Bacterial status of frozen marketed pigeon meat

Saad, M.S.[1]; Faten, S. Hassanin[1]; Marionette Z. Nassif [2] and Hamza, M.R.[3]

[1]*Food control Dept., Fac. Vet. Med., Benha University.*
[2]*Animal Health Research Institute, Benha branch.*
[3]*Officer of the Armed Forces.*

A B S T R A C T

This study was conducted to evaluate bacteriological contamination of marketed frozen pigeon meat and their hazards on public health. A grand total of 75 random meat samples resembled breast and thigh of marketed frozen pigeon were collected from 3 different poultry factories A, B, C, (25 of each) at El-Kalyobia Governorate. The mean values of APC, Coliform and *Staph. aureus* counts (log cfu\g) were $6.76\times 10^6 \pm 1.49\times 10^{6,}$ $2.92\times 10^4 \pm 0.19\times 10^{4,}$ $7\times 10^4 \pm 0.37\times 10^4$ in the examined pigeon meat collected from factory A, respectively, while they were $7.62\times 10^6 \pm 2.31\times 10^{6,}$ $5.71\times 10^4 \pm 0.35\times 10^{4,}$ $6.66\times 10^4 \pm 0.52\times 10^4$ in the examined pigeon meat collected from factory B, respectively, but they were $8.45\times 10^6 \pm 1.73\times 10^{6,}$ $5.87\times 10^4 \pm 0.25\times 10^{4,}$ $5.81\times 10^4 \pm 0.44\times 10^4$ in the examined pigeon meat collected from factory C, respectively. The serologically identified *E. coli* were Enteropathogenic *E. coli which* was the highest *(*12%) (O_{111}:H_4 and O_{119}:H_4) in all factories. Salmonella organisms were isolated from the examined samples were varied from 8% for factory A, 12% for factory B and 12% for factory C of the examined samples of pigeon. *Salmonella* could be identified serologically as *Salmonella typhimurium*, *Salmonella enteritidis and Salmonella anatum.* The public health importance of the isolated microorganisms is discussed.

Keywords: Pigeon, Enteropathogenic *E. coli* and *Salmonella.*

(http://www.bvmj.bu.edu.eg) **(BVMJ-32(2): 14-19, 2017)**

1. INTRODUCTION

Squab or Pigeon - This species originated in the Middle East and Asia, and is one of the oldest birds known to man. A squab is a young, immature pigeon about 4 weeks old. Because it is too young to fly, the meat is very tender. Squabs usually weigh about 12 to 16 ounces, including giblets, and have dark, delicately flavored meat. They are usually stuffed whole and roasted. A pigeon has been allowed to mature and has tougher meat than a squab. Pigeon are raised by many peasant farmers, they are hardly and less susceptible to many diseases of poultry birds. They are gentle and because of their long wings and powerful flight muscles, they are strong, swift flier. Pigeon are easy to raise foragers and requires less capital outlays in terms of housing, management and health care (Omojola et al., 2012). Food borne diseases are of wide spread and growing public health in many countries. Bacterial food borne zoonotic infectious are the most common cause of human intestinal diseases (Thorns, 2000). Enterobacteriaceae as well as aerobic bacterial count in poultry carcasses can be routinely used as indicators of improper hygienic during processing and incorrect storage conditions, which can lead to proliferation of pathogens, such as salmonella and toxin production (Roberts, 1990; Zweifel et al., 2005). *Salmonella* is the causative agent of the majority of food-borne bacterial poisoning. It is responsible for about 100 million human cases annually, not only in developing countries but also in developed communities, where *salmonellosis* is still not vanquished. *Salmonella* could cause severe disease in humans, such as gastroenteritis and typhoid fever (Schikora et al., 2012). The presence of *staphylococcus* may be due to contamination during dressing and evisceration in the slaughtering house, contaminated equipment, butchers, hands with abrasion and wounds, slaughter of animal beside dressed one in the same area in the slaughter hall and contaminated air from workers with their aerosol which contaminate air with *staphylococci* (Bennett, 2005). The presence of *E. coli* may cause several types of diarrheal

illnesses. Strains of *E. coli* that causes diarrhea include five major categories of diarrheogenic *E. coli,* based on definitive virulence factors, clinical manifestation produced, epidemiology and different O:H serotypes. These include the followings: Enteropathogenic *E. coli* (EPEC), Enterotoxogenic *E. coli (ETEC),* Entero-aggregative *E. coli* (EAEC), Enteroinvasive *E. coli (EIEC) and* Enterohaemorrhagic *E. coli (EHEC)* (Nataro and Kaper, 1998). The psychrotrophic count provide a useful information about the keeping quality of poultry meat. Moreover, there is a general agreement that aerobic spoilage of poultry meat becomes evident when the level of bacteria reaches 10^7 (off odors) or 10^8 (slime formation) (Prieto et al., 1992). Storage of meat for long period at low temperature is responsible for several quality problems to meat industry. These problems related to growth of psychrotrophic microorganisms (Nasser and Fathi, 1997). Also, exposure of frozen meat to thawing and refreezing in market shops and street vendors, yielding an abundant supply of water and form an excellent media for growth and multiplication (Jay et al., 2005).

Therefore, the aim of this present study was to evaluate the microbiological status of frozen pigeons.

2. MATERIAL AND METHOD:

2.1. Collection of samples:

A grand total of 75 random meat samples (resembled breast and thigh) of marketed frozen pigeon were collected from 3 different poultry factories A, B, C, (25 of each) at El-Kalyobia Governorate. The purchased samples were transferred directly to the laboratory in an ice box under complete aseptic conditions without undue delay and then subjected to following examination.

2.2. Preparation of samples ((ISO), 2003):

Twenty-five grams of the examined samples were transferred to a septic blender jar and 225 ml of 0.1 % sterile buffered peptone water were aseptically added to the content of jar. Each sample was then homogenized in the blender at 2000 r.p.m for 1-2 minutes to provide a homogenate, from which tenth - fold serial dilutions were prepared. The prepared samples were subjected to the following examination:

2.3. Determination of Aerobic plate count ((APHA), 2001).

2.4. Determination of coliforms counts (International Organization of Standardization (ISO), 2004).

2.5. Isolation and identification of E. coli (APHA, 2001).

2.6. Isolation and identification of staphylococci count (Food and Drug administration (FDA), 2001).

2.7. Determination of total pscychrotrophic count (APHA, 2001).

3. RESULTS

It is evident from the results recorded in table (1) that the total APC (cfu/g) in the examined pigeon samples varied from 5×10^6 to 8.7×10^6, 5.6×10^6 to 9.7×10^6 and 6.7×10^6 to 9.9×10^6, respectively, with a mean value of $6.76\times 10^6 \pm 1.49\times 10^6$ for factory A, $7.62\times 10^6 \pm 2.31\times 10^6$ for factory B and $8.45\times 10^6 \pm 1.73\times 10^6$ for factory C. In other words, there is a highly significant difference of total APC between the examined pigeon meat from different poultry factories ($P< 0.05$). According to safe permissible limits stipulated by EOS (2005) NO. (1651/2005) for total APC, it is clear that, the result is not compatible to EOS (not exceed 10^5). It is evident from the results recorded in table (2) that the total coliforms count (cfu/g) in samples collected from three different poultry factories varied from 1.5×10^4, 3.5×10^4 and 3.5×10^4 respectively, with a mean value of $2.92\times 10^4 \pm 0.19\times 10^4$ for factory A, $5.71\times 10^4 \pm 0.35\times 10^4$ for factory B and $5.87\times 10^4 \pm 0.25\times 10^4$ for factory C. In other words, there is the high significant difference of total Coliform count between the examined pigeon meat samples (from different factories) ($P< 0.05$). According to safe permissible limits stipulated by EOS (2005) NO. (1651/2005) for total coliform count it is clear that, the result is not compatible to EOS (not exceed 10^2). It is evident from the result recorded in table (3) that the Total staphylococcal count (cfu/g) in the examined samples from different factories varied from 4.9×10^4 to 9.8×10^4, 3.6×10^4 to 9.7×10^4 and 5.1×10^4 to 9×10^4, respectively, with a mean value of $6.50\times 10^4 \pm 0.21\times 10^4$ for factory A, $7.00\times 10^4 \pm 0.32\times 10^4$ for factory B and $6.71\times 10^4 \pm 0.20\times 10^4$ for factory C. In other words, there is no significant difference of total staphylococcal count between the examined pigeon meat from different poultry factories. Results achieved in table (4) indicated that the total Psychrotrophic bacterial count (cfu/g) in the examined samples from different factories varied from 7.4×10^6 to 1.52×10^7, 1.4×10^6 to 1.65×10^7 and 8.8×10^6 to 1.70×10^7, respectively,

with a mean value of $1.02\times 10^7 \pm 0.37\times 10^6$ for factory A, $9.74\times 10^6 \pm 0.54\times 10^6$ for factory B and $1.15\times 10^6 \pm 0.44\times 10^6$ for factory C. In other words, there was high significant difference of total Psychrotrophic bacterial count between the examined pigeon meat samples (from different factories) ($P< 0.05$).

Results achieved in table (5) indicated that *E. coli* was isolated from the examined samples of different factories with a percentage of 8% for factory A, 12% for factory B and 24% for factory C of the examined samples of pigeon. Moreover, the incidence of serologically identified Enteropathogenic *E. coli* was the highest *(*12%) (O_{111}:H_4 and O_{119}:H_4) in all factories which isolated from the examined samples of frozen pigeon meat. By comparing results with those obtained by Egyptian Organization for Standardization and Quality (EOS) (2005) NO. (1651/2005) the results are not compatible to EOS for chicken carcasses (free E. *coli*). Results achieved in Table (6) indicated that, salmonella organisms were isolated from the examined samples of different factories in a percentage of 8% for factory A, 12% for factory B and 12% for factory C of the examined samples of pigeon. *Salmonella* could be identified serologically as *Salmonella typhimurium*, *Salmonella enteritidis and Salmonella anatum.* According to the safe permissible limits of salmonellae stipulated by EOS (2005), the results were not compatible to EOS (samples should be free from Salmonella).

Table (1): Statistical analytical results of Aerobic Plate Count (cfu/g) in the examined samples of frozen pigeon meat (n=25).

Samples	Min.	Max.	Mean± S.E*
Factory A	5.0×10^6	8.7×10^6	$6.76\times10^6\pm 1.49\times10^6$
Factory B	5.6×10^6	9.7×10^6	$7.62\times10^6\pm 2.31\times10^6$
Factory C	6.7×10^6	9.9×10^6	$8.45\times10^6 \pm 1.73\times10^6$

S.E*= Standard error of mean

Table (2): Statistical analytical results of Coliform counts (cfu/g) in the examined samples of frozen pigeon meat (n=25).

Samples	Min.	Max.	Mean± S.E*
Factory A	1.5×10^4	4.1×10^4	$2.92\times10^4\pm 0.19\times10^4$
Factory B	3.5×10^4	8.8×10^4	$5.71\times10^4\pm 0.35\times10^4$
Factory C	3.5×10^4	8.3×10^4	$5.87\times10^4\pm 0.25\times10^4$

S.E*= Standard error of mean

Table (3): Statistical analytical results of Staphylococci counts (cfu/g) in the examined samples of frozen pigeon meat (n=25).

samples	Min.	Max.	Mean± S.E*
Factory A	4.9×10^4	9.8×10^4	$6.50\times10^4\pm 0.21\times10^4$
Factory B	3.6×10^4	9.7×10^4	$7.00\times10^4\pm 0.32\times10^4$
Factory C	5.1×10^4	9.0×10^4	$6.71\times10^4 \pm 0.20\times10^4$

S.E*= Standard error of mean

Table (4): Statistical analytical results of Total pscychrotrophs counts (cfu/g) in the examined samples of frozen pigeon meat (n=25).

samples	Min.	Max.	Mean± S.E*
Factory A	7.4×10^6	1.52×10^7	$1.02\times10^7\pm 0.37\times10^6$
Factory B	1.4×10^6	1.65×10^7	$9.74\times10^6\pm 0.54\times10^6$
Factory C	8.8×10^6	1.70×10^7	$1.15\times10^7\pm 0.44\times10^6$

S.E*= Standard error of mean

Table (5): Incidence and serotyping of *E. coli* isolated from the examined samples of frozen pigeon meat (n=25).

E.coli Strains	Factory A		Factory B		Factory C		Total	
	No.	%	No.	%	No.	%	No.	%
O26:H11	-	-	-	-	1	4	1	4
O55:H7	1	4	-	-	1	4	2	8
O86	-	-	-	-	-	-	1	4
O111:H4	-	-	2	8	1	4	3	12
O119:H4	1	4	-	-	2	8	3	12
O124	-	-	1	4	-	-	1	4
O127:H6	-	-	-	-	1	4	1	4
Total	2	8	3	12	6	24	12	48

Table (6): Incidence and serotyping of *Salmonellae* isolated from the examined samples of frozen pigeon meat (n=25).

