

# **POULTRY MEAT SAFETY IN TURKEY**

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## **Introduction**

Poultry meat is the combination of muscle tissue, attached skin, connective tissue, and edible organs of avian species commonly used for food. Chicken and turkey are the major types of poultry meat. Chicken meats comprise about the two-thirds of the total production in the world (ICMSF, 1998; Mead, 2000.).

Poultry meat is one of the most popular food products worldwide. Several nutritional factors such as high level of protein and low fat content and favorable content of unsaturated fatty acids contribute to the popularity of poultry meat, of which sensory, dietary and economic factors are important. Poultry meat is easy to prepare at home and widely used in restaurants and fast-food establishments. There is no primary religious restriction on the consumption of poultry meat (Mulder, 1999). On the other hand, poultry meat is an excellent substrate for the growth of a wide variety of microorganisms including pathogens and spoilage microorganisms. In addition to the nutrients in raw poultry meat, other properties influence the growth of microorganisms such as water activity and pH value. For example, water activity ( $a_w$ ) is about 0.98 to 0.99. The pH of chicken breast muscle is 5.7 to 5.9, and leg muscle is 6.4 to 6.7. The redox potential of poultry meat is similar to that of beef, pork and lamb. The skin, which harbors many microorganisms while serving as a physical barrier to microorganisms (ICMSF, 1998).

Over the past 30 years, poultry meat production has increased rapidly worldwide and many processing plants are producing more than 6.000 carcasses per hour on a single live. The rapid increase of the poultry production has led to intensive animal production with a rise in the number of farms and flock size. Both have brought up specific problems, such as contamination with human and animal pathogens, and welfare and environmental problems. (Bolder, 1998).

The transmission of food borne pathogens in poultry production is significantly affected by the intensive nature of present system for breeding, hatching, growing, slaughtering and processing the birds. Pathogens of concern to humans and poultry production can be readily transmitted among the birds in a flock. Poultry can become colonized by the pathogenic microorganisms via drinking water, eating feed, or pecking in contaminated soil or litter (Mead, 2000).

Incoming flocks are the main source of microorganisms found on poultry carcasses. The feathers, feet and bodies of the birds, and crates are contaminated with a variety of bacteria. During hanging and bleeding, flapping wings create aerosols and dust. The intestinal tract is another important source of bacterial contamination. During the process, intestines are

ruptured, which causes the contamination of carcasses. Therefore, withdrawal of feed from poultry flock about 8-12 hours before slaughtering reduces the intestine rupture risk (Bilgili, 1988).

Processes for fattening, catching, loading, transporting and holding at the slaughterhouse are designed to minimize environmental stress to the birds. To facilitate the removal of feathers, carcasses are scalded, usually by immersion in a continuous flow water tank at 50 to 63°C. During this operation, bacteria from the carcasses are washed into the scald water. The defeathering process may spread microorganisms between carcasses or from the defeathering equipment contributing to an increase in the numbers of psychrotrophs and aerobic mesophiles on the carcasses. The evisceration process provides an opportunity for cross contamination from human, equipments and worker's hands (Jackson et al. 2001.) Regarding the slaughter process, special emphasis has been placed on developments in scalding, plucking and evisceration of the carcass. With multistage cleaning and scalding, followed by plucking, and combined scalding and plucking, cross contamination between carcasses is reduced. Further, new evisceration equipment separating carcasses from the viscera and giblets, has improved the microbiological quality of carcasses with respect to pathogens (Mulder, 1999).

