ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 2, Issue 3, pp: (1-7), Month: July 2014 - September 2014, Available at: www.researchpublish.com

# Bacterial Pathogens in Chicken Meat: Review

[1]Darshana B. Bhaisare, [2]D. Thyagarajan, [3]R. Richard Churchil, [4]N. Punniamurthy

[1]PhD Scholar, Central Avian Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India-243 122.

[2]Directorate of Distance Education, Madhavaram Milk Colony, Tamil Nadu Veterinary and Animal Sciences University, Chennai, India-600 051.

[3]Instructional Livestock Farm Complex, Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamil Nadu, India-614 625.

[4]Veterinary University Training and Research Centre, Tamil Nadu Veterinary and Animal Sciences University, Thanjavur, Tamil Nadu, India.

***Abstract:*** **Chicken is a nutritious, healthy food which is low in fat and cholesterol compared to other meats but an excellent source of protein. Meat must be of a high microbiological quality in order to ensure that the consumer receives a product that is not spoilt or does not carry food-borne disease. Food borne diseases associated with the consumption of poultry meat and its processed products are of public health significance worldwide. This paper reviewed information on the sources of microbial contamination, contamination of poultry with major pathogenic microorganisms, the consequences of this contamination to human health, prevalence of microbes in poultry meat and products in the world and in India.**

***Keywords:*** **poultry carcass, microbes, chicken meat, microbial contamination.**

## I. INTRODUCTION

The term 'chicken meat' principally refers either whole carcasses or parts of the carcass or boned out meat of the species *Gallus gallus*. The poultry has gained the acceptance by consumers and growing 10-15% annually. The chicken meat contributes about 37% meat to total production and number one contributors. The growth is expected more in near future. This might be due to popularity, price, easy availability, no religious taboos, highly digestible, tasty and low-calorie food often recommended by nutritionists over other meats. The popularity of this product is due to sensory and dietary, as well as economic considerations. The consumption of poultry products is increasing every year and consumers wants a safe and quality product, without the presence of pathogenic microorganisms. Thus, it is essential that the poultry industry achieves this goal. In most developed and some developing countries today, high-quality poultry meat is often less costly than other types of meat. This is due mainly to the revolutionary industrialization of the poultry industry in the last 30 years, which has changed poultry meat from a rather limited product, only available to a limited group of consumers, into a popular and inexpensive product within everyone's budget. Special attention in poultry meat production is paid to the fact that live animals are hosts to a large number of different microorganisms residing on their skin, feathers or in the alimentary tract. During slaughter most of these microorganisms are eliminated, but subsequent contamination is possible at any stage of the production process, from feather plucking, evisceration, and washing to storage by cooling or freezing (Mead, 1989). Microorganisms from the environment, equipment and operators' hands can contaminate meat. Hardly 5 per cent of the poultry meat produced in India is from organized processing units whereas, the rest is from the birds slaughtered in unorganized sector (retail shops) where due to poor hygiene there is ample scope for contamination (Kumar *et al*., 2001).

ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 2, Issue 3, pp: (1-7), Month: July 2014 - September 2014, Available at: www.researchpublish.com

## II. PATHOGENS IN POULTRY MEAT

Poultry and poultry meat are often found contaminated with potentially pathogenic microorganisms such as *Salmonella*, *Campylobacter*, *S. aureus*, *E. coli* and *Listeria*. In some occasions also *Yersinia enterocolitica*, *Aeromonas* and *Cl. perfringens* have the potential to be important pathogens in poultry products. However, *Salmonella*, *Campylobacter* and to a lesser extent *Listeria*, are considered to be the major food-borne pathogens in the poultry industry.

The meat surface do not normally, inherently contain pathogenic organisms but can acquire the organisms from faecal matter or from cross contamination during slaughter. The organisms tend to remain on the surface or just under it. Meat is an ideal medium for bacterial growth because of high moisture content, richness in nitrogenous compounds (essential amino acids, proteins), good source of minerals, vitamins and other growth factors. Furthermore, its pH is favourable for the growth of micro-organisms. The water activity (aw) of poultry meat is about 0.98 to 0.99 depending on if and how long the meat has been stored in dry air. The pH of chicken breast muscle is 5.7 to 5.9, while that of leg muscle is 6.4 to 6.7. Both poultry muscle and skin are excellent substrates for supporting the growth of a wide variety of microorganisms (ICMSF, 2005).

Contamination of poultry carcasses and parts with Salmonella organisms is well documented and data are available for many parts of the world (Simmons *et al.,* 2003). Most salmonella found on poultry meat are non-host-specific and are considered capable of causing human food poisoning. Salmonellosis (gastroenteritis) is the most common disease in human. Incubation period is generally 6 to 72 hours (Behravesh *et al*., 2008) and can be longer than 10 days. Symptoms include nausea, vomiting, diarrhea, abdominal cramps and fever of 100 to 102°F (Pickering, 2006).

Campylobacter species are found in the intestinal and genital tracts of domestic animals and are widely distributed geographically. The principal cause of human campylobacteriosis is mainly *C. jejuni*. *Campylobacter coli* and *C. lari* are sometimes implicated. The disease conditions associated with infection are either intestinal, presenting as diarrhoea, or genital, causing infertility or abortion. The majority of campylobacteriosis results in mild or acute but self-limiting gastrointestinal disease. Infrequently complications, such as reactive arthritis and neurological disorders, may occur. Moreover, 0.1% of cases develop into Guillain-Barre Syndrome (Allos, 1997), autoimmune disorder affecting the peripheral nervous system that can result in respiratory and severe neurological dysfunction and even death. As little as 53-750 CFU/cm$^2$ in fresh chicken meat could cause human infections (Rosenfield *et al.,* 1985). The three most commonly isolated species in broiler meat are *C. jejuni, C. coli* and *C. lari* (EFSA, 2010). Several incidences of Campylobacteriosis have also been reported from almost all parts of India (Naik *et al*., 1998). *Campylobacter* infections are primarily because of handling and consumption of raw or undercooked poultry and due to cross contamination (Stanley *et al*., 2003). Studies on isolation of *Campylobacter* from poultry meat have been carried out from the regions Tamil Nadu and Calcutta using conventional method (Varma *et al.,* 2000). Incubation period is usually 2 to 5 days but can be from 1 to 11 days. *Staphylococcus aureus* is one of the most common agents in bacterial food poisoning outbreaks and symptoms of staphylococcal food intoxication generally occurs within one to six hours after the ingestion of food and the common symptoms are nausea, vomiting, abdominal cramps, and diarrhea (Adwan *et al.,* 2005).

Epidemiological reports all over the world incriminate poultry meat as a source of outbreaks of human food-borne disease. Since poultry meat is usually not consumed raw, these outbreaks are caused by undercooking or cross-contamination of ready-to-eat products with microbial contaminants from the raw poultry or others introduced during preparation of the food. The aim of the poultry industry is to find ways to avoid contamination of live poultry and poultry products with potential pathogens. Further they should be able to deliver live poultry free of pathogens to the processing plant.

## III. PREVALENCE IN WORLD

In Crotia**,** bacteriological analysis was performed on 66 samples of fresh, retail-cut chicken meat (21 samples of chicken breasts without skin - "fillet", and 19 samples of chicken breasts with skin) and 26 samples of frozen ground chicken meat and found the presence of *Salmonella* spp (10.60%), *S. aureus* (30.30%), *L. monocytogenes* (3.03%), *Enterobacteria* spp (34.84%) and sulphite-reducing clostridia (1.50%) (Kozacinski *et al.,* 2006).

A total of 800 poultry meat samples from raw chicken (280), quail (248), turkey (212) and ostrich (60) were procured from the Esfahan city of Iran and analyzed for the prevalence of *Campylobacter spp*. The highest prevalence (68.4%) of

*Campylobacter* spp. was recorded in quail meat, followed by chicken meat (56.1%), turkey meat (27.4%) and ostrich meat (11.7%). The overall prevalence of *Campylobacter* in studied samples was 47.1% (377 from 800). Out of which, 76.4% were identified as *C. jejuni* and 23.6% as *C. coli*. (Rahimi and Tajbakhsh, 2008).

In a research conducted at five poultry slaughterhouses in Medimurje country in Crotia which included a total of 75 poultry meat swabs, 15 of which carcass cooling water samples and 15 samples of poultry meat collected in retail shops. Of which 10 samples of poultry meat were found positive for *Campylobacter* spp. (66.6%), out of these which *C. jejuni* was isolated from six samples (40%), and *C. coli* from four sam6ples (26,6%) of poultry meat (Kornelija *et al.*, 2009).

Bacteriological analysis was performed on 80 fresh chicken meat samples, marketed in Tabriz in Iran, results demonstrated the presence of *S. aureus* (65%), *Cl. perfringens* (83%), *Streptococcus* (100%) and *Coliforms* (100%) (Javadi and Saeid, 2011).

A study carried out on 40 random samples of cooked chicken products represented by chicken luncheon and Shawerma (20 of each) in KSA were subjected to the microbiological investigations which revealed the presence of some microbiological investigations, which revealed the presence of *S. aureus*, *E.coli*, mould, yeast in 10.0, 25.0, 50.0 and 65.0% in Luncheon and zero, 20.0, 65.0 and 70.0% in Shawerma, respectively (Sharaf and Sabra, 2012).

The microbial quality of 50 frozen chicken meat samples from grocery stores in Qena city, Egypt was assessed and the mean values for total aerobic, total coliform, total faecal coliform and total *E. coli* counts for locally produced chicken meat were 2.1 x$10^3$, 5.1 x10, 4.9x10 and 3.5 cfu/g for breast and 2.7x $10^3$, 6.4x10, 6.4x10 and 1.5 x10 cfu/g for thigh samples respectively (Daoud *et al*., 2012).

Samples collected from 50 raw frozen chickens meat in Egypt when bacteriologically processed, revealed the presence of 4% *Salmonella* spp. among which 58.33% and 41.66% were identified as *S. enteritidis* and *S. typhimurium* respectively (Rabie *et al.*, 2012).

## IV. PREVALENCE IN INDIA

A total of 144 swab samples were collected from poultry carcass sites, viz. neck, breast, wing and leg during various unit operations from an organized poultry slaughterhouse in Mumbai. The percent prevalence of indicator organisms viz. *Enterococci*, fecal coliforms, *Clostridium* spp. and *E. coli*, was 24.41, 18.74, 13.88 and 14.57 respectively (Vaidya *et al*., 2005).

Fourty numbers of hot dressed chicken carcasses from retail outlets of local poultry meat in Pune and Mumbai were processed according to the FDA/CFSAN-BAM rinse method. Among this 95% of the samples were found to be positive for *Campylobacter* with a MPN range between $10^2$-$10^4$ cfu/kg of the sample (Bandekar *et al.*, 2005).

Assessment of microbial contamination of chicken products have been carried out in Parbhani city in Maharashtra and the organisms isolated from chicken curry were *E. coli*, *Clostridium spp* while *Salmonella from tandoori* chicken (Rindhe *et al.*, 2008).

A study to isolate and identify *Salmonella* spp. from chicken slaughtered under different processing conditions viz. wet market, super market and modern processing units in Karnataka was carried out. A total of 450 (225 breast and 225 thigh muscle) samples were tested by PCR and shown that prevalence of *Salmonella* spp. was higher in thigh meat (31.99 %) compaired to breast muscles (24.88%) (Ruban *et al*., 2010).

A cross sectional study of different portions of raw meat samples from the local meat markets of North East India was carried on a total of 110 samples. Results revealed the presence of 74 different bacteria viz. *E. coli* (98%), *S. aureus* (20%), *L. monocytogenes* (15%) and *S. typhi* (20%) (Saikia and Joshi, 2010).

A study was conducted to determine the prevalence and plasmid patterns of *S. enteritidis* on chicken meat samples. Over a period of 2 years from different outlets, prevalence of *S. enteritidis* was recorded 92 (15.91%) out of total 578 chicken meat sample and examined of residential area of Namakkal city (Maripandi and Al-Salamah, 2010).

A study was undertaken to determine the microbial quality of chicken meat in Kolkata and found that the *Staphylococcal* and *E. coli* counts were higher in chicken meat from urban markets than semi-urban markets (Sengupta *et al*., 2011).

Contamination of chicken meat, by *S. aureus* sold at various retail markets of Namakkal of Tamil Nadu was assessed by culture of meat samples and colonial count. Out of 210 meat samples collected, 6.67% of the meat samples were positive by culture and the colony count was 1.03 ± 0.08 log10 cfu/g (Arul kumar and Saravanan, 2011).

Out of 130 samples of poultry meat from Hyderabad when examined, 87 were positive for *Salmonella* spp. by PCR methods whereas *77* were positive by cultural method (Ramya *et al.*, 2012).

A study on the prevalence of common food borne pathogens (*Salmonella*, *Staphylococcus* and *E. coli*) in chicken meat obtained from wet market in Bangalore under different processing conditions was carried out. Results revealed higher prevalence of *Salmonella* in the range of 25 to 65 per cent and *E. coli in the range of* 42 to 88 per cent (Ruban *et al*., 2012).

14.6% of *S. typhimurium* were isolated from total 82 samples of poultry related products in Namakkal district of Tamil-Nadu (Prakash *et al.*, 2012).

## V. SOURCES OF CONTAMINATION

The possible sources of contamination of *Campylobacter* spp. in poultry meat before slaughter found to be examining samples of feathers, cloaca swabs, litter swabs, transport coops, rinse water from coop washing equipment, and chicken breast supports in the slaughter line just before stunning (Franchin *et al*., 2005). The samples were collected from eight broiler houses and from eight different producers, from a poultry integration system in southern Brazil. The study was carried out over a 12-month period, and each broiler house was sampled in three consecutive flocks, for a total of 24 flocks/broiler house. *Campylobacter* was found in 79.2% of the feather samples, followed by cloacal swabs (75.0%) and transport coop (50.0%), litter (37.5%), breast support (33.3%) and coop rinse water (25.0%) samples.

Although chickens may excrete $10^4$ to $10^8$ *Campylobacter* cells per gram of feces, they are asymptomatic (Schoeni and Doyle, 1992). It is believed that the source of bacterial contamination of poultry meat is essentially the intestine or gut content which may come in contact with carcasses already in the broiler house and during transport and slaughter, either directly or indirectly, through a vehicle such as transport and processing equipment.

High levels of bacterial cross-contamination may occur especially during defeathering and water chilling, with intestinal contamination apparently being the only source. However, these levels may also increase during evisceration of the carcasses, washing and processing due to contamination by personnel (Oosterom *et al.*, 1983 and Wempe *et al.*, 1989). Although *Campylobacter* has been isolated from different body parts of the chicken such as cloaca (Carvalho *et al*., 2000), carcasses, feathers and crops (Nielsen *et al.*, 1997). Thermophilic *Campylobacte*r were detected in 22 of 24 chicken batch samples destined to slaughter, corresponding to a 91.7% rate of contaminated batches. Machado and Carvalho (2000) who detected *Campylobacter* spp. in about 57% and 42% of samples, respectively. Berrang *et al*. (2000) found 5.4 log10 CFU/g in the feathers and 3.8 log10 CFU/g in the skin of 18 chicken samples examined at the end of the bleeding tunnel, but before scalding. De Zutter (2000) studied 12 chicken batches of broiler flocks and the possibility of cross-contamination during transit to slaughter, and found that two batches which were initially free of *Campylobacter* spp. became infected with the organism when they reached the slaughter stage, indicating that infection occurred during transportation.

Their presence in the litter, coops, feathers and breast support renders the chicken meat vulnerable to cross contamination, thus increasing the risk of the presence of this pathogen in chicken meat and products.

## VI. EFFECT OF PROCESSING PRACTICES ON MICROBIOLOGICAL QUALITY OF CHICKEN MEAT

Rapid growth in consumer demand for poultry and poultry products over the last decade and increased international trade in these foods have focused attention on objective measures of food safety and quality. There is no specific policy regarding slaughter, dressing and sale of poultry meat in India. As a result roadside slaughter in most unhygienic manner is prevalent in most of the cities, towns and villages of India. Although a very few modern poultry processing plants have been established, majority of the consumers purchase meat from the roadside shops or small retailers where chickens are being slaughtered and dressed in unhygienic condition in their presence (Das and Biswas, 2003). But with the changing

busy lifestyle of modern urban population, it is now becoming a common practice for many consumers to purchase branded meat and meat products from the refrigerated display cabinets of the super market which are mostly processed in modern meat processing plants. Therefore there is a need to undertake a systematic study to evaluate quality differences in meat obtained from different sources of processing of ready to cook chicken.

Kumar *et al*, (2012) carried out the work in Pondicherry (India) to find and compare the differences in quality of fresh chicken obtained from different sources with different processing practices viz., market/road side chicken shop (MSC), retail outlets (RSC) and semiautomatic processing plant (Scientifically Slaughtered Chicken)(SSC).Total Viable Count (TVC), Psychrophilic Count (PPC), coli form count and Yeast and Mould Count (YMC) were determined following procedures recommended by APHA (1984) presented in table 1.

**TABLE I. Effect of Processing Practices on Microbiological Quality of Chicken Meat**

| Parameters | Sources of Samples | | |
|---|---|---|---|
| Microbiological (log cfu /g) | MSC | RSC | SSC |
| Total Viable Count | 6.28±0.16[a] | 6.23±0.10[a] | 3.03±0.16 [b] |
| Psychrophilic Count | 6.71±0.07 [a] | 5.63±0.25[b] | 2.82±0.11 [c] |
| Coliform count | 5.12±0.34 [a] | 4.97±0.33[a] | 2.03±0.41 [b] |
| Yeast and Mould Count | 2.52±0.07[a] | 2.26±0.07 [b] | 1.87±0.13[b] |

Barbudhe *et al*, (2003) recorded high mesophilic (log7.24 cfu/g) and yeast and mould counts (log 6.86 cfu/g) in poultry meat sold in Goa. Similarly high microbial counts of log 7.61, 5.85 and 7.10 cfu/g for Psychrophilic Count, Coliform and YMC were reported in fresh chicken meat obtained from retail outlets of Pondicherry (Mukhopadhyay *et al*., 2004).

## VII. CONCLUSION

It is concluded that contamination of poultry and poultry products should be prevented during handling, slaughter and processing to protect the public from infections and diseases. From this review out of 2030 chicken meat samples examined in different parts of India 759 was positive for pathogens. This review revealed that the Indian chicken meat contains pathogenic bacteria like *Salmonella* spp. (33.16%), *Campylobacte*r spp. (95%), *Escherichia coli* (70.22%), *Clostridium* spp. (13.88%), *Listeria monocytogenes* (15%) and *Staphylococcus aureus* (11.25%).

## REFERENCES

[1] C. F. B. Carvalho, V. H. C. Lima, G. T. Pereira, " Determinaçao dos principais pontos de contaminaçao de frangos por *Campylobacter* durante o abate industrial", Hig. Alim, vol. 16, pp. 89-93, 2000.

[2] Javadi and S. Saeid, "Microbial profile of marketed broiler meat", Middle-East J. Sci. Res, vol. 9, pp. 652-656, 2011.

[3] K. Das and S. Biswas, "Effects of slaughtering methods on microbiological quality of chicken", J. Vet. Pub. Health, vol. 101, pp. 147-152, 2003.

[4] Maripandi and A. A. Al-Salamah, "Multiple-Antibiotic resistance and plasmid profiles of *Salmonella enteritidis* isolated from retail chicken meats, Am. J. Food Technol, vol. 5, no. 4, pp. 260-268, 2010.

[5] APHA, "Compendium of methods for the microbiological examination of foods", 2nd Edn., Amrican Public Health Association, Washington, DC., USA, 1984.

[6] M. Allos, "Association between Campylobacter infection and Guillain-Barré syndrome", J. Infect. Dis, vol. 2, pp. 125-128, 1997.

[7] Prakash, P. Perumal, K. D. Jegadeesh, P. Tamilmani, "Molecular characterization of plasmid mediated esbl resistant *Salmonella* isolated from poultry environment in Namakkal district (India)", Adv. Biotech, vol. 12, no. 2, 2012.

[8] B. Behravesh, "Salmonellosis, in Control of communicable diseases manual", 19th Edition, published by American Public Health Association, pp. 535-540, 2008.

[9] G. Naik and Y. M. Jayaraj, "*Campylobacter jejuni* diarrhea in north Karnataka", Indian Pediatrics, vol. 35, pp. 768-770, 1998.

[10] M. Nielsen, J. Engberg, M. Madsen, "Distribution of serotypes of *Campylobacter jejuni* and *C. coli* from Danish patients, poultry, cattle and swine", FEMS Immunol. Med. Microbiol, vol. 19, pp. 47-56, 1997.

[11] E. M. Sharaf and S. M. Sabra, "Microbiological loads for some types of cooked chicken meat products at Al-Taif Governorate, KSA. World", Appl. Sci. J, vol. 17, pp. 593-597, 2012.

[12] E. Rahimi and E. Tajbakhsh, "Prevalence of campylobacter species in poultry Meat in the esfahan city, Iran", Bulg. J. Vet. Med, vol. 11, pp. 257-262, 2008.

[13] Adwan, B. A. Shanab, K. Adwan, "Enterotoxigenic Staphylococcus aureus in raw milk in the North of Palestine", Turk. J. Biol, vol. 29, pp. 229-232, 2005.

[14] C. Mead, "Hygiene Problems and Control of Process Contamination. In: Processing of poultry", (Mead G. C., Ed.), Elsevier Science Publishers Ltd., pp. 183-220, 1989.

[15] G. Kornelija, K. Damir, S. Uhitil, S. Jaksic, "Determination of Campylobacter spp. in poultry slaughterhouses and poultry meat", Vet. arhiv, vol. 79, pp. 491-497, 2009.

[16] K. Mukhopadhyay, R. M. Pillai, U. K. Pal and K. V. J. Ajay, "Microbial quality of fresh chicken in retail outlets of Pondicherry", Indian J. Poult. Sci, vol. 39, pp. 291-293, 2004.

[17] H. S. Kumar, S. Otta and I. Karunasagar, "Detection of Shiga toxigenic *Escherichia coli* in fresh sea food and meat marketed in Mangalore, India by PCR", Lett. Appl. Microbiol, vol. 32, pp. 334-338, 2001.

[18] H. T. S. Kumar, U. K. Pal, V. K. Rao, C. D. Das, P. K. Mandal, "Effects of processing on the physic-chemical, Microbiological and sensory quality of fresh chicken meat", Int. J. Meat Sci, vol. 2, pp. 1-6, 2012.

[19] A. Rosenfield, G. J. Arnold, G. R. Davey, R. S. Archer and W. H. Woods, "Serotyping of *Campylobacter jejuni* from an outbreak of enteritis implicating chicken", J. Infect, vol. 11, pp. 159-165, 1985.

[20] L. Schoeni and M. P. Doyle "Reduction of *Campylobacter jejuni* colonization of chicks by cecum colonizing bacteria producing anti *C. jejuni* metabolites", Appl. Environ. Microbiol, vol. 58, pp. 664-670, 1992.

[21] J. M. Wempe, C. A. Genigeorgis, T. B. Farver, H. I. Yusufu, "Prevalence of *Campylobacter jejuni* in two California chicken processing plants", Appl. Environ. Microbiol, vol. 45, pp. 355-359, 1989.

[22] J. Oosterom, S. Notermans, H. Karman, G. B. Engels, "Origin and prevalence of *Campylobacter jejuni* in poultry processing", J. Food Prot, vol. 46, no. 4, pp. 339-344, 1983.

[23] J. R. Bandekar, A. D. Raut and B. P. Kapadnis, "Occurrence of *Campylobacter* in local poultry meat in Pune and Mumbai", Founder's Day Special Issue, 120-123, 2005.

[24] J. R. Daoud, "Microbial quality of frozen chicken meat at grocery stores in qena city", International Conference and Exhibition on Food Processing & Technology, 2012.

[25] Stanley and K. Jones, "Cattle and Sheep farms as reservoirs of *Campylobacter*", J. Appl. Microbiol, vol. 94, pp. 104-113, 2003.

[26] K. T. Arul and S. Saravanan, "Assessment of contamination in chicken meat by food- borne *Staphylococcus aureus*", Intl. J. Res. Pure and Appl. Microbiol, vol. 1, pp. 59-60, 2011.

[27] De Zutter, "Crates inoculate broilers with *Salmonella* and *Campylobacter*", World Poult, vol. 16, pp. 19, 2000.

[28] L. K. Pickering, "American Academy of Pediatrics, *Salmonella* infections," Red Book, Report of the Committee on Infectious Diseases, pp. 581-584, 2006.

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

[30] E. Berrang, R. J. Buhr, J. A. Cason, "*Campylobacter* recovery from external and internal organs of commercial broiler carcass prior to scalding", Poult. Sci, vol. 79, pp. 286-290, 2000.

[31] M. Simmons, D. I. Fletcher, J. A. Cason and M. E. Berrang, "Recovery of Salmonella from retail broiler by a whole-carcass enrichment procedure", J. Food Prot, vol. 66, pp. 446-450, 2003.

[32] S. Rabie, N. O. Khalifa, M. E. I. Radwan, J. S. A. Afify, "Epidemiological and Molecular Studies of Salmonella Isolates from Chicken, Chicken Meat and Human in Toukh, Egypt", Global Veterinaria, vol. 8, pp. 128-132, 2012.

[33] R. Franchin, K. E. Aidoo, C. R. V. Batista, "Sources of poultry meat contamination with thermophilic *Campylobacter* before slaughter", Braz. J. Microbiol, vol. 36, pp. 157-162, 2005.

[34] Ramya, T. Madhavarao, L. Rao, "Study on the incidence of *Salmonella enteritidis* in poultry and meat samples by cultural and PCR methods", Vet. World, vol. 5, pp. 541-545, 2012.

[35] P. Saikia and S. R. Joshi, "Retail market poultry meats of North-East India – A microbiological survey for pathogenic contaminants", Research. J. Microbiol, vol. 5, pp. 36-43, 2010.

[36] Sengupta, R. Das, S. Ganguly, S. K. Mukhopadhayay, "Survey on microbial quality of chicken meat in Kolkata, India", Int. J. Res. in Pure and Appl. Microbiol, vol. 1, no. 3, pp. 32-33, 2011.

[37] B. Barbudhe, B. K. Swain, E. B. Chakurkar and R. N. S. Sundaram, "Microbial quality of poultry meat with special reference to *Listeria monocytogenes*", Indian J. Poult. Sci, vol. 38**,** pp. 305-307, 2003.

[38] K. Varma, N. Jagadeesh, H. K. Mukhopadhyay and N. Dorairajan, "Incidence of *Campylobacter jejuni* in poultry and their Carcasses", J. Food Sci. Technol, vol. 37, pp. 639-641, 2000.

[39] S. N. Rindhe, P. N. Zanjad, V. K. Doifode, A. Siddique, M. S. Mendhe, Assessment of microbial contamination of chicken products sold in Parbhani city", Vet. World, vol. 1, pp. 208-210, 2008.

[40] S. W. Ruban, M. Thyageeswaran, R. Sharadha, "Isolation and identification of *Salmonella* spp from retail chicken meat by polymerase chain reaction", Intl. J. Micro. Res, vol. 1, pp. 106-109, 2010.

[41] S. W. Ruban, N. K. Prabhu , G. S. Naveen Kumar, "Prevalence of food borne pathogens in market samples of chicken meat in Bangalore", Int. Food Res. J, vol. 19, pp. 1763-1765, 2012.

[42] M. Vaidya, A. M. Paturkar, V. S. Waskar, R. J. Zende, D. B. Rawool, "Detection of indicator organisms on poultry carcass sites in an organized slaughterhouse", J. muscle foods, vol. 16, pp. 289–297, 2005.