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Effect of Proceesing Conditions on Microbiological Quality of Market Poultry Meats in Bangalore, India

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Abstract: The aim of the present study was to evaluate the bacterial quality of chicken meat produced under different processing conditions and marketed in Bangalore, Karnataka, India. Poultry samples (n = 280) from both breast and thigh muscles were collected randomly from traditional shops, supermarkets and processing units. The samples were analyzed for the presence and counts of various bacteria. Results indicated that total plate counts, fecal coliforms and staphylococcus counts were particularly high in all the samples obtained from outlets with minimal facilities and that increase in sophistication and hygiene brought about a significant reduction in microbial counts. Irrespective of the processing condition thigh meat had higher microbial load compared to breast meat. The highest bacterial counts in poultry meat samples were recorded with the traditional slaughtering process ($p<0.05$). Results on the prevalence of Salmonella revealed higher prevalence of Salmonella in the range of 25-65% with higher prevalence in traditional meat shops with minimal facilities and poor hygiene. These high levels of microbial contamination and occurrence of pathogenic bacteria reflect the poor hygienic quality of poultry meat under these conditions.

Key words: Chicken meat, microbiology, processing, market analysis, contamination, hygienic

INTRODUCTION

Microbial food safety and food-borne infections are important public health concern worldwide. There have been a number of food-borne illnesses resulting from the ingestion of contaminated foods such as chicken meats. Most of the pathogens that play a role in foodborne diseases have a zoonotic origin (Busani *et al*., 2006). Raw meat remains an important and probably the major source of human food borne infection with pathogenic bacteria. In spite of decades of effort it has been difficult to obtain food animals free of pathogenic bacteria.

Meat and poultry carcasses and their parts are frequently contaminated with pathogens which reach the carcasses from the intestinal tract or from faecal material on feet and feathers. Cross-contamination is a particular problem and several recommendations have been published to control pathogens throughout, the chain from hatcheries to the preparation in the home (Dincer and Baysa, 2004).

In recent years, food borne infections and intoxications have assumed significance as a health hazard. Epidemiological reports suggest that poultry meat is still the primary cause of human food poisoning (Mulder, 1999). Poultry meat is more popular in the consumer market because of advantages such as easy digestibility and acceptance by the majority of people (Yashoda *et al*., 2001). However, the presence of pathogenic and spoilage microorganisms in poultry meat and its byproducts remains a significant concern for suppliers, consumers and public health officials worldwide.

Birds in general are received at the processing plant with feces and dust picked up from litter and from other birds during transit. Consequently, the microorganisms including pathogens present on the surface increase in number during slaughtering, processing and handling. Several studies have indicated that consumption of poultry meat has been associated with incidence of outbreaks of food borne infections including Salmonellosis (Prakash *et al*., 2005), Campylobacteriosis (Berrang and Dickens, 2000) and Listeriosis (Lunden *et al*., 2003). Reduction of initial bacterial load in meat is of prime importance in an attempt to improve the shelf-life of the product (Lillard *et al*., 1984).

The absence of centralized slaughter facility and the small volume of retail business, prohibitive capital costs on mechanized infrastructure and recurring expenditure have been the hurdles for hygienic production of chicken meat.

Hence the present study was undertaken to bring to lime light the ground realities about the microbial profile of poultry meat slaughtered under different processing conditions from the wet market in Bangalore, Karnataka.

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MATERIALS AND METHODS

Sample collection: Samples were collected between July 2008 and June 2009. Chicken carcasses for the present study were sourced from different processing facilities and local chicken vendors in and around Bangalore. They were designated as NS-Non-Sophisticated outlets where a minimal facility was available and the same area was utilized for slaughter, cleaning and evisceration. Water from bore wells is used in these outlets for cleaning; MF-Moderated facility outlets where separate units are available for scalding, defeathering, evisceration and portioning of the carcass. They have their own water facility. SOF-Sophisticated outlets where tiled floors and walls are available, all modern facilities for slaughter of birds is available and they have water purifying systems for better quality of water used for cleaning and PP-Poultry Processing Plants where birds are slaughtered on rail and strict hygiene measures are in place. RO plant supplies water for all the operations.

Sample processing: A total of 280 (35 samples from each of the brand from both breast and thigh region) samples were drawn and were subjected to microbial analysