educational programs for consumers informed the risks resulted from eating under cooked eggs particularly the elderly and immune–compromised persons who are more susceptible to infection.

REFERENCES


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