Epidemiological reports from all over the world indicated that poultry meat is the most incriminated food as a source of food borne outbreaks. Most of the outbreaks involving high numbers of people are usually due to *Salmonella* spp., *Campylobacter* spp., *Clostridium perfringens*, and *Staphylococcus aureus* (ICMSF, 1998)

### **Poultry Meat Production and Regulation in Turkey**

Poultry production in Turkey is mostly made in the areas, where are close to poultry farms and markets. Intensive broiler farms are massively located in the regions of Bolu-Sakarya-İstanbul; Bandırma-Eskişehir; İzmir; Çukurova and Ankara. Fifty-five of combined poultry slaughterhouses and processing plants and 20 slaughterhouses are working by the approval and under the control of the General Directorate of Protection and Control, Ministry of Agriculture and Rural Affairs. In some of the large scale processing plants, which are able to export of poultry meat to EU countries, the meat inspection is carried out by the official veterinarians employed by the competent authority. In the future, the official veterinarians appointed by the competent authority will perform the meat inspection in all slaughterhouses and processing plants. This is an obligatory aspect of the meat control regulation in EU. Turkey is a candidate country for accession to the European Union (EU). As such it has to fully approximate its legislation to the body of the EU legislation (the “*acquis communautaire*”). Poultry meat legislation in Turkey mostly meets the terms of EU regulations.

In general poultry meat industry is well developed and particularly some of the large processing plants are provided with highest technology, good hygienic and maintenance conditions which comply with requirements of EU regulation.

Twenty large scale plants produces 84% of total poultry meat, and their production capacity is about 472.980 tons per year, which leads that an average poultry production of approximately 870.000 tons annually (Anon, 2001).

In early 1990's, large investments were made to reach global production standards. Production levels have increased year by year, but affected by the two big economical crises in 1994 and 2001. Poultry meat consumption has an essential position for the balanced diet of Turkish people. Animal source proteins are balanced with poultry meat after the decline in red meat area. Poultry meat consumption per capita increased to 11.68 kg with a rate of 136 % between 1994 and 2000 (Anon, 2001).

Not only the chicken meat but also turkey meat has a defined market sales in poultry production with 20 tons of production. In developed countries, turkey meat consumption per capita is 8-10 kg. However in Turkey, people used to consume it only in new year parties, and this was about 300g per capita only (Anon, 2001). Global poultry meat production in Turkey and worldwide is given in Table 1.

**Table 1: Poultry production in Turkey (x1000) (Anon, 2004)**

	1999	2000	2001	2002	2003
<b>Chicken</b>	239.748	258.168	217.575	245.776	277.533
<b>Broilers</b>	167.863	193.459	161.899	188.637	217.133
<b>Egg Laying Hens</b>	71.885	64.709	55.676	57.139	60.400
<b>Turkey</b>	3.763	3.682	3.254	3.092	3.994
<b>Duck</b>	1.295	1.104	914	832	811
<b>Goose</b>	1.671	1.497	1.398	1.400	1.337
<b>Chicken meat (x1000 tons)</b>	597	643	615	696	872

## Poultry-borne pathogens

Despite the wholesome image among consumers, raw poultry is a common source of foodborne pathogens, especially due to *Salmonella* spp. and *Campylobacter* spp. Other foodborne pathogens that are often present on carcasses including *C. perfringens*, a common intestinal organism, and *S. aureus* which is carried on the skin and nasopharynx, *L. monocytogenes* is a common pathogen in raw poultry (ICMSF, 1998). Selected publications on the prevalence of some food borne pathogens in poultry meat in Turkey is given in Table 2.

### *Salmonella*

Because of intense poultry husbandry practices and major difficulties in controlling the spread of *Salmonella* spp. in vertically integrated poultry production and processing industries, raw poultry meats rank as the main vehicles of human food borne salmonellosis. Outbreaks of salmonellosis are often due to inadequate cooking or recontamination of poultry after cooking. During processing, carcass becomes contaminated, and to some degree, *Salmonella* spp. are spread from carcass to carcass by equipment, tools and workers (Jackson et al. 2001).

During the late 1980's, there was a dramatic increase in *S. Enteritidis*, and since 1987 it has been the most frequent serotype isolated from poultry in the UK. The increase was associated with the emergence of PT 4 and a corresponding rise in human's illness, with many food borne infections had been attributed to the poultry products. Likewise *S. Typhimurium* is another important serotype in poultry and currently the presence of DT104, because of its common penta-resistance to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline (additional resistance to gentamicin, trimethoprium, and fluoroquinolones have

been reported), is the important cause of major concern (Threlfall et al. 1997; Wray et al. 1999; D'Aoust, 2000; Humphrey, 2001).

In a study conducted to determine distribution of *Salmonella* serotypes in whole chicken carcasses and chicken parts in Turkey showed a contamination of 27.5 %. Contamination of whole carcass, wings, breast, drum sticks and edible offal were 31.25 %, 46.66 %, 36.66 %, 6.7 % and 10.0 % respectively. *S. Enteritidis*, *S. Typhimurium*, *S. Agona* were detected as predominant serotypes. Strains isolated were analyzed for antimicrobial resistance of ampicillin, chloramphenicol, enrofloxacin, gentamycin, kanamycin, tetracycline and trimethoprim. Multiple resistances identified in 6 of 10 resistant strains. Two of *S. Duisburg* strains showed resistance to four antibiotics (ampicillin, chloramphenicol, kanamycin, tetracycline), two other strains showed resistance to 3 different antibiotics; one showed resistance to ampicillin, chloramphenicol, tetracycline the other one showed resistance to chloramphenicol, kanamycin, tetracycline. Both *S. Enteritidis* strains showed resistance to tetracycline and one was also resistant to chloramphenicol. All *S. Typhimurium* were resistant to trimethoprim, both *S. Virchow* and *S. Infantis* strains were resistant to ampicillin, *S. Infantis* strains were resistant to tetracycline (Mutluer et al., 1992).

In one study, Sarımeahmetoğlu et al. (1997) determined the presence of *Salmonella* spp. in scalding tank inlet water, scalding tank outlet water, post defeathering, water chilling inlet, water chilling outlet and packaged chicken carcasses. The isolation and identification results showed a serotype distribution of 30 % *S. Java*, 23 % *S. Enteritidis*, 13 % *S. Infantis*, 11 % *S. Agona*, 7 % *S. Typhimurium*, 3 % *S. Bredeney* and 2 % *S. Montevideo*.

In a comparative study for detection of *Salmonella* spp. from 69 chicken carcasses with culture technique versus IMS-PCR, Erol et al. (2005) showed *Salmonella* contamination with 88.4 % of traditional method and 86.9 % of IMS-PCR method. Predominant serotypes were reported as *S. Enteritidis*, *S. subsp. I* and *S. Java*.

### ***Campylobacter***

Raw poultry are the major vehicle of *Campylobacter* spp. primarily *C. jejuni*. In most countries the majority (50 to 80 %) of chicken carcasses sold at retail are contaminated with *C. jejuni*. Consuming undercooked poultry appears to be a significant source of human infection (ICMSF, 1998). Fluoroquinolone-resistant *Campylobacter* spp. can be related to retail poultry, and the prevalence of resistance roughly parallels the resistance rates observed in human infectious (Nachamkin, 2000).

Yıldırım (1995) collected chicken carcasses from slaughterhouses, and retail markets and also frozen chicken carcasses from markets for the detection of thermophilic *Campylobacter*. The samples were found contaminated as 92, 81.7 and 6.2 % respectively .

Dizgah (1996) detected thermophilic *Campylobacters* from fresh chicken carcasses and edible offals at levels of 96 and 90 % respectively. Among the positive samples 52% *C. jejuni*, 20 % *C. coli* and 28 % *C. lari* were identified.

Ozdemir et al. (2005) carried out a study in two different slaughterhouses, in which different samples obtained from different stages of slaughter process. A total of 528 samples were analyzed and 79 (14.9 %) were found to be contaminated with *Campylobacter jejuni*. Contamination with *Campylobacter jejuni* in post defeathering, post evisceration, post water

chilling tank, pre packaged whole chicken rinse samples were 29.1, 37.5, 37.5 and 20.8 % respectively.

In another study, presence of *Campylobacter* was determined in 60 chicken liver samples. Results showed that 54 of 60 samples were contaminated with thermophilic *Campylobacters*. Distribution of total 23 strains was 77 % *C.jejuni*, 18.1 % *C.coli* and 4.7 % *C.lari* (Yıldırım, 2005).

### ***S. aureus***

Live poultry can carry staphylococci in bruised tissues, infected lesions, nasal sites, and arthritic joints and on skin surfaces. The carcass becomes recontaminated with *S.aureus* particularly from the defeathering machines at the slaughterhouses (ICMSF, 1998).

In a study, Erol and Usca (1996) determined the enterotoxin formation abilities of coagulase positive staphylococci isolated from 33 (66 %) in 50 chicken carcass samples. Mean number of coagulase positive staphylococci contamination was  $1.3 \times 10^3$  cfu/g. Seven (21.2 %) of the 33 coagulase positive chicken samples were found enterotoxigenic. The enterotoxin types of these strains were as follows: 3 produced only type A, 2 produced only type D, 1 produced both A and B types, 1 produced A, B and C types.

Altay et al. (2003) isolated a total of 120 staphylococci strains from the edible offals of chickens, among 46 isolates were coagulase positive. Within the coagulase positive isolates 23.3 % were identified as *S. aureus*.

### ***L. monocytogenes***

*L. monocytogenes* is a common contaminant of raw poultry meat and may also be found in the further processing environment. About 60 % of chicken carcasses may carry the organism in low number. With ready to eat (RTE) products, there have been concerns over the possible presence and low rates of contamination with *L. monocytogenes* (ICMSF, 1998; Mead, 2000).

Arslan et al. (1999) analyzed chicken parts for *Listeria* spp. From 10-15 % of the samples *Listeria* spp. were isolated and 5-15 % of these samples were identified as *L. monocytogenes*.

Erol and Şireli (1999) showed *Listeria* spp. contamination in 47 of 50 frozen chicken carcasses. The results of the study showed contamination with 5 different species as 90 % *Listeria innocua*, 30 % *Listeria monocytogenes*, 8 % *Listeria welshimeri*, 2 % *Listeria grayi* and 2 % *Listeria murayi*. Serotyping showed that 73.3% of the *L. monocytogenes* isolates belonged to serotype 1/2a. Other serotypes including 1/2b, 1/2c, 3c and 4b were also identified in this study.

Şireli et al. (2002) determined the *Listeria* spp. in ground chicken meat, chicken meatballs and chicken burgers. Thirty-four of 40 (85 %) ground chicken meat, 25 of 30 (83.3 %) chicken meatballs and 12 of 30 (40 %) burgers were found contaminated with *Listeria* spp. In another study held to determine the contamination of fresh chicken meat parts and edible offals with *Listeria* spp. showed *Listeria* contamination of 90 % and 46.6 % respectively. *Listeria monocytogenes* was isolated and identified from 23.3 % chicken meat parts (leg, breast and wing) and 33.3 % edible offals (liver and heart) at the levels of  $10^1$ - $10^2$  and 3.8 MPN/g respectively (Erol et al., 1999).

Kalender (2003) isolated *L. monocytogenes* from 4.3 % of 206 chicken feces samples tested.

### ***C. perfringens***

Çakmak et al. (2005), showed that 28 of 40 frozen chicken carcasses (% 70) and 1 of 40 chicken burger (% 2.5) sold in retail markets of Ankara, were found contaminated with *C. perfringens*. Similarly, in another study researchers isolated *C. perfringens* from 58 (% 58) of 100 ground turkey meat samples tested (Sarıgüzel and Erol, 2005). None of the *C. perfringens* isolates were identified as carrying the *cpe* gene tested by PCR.

## **Spoilage and Other Microorganisms**

Poultry skin and muscle provide excellent growth substrates for spoilage microorganisms. The shelf life of raw poultry meat depends on the combined effects of certain intrinsic and extrinsic factors, including the numbers and types of psychrotrophic microorganisms present initially, the storage temperature, muscle pH and type, as well as the type of packaging material used. Spoilage of poultry meat has been associated with the growth of *Pseudomonas* spp., *S. putrefaciens*, *Acinetobacter* spp., and *Moraxella* spp. Under aerobic storage, *Pseudomonas* spp. constitutes the dominant spoilage microflora (Mead, 2000; Jackson et al. 2001).

In a study performed to determine the microbiological quality of chicken meat at retail markets indicated that all 50 chicken samples were found to be contaminated with aerobic mesophilic counts at  $\log_{10} 4.9 \times 10^5$  cfu/g, yeast and moulds  $\log_{10} 8.1 \times 10^4$  cfu/g. And also a high number of the samples contained *Pseudomonas* spp. at  $\log_{10} 2.9 \times 10^4$  cfu/g, Micrococci and Staphylococci at  $\log_{10} 5.8 \times 10^4$  cfu/g, Coliforms at  $\log_{10} 2.8 \times 10^4$  cfu/g, *Enterbacteriaceae* at  $\log_{10} 3.5 \times 10^4$  cfu/g and sulphite reducing anaerobes at  $\log_{10} 2.0 \times 10^1$  cfu/g (Usca, 1996)

To compare the effects of water chilling and air chilling systems on the microbiological quality of chicken carcasses Sahin (2005) showed that aerobic mesophilic counts of pre air chilling, post air chilling, pre water chilling and post water chilling were  $\log_{10} 5.13$  cfu/cm<sup>2</sup>,  $\log_{10} 4.54$  cfu/cm<sup>2</sup>,  $\log_{10} 5.12$  cfu/cm<sup>2</sup> and  $\log_{10} 4.93$  cfu/cm<sup>2</sup> respectively. The results of this study indicated the direct effect of air and water chilling on the microbial quality of chicken meat.

Table 2.: Selected publications on the prevalence of some food borne pathogens in poultry meat in Turkey

Pathogen of Concern	Type of the Sample	Contamination Levels	Notes	References
<i>Salmonella</i> spp.	Whole chicken carcass Wings, Breast, Drum stick Edible offals	31.25 % 46.6, 36.6, 6.7 % 10.0 %	<i>S. Enteritidis</i> , <i>S. Typhimurium</i> and <i>S. Agona</i> were detected as predominant serotypes	Mutluer et al. (1992)
<i>Salmonella</i> spp.	Chicken slaughterhouse Environmental samples	30 % <i>S. Java</i> 23 % <i>S. Enteritidis</i> 13 % <i>S. Infantis</i>	<i>S. Java</i> , <i>S. Enteritidis</i> ve <i>S. Infantis</i> were predominant serotypes	Sarımehmetoğlu et al. (1997)
<i>Salmonella</i> spp.	Chicken carcass	88.4 % traditional cult.meth. 86.9 % IMS-PCR	<i>S. Enteritidis</i> , <i>S. subsp. I</i> , <i>S. Java</i>	Erol et al. (2005)
<i>Campylobacter</i> spp.	Chicken carcasses from Slaughterhouse level and retail market level Frozen chicken carcass	92 % 81.7 % 6.2 %		Yıldırım (1995)
<i>Campylobacter</i> spp.	Fresh chicken carcass Edible offals	96 % Fresh chicken carcass 90 % Edible offal	52 % <i>C. jejuni</i> 20 % <i>C. coli</i> , 28 % <i>C. lari</i>	Dizgah (1996)
<i>Campylobacter</i> spp.	Chicken slaughterhouse samples taken from different stages	20.8 - 37.5 %	<i>C. jejuni</i>	Özdemir et al. (2005)
<i>Campylobacter</i> spp.	Chicken liver	90 % Thermophilic <i>Campylobacter</i> spp	77 % <i>C. jejuni</i> 18.1 % <i>C. coli</i> , 4.7 % <i>C. lari</i>	Yıldırım (2005)

Table 2.: Selected publications on the prevalence of some food borne pathogens in poultry meat in Turkey (Continued)

<b>Pathogen of Concern</b>	<b>Type of the Samples</b>	<b>Contamination Levels</b>	<b>Notes</b>	<b>References</b>
<b><i>Staphylococcus</i> spp.</b>	Frozen chicken carcass	66 % coagulase positive staphylococci ( mean ratio $1.3 \times 10^3$ cfu/g)	The predominant enterotoxin types were type A, type D	Erol and Usca (1996)
<b><i>Staphylococcus</i> spp.</b>	Edible offals	38.3 % coagulase positive staphylococci	23.3 % <i>S.aureus</i>	Altay et al. (2003)
<b><i>Listeria</i> spp.</b>	Frozen chicken carcass	94 % <i>Listeria</i> spp.	30 % <i>Listeria monocytogenes</i> 73.3 % Serotype 1/2a	Erol and Şireli (1999)
<b><i>Listeria</i> spp.</b>	Chicken ground meat Edible offals	90 % chicken ground meat 46.6 % edible offals	23.3 % <i>Listeria monocytogenes</i> 33.3 % <i>Listeria monocytogenes</i>	Erol et al. (1999)
<b><i>Listeria</i> spp.</b>	Chicken parts	10-15 % <i>Listeria</i> spp.	5-15 % <i>Listeria monocytogenes</i>	Arslan et al. (1999)
<b><i>Listeria</i> spp.</b>	Ground chicken meat, Chicken meatballs Chicken burger	85 % 83.3 % 40 %	35 % <i>Listeria monocytogenes</i> 20 % <i>Listeria monocytogenes</i> 26.6% <i>Listeria monocytogenes</i>	Şireli et al. (2002)
<b><i>Listeria</i> spp.</b>	206 chickens feces	4.3 % <i>L.monocytogenes</i>		Kalender (2003)
<b><i>Clostridium perfringens</i></b>	Frozen ground chicken meat Chicken burger	70 % 2.5 %		Çakmak et al. (2005)
<b><i>Clostridium perfringens</i></b>	Ground turkey meat	58 %		Sarıgüzel and Erol (2005)
<b><i>Yersinia</i> spp.</b>	Chicken carcass Liver and Heart	20 % 8 % and 5 %	Totally 33 % <i>Yersinia</i> spp. 9.7 % <i>Y.enterocolitica</i>	Sırken (1997)

## Preventive and Control Measures

To produce safe poultry meat products, effective preventive and control measures should be taken on every part of the production. Because of the potential hazards of the presence of pathogens on every part of poultry meat manufacturing process, approach used in the production "from farm to table" should be based on GMP (Good Manufacturing Practices) and HACCP (Hazard Analysis and Critical Control Points) rules, including poultry house hygiene, feed control, stress reducing, competitive exclusion (CE), control of drinking water, dead bird disposal, wild birds, rodents and reptiles control, hatchery hygiene, feed withdrawal, slaughterhouse hygiene particularly in the critical control points, decontamination, temperature control, equipment hygiene, workers hygiene, adequate cleaning and disinfection (ICMSF, 1998).

## Conclusion

Poultry meat industry is well developed in Turkey and the industry is able to export part of their products to other countries including EU countries. However, because of the significance of food borne pathogens on every part of the poultry meat production, from farm to table, more consideration should be taken into to provide official veterinary control, to enhance the hygienic quality, and to strengthen the residues monitoring plan, as well as prolonging the shelf life for the safe poultry meat production and to protect of public health.

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