Products Salmonella Strains	Factory A		Factory B		Factory C		Group	Antigenic structure	
	No.	%	No.	%	No.	%		O	H
S. Enteritidis	1	4	1	4	1	4	D1	1,9,12	g,m : -
S.Typhimurium	-	-	2	8	1	4	B	1,4,5,12	i : 1,2
S. Anatum	1	4	-	-	1	4	E1	3,10,15,34	e,h : 1,6
S. Muenster	-	-	-	-	-	-	E1	3,10,15,34	e,h : 1,5
Total	2	8	3	12	3	12			

4. DISCUSSION

Aerobic plate counts are acceptable measure of the general degree of bacterial contamination and the hygienic conditions of processing plants (Cohen et al., 2007). Nearly similar results were obtained by Abu-ruwaida et al. (1994) (3.2×10^6 to 4×10^6 cfu/g), while lower APC in chicken meat obtained by Javadi and Safarmashaei (2011) (1.16×10^5 cfu/g), and higher APC in chicken meat obtained by Vural et al. (2006) (1.48×10^7). However, high APC in the examined frozen pigeon samples may be due to unsanitary conditions during preparation procedures, prolonged frozen storage period, contamination before and\ or after slaughtering, bad handling during retail display and bad storage conditions or exposure to condition favoring bacterial proliferation and contamination of meat from different sources as skin of the animals, pollution in abattoir atmosphere, visceral content in normal condition, transport and storage, halving, quartering, packaging utensil and also the water used for cleaning and personal uses (Thatcher and Clark, 1978). Coliforms is used as an indicator of water pollution or as a general indicator of sanitary condition in the food-processing environment.

The current results of coliform count are nearly similar to those obtained by Vural et al. (2006) and Javadi and Safarmashaei (2011) , while higher coliform counts were obtained by Amara et al. (1994) and Hegazi (1995), and lower coliform counts were obtained by Cohen et al. (2007) and Huong et al. (2009). High coliform counts indicated poor hygienic quality of meat. The contamination with coliforms may occur during slaughtering, cutting or dressing of carcasses. Soiled hands, shopping blocks or knives used for handling and cutting or contaminated water were considered as sources of coliforms in meat (Yadav et al., 2006). The presence of *Staph. aureus* in foods commonly indicates contamination that may be directly introduced into the food by workers who have skin lesions containing *Staph. aureus*, or sneezing or coughing. Nearly similar results were obtained by Ibrahim Ghada (1997) (4.72 $\log_{10}$ cfu/g) and El-Morsi (1998) (4.49 $\log_{10}$ cfu/g), while lower counts were obtained by Al- Mohizea et al. (1994) (2.79 $\log_{10}$ cfu/g). The presence of *E. coli* in high numbers indicates the presence of organisms originating from fecal pollution. This is

due to improper slaughtering techniques, contaminated surfaces and/or handling of the meat by infected food handlers (Nel et al., 2004). Nearly similar results were obtained by Lee et al. (2009) who found that out of 900 poultry samples 41 (4.6%) were positive for *E. coli. E. coli* isolates were categorized into three virulence groups, namely Enterotoxigenic *E. coli* (43.6%), Enterohemorrhagic *E. coli (EHEC)* (35.9%) and Enteropathogenic *E. coli* (20.5%). Fourteen strains were identified as belonging to the EHEC, which included O_{18}, O_{136}, O_{119}, O_{86}, O_8, O_{111}, O_{15}, O_{128} and O_6 in Korea. Psychrotrophic bacterial count can provide useful information about the keeping quality of pigeon meat. Moreover, there is a general agreement that aerobic spoilage of meat becomes evident when the level of bacteria reach 10^7 (off odor) or 10^8 (slime information) (Prieto et al., 1992). These results were nearly similar to those reported by Hafez (1986) who mentioned that the average Psychrotrophic bacterial count of frozen meat was 11×10^6 (cfu/g). While, lower results were obtained by Badafwi (2008) who found that the average Psychrotrophic bacterial count of frozen meat was 43×10^3 (cfu/g).

The presence of *Salmonella* in pigeon meat can occur at multiple steps along the food chain, which includes production, processing, distribution, retail marketing, handling and preparation (Cui et al., 2005). Nearly similar results were obtained by Kozacinski et al. (2006) and Abdellah et al. (2008), while higher results were obtained by Al-Nakhli et al. (1999) and Vural et al. (2006), and lower results were obtained by, Limawongpranne et al. (1999) and Jordan et al. (2006).

Finally, it could be concluded from the present study that pigeon meat possesses a higher number of microorganisms with significant risks of meat spoilage and contamination. In addition, these results may be attributed to unsanitary condition, cross contamination, fecal pollution, personal hygiene and during handling, packaging, storage, distribution and selling. Therefore, a concerted effort should be made to maintain sanitary condition in processing, preparation and handling.

5. REFERENCES

(APHA), A.P.H.A., 2001. Compendium of Methods for the Microbiological Examination of Foods Fourth edition. F.P. Downes and K. Ito (editors), American Public Health Association, Washington, D.C.

(ISO), I.O.o.S., 2003. No. 6887-2. Microbiology of food and animal feeding stuffs – Preparation of test samples, initial suspension and decimal dilutions for microbiological examination. Part 2: Specific rules for the preparation of meat and meat products.

Abdellah, C., Fouzia, F.R., Abdelkader, C., Rachida, B.S., Mouloud, Z., 2008. Occurrence of salmonella in chicken carcasses and giblets in Meknes-Morocco. Pak. J. Nutr. 7, 231-233.

Abu-ruwaida, A.S., Sawaya, W.N., Dashti, B.H., Murad, M., Al- Othman, H.A., 1994. Microbiological quality of broilers during processing in a modern commercial slaughterhouse in Kuwait. J. Food Prot. 57, 887-892.

Al- Mohizea, I.S., Mashhsdi, A.S., Fawwal, A., Al-Shalhat, A., 1994. Microbiological and shelf life assessment of chilled eviscerated whole chicken broilers in Saudi Arabia. Br. Poult. Sci. 35, 519-526.

Al-Nakhli, H.M., Alogaily, Z.H., Nassar, H.M., 1999. Representative salmonella serovars isolated from poultry and poultry environment in Saudi Arabia. Rev. Sci. Off. Int. Epiz. 18, 700-709.

Amara, A., Badonm, M., Faid, M., Bouzoubaa, K., 1994. Microbial contamination of poultry slaughtered in traditional shops in Morocco. Prot. Aliments Nutr. 12, 323-327.

Badafwi, M., 2008. Further studies on imported frozen meat. PhD Thesis (Meat Hygiene), Fac. Vet. Med., Alex. University.

Bennett, R.W., 2005. Staphylococcal enterotoxin and its rapid identification in food by enzyme-linked immunosorbent assay-based methodology. J. Food Prot. 68, 1264-1270.

Cohen, N., Ennaji, H., Bouchrif, B., Hassar, M., Karib, H., 2007. Comparative study of microbiological quality of raw poultry meat at various seasons and for different slaughtering processes in Casablanca (Morocco). J. Appl. Poul. Res. 16, 502-508.

Cui, S., Ge, B., Zheng, J., Meng, J., 2005. Prevalence and antimicrobial resistance of campylobacter spp. and Salmonella serovars in organic chickens from Maryland retail stores. J. Appl. Environ. Microbiol. 71, 4108-4111.

Egyptian Organization for Standardization and Quality (EOS), 2005. 1651 /2005. Chilled poultry and rabbit.

El-Morsi, A.S., 1998. Occurrence of food poisoning organisms in poultry products with references to Campylobacter. PhD Thesis (Meat Hygiene). Fac. Vet. Med., Zagazig Univ.

Food and Drug administration (FDA), 2001. Foodborne illness, what consumers need to know. USDA Food Safety and Inspection Service. September 2001.

Hafez, A.F., 1986. Studies on the sanitary condition of frozen meat marketed in Sharkia province. PhD Thesis. Fac. Vet. Med., Zag. Univ.

Hegazi, S.A., 1995. Hygienic problems in handling and storage of, slaughtered animal and bird. PhD Thesis, Fac. Vet. Med., Cairo Univ.

Huong, C.T.T., Duong, N.T.H., Hien, N.T.T., 2009. Contamination of some bacteria isolated from chicken meat in retail markets in Hanoi and examination of the antibiotic resistance ability of salmonella and E.coli strains isolated. J. Sci. Dev. 7, 181-186.

Ibrahim Ghada, M.M., 1997. Microbiological and sensory evaluation of fresh broiler chichen carcass. M.V.Sc. Thesis, Fac. Vet. Med., Alex. Univ.

International Organization of Standardization (ISO), 2004. International Organization for Standardization. No. 11291-1. Microbiology of food and animal feeding stuffs - Horizontal methods for detection and enumeration of Enterobacteriaceae part2 : colony count, method.

Javadi, A., Safarmashaei, S., 2011. Microbial profile of marketed broiler meat. Middle-East J. Sci. Res. 9, 652-656.

Jay, J.M., Loessner, M.J., Golden, D.A., 2005. Modern Food Microbiology. 7th Ed., Springer Science and Business Media. NY, PP: 63-101.

Jordan, E., Egan, J., Dullea, C., Ward, J., Mcgllicuddy, K., Murray, G., Murphy, A., Bradshaw, B., Leonard, N., Rafter, P., 2006. Salmonella surveillance in raw and cooked meat and meat products in the Republic of Ireland from 2002 to 2004. Inter. J. Food Microbiol. 112, 66-70.

Kozacinski, L., Hadziosmanovic, M., Zdolec, N., 2006. Microbiological quality of poultry meat on the Croatian market. Vet. Arhiv 76, 305-313.

Lee, G.Y., Jang, H.I., Hwang, I.G., Rhee, M.S., 2009. Prevalence and classification of pathogenic Escherichia coli isolated from fresh beef, poultry, and pork in Korea. Inter. J. Food Microbiol. 134, 196-200.

Limawongpranne, S., Hayashidani, H., Okatani, A.T., Ono, K., Hirota, C., Kaneko, K., Ogawa, M., 1999. Prevalence and persistence of salmonella in broiler chicken flock. J. Vet. Med. Sci. 61, 255-259.

Nasser, A., Fathi, S.H., 1997. Prevalence of psychrotrophic microorganisms in imported frozen meat. Fleisch wirtschaft 87, 25-27.

Nataro, J.P., Kaper, J.B., 1998. Diarrheagenic Escherchia coli. Clin. Microbiol. Rev. 11, 142-201.

Nel, S., Lues, J.F.R., Buys, E.M., Venter, P., 2004. Bacterial populations associated with meat from the deboning room of a high throughput red meat abattoir. J. Meat Sci. 66, 667-674.

Omojola, A.B., Isa, M.A., Jibir, M., Ajewola, B.T., Garba, S., Kassim, O.R., Omotoso, A.B., Adeyemo, O.A., Akinleye, S.B., 2012. Carcass characteristics and meat attributes of pigeon (Columbia Livia) as influenced by strain and sex. J. Anim. Sci. Adv. 2, 475-480.

Prieto, M., Garcia, M.R., Garcia, M.L., Alonso, C., Otero, A., 1992. Species of Pseudomonas obtained at 7°C and 30°C during aerobic storage of lamb carcasses. J. Appl. Bacteriol. 73, 317-323.

Roberts, D., 1990. Sources of food infection. lancet 336, 8719-8859.

Schikora, A., Garcia, A.V., Hirt, H., 2012. Plants as alternative hosts for Salmonella. Trends plant sci. 17, 245-249.

Thatcher, F.S., Clark, D.S., 1978. Microorganisms in foods, their significance and methods of enumeration. 1st Ed. Univ. Toronto Press, Toronto, Cited after Koburger and Wahlguists. J. Food Prot. 42, 956.

Thorns, C.J., 2000. Bacterial food-borne zoonoses. Rev. Sci. Tech. 19, 226-239.

Vural, A., Erkan, M.E., Yesilme, S., 2006. Microbiological quality of retail chicken carcasses and their products in Turkey. Medycyna Wet 62, 1371-1374.

Yadav, M.M., Tale, S., Sharda, R., Sharma, V., Tiwari, S., Garg, U.K., 2006. Bacteriological quality of sheep meat in Mhow town of India. Inter. J. Food Sci. Technol. 41, 1234–1238.

Zweifel, C., Baltzer, D., Stephan, R., 2005. Microbiological contamination of cattle and pig carcasses at five abattoirs determined by swab sampling in accordance with Eu Decision 2001/471/EC. J. Meat Sci. 69, 559-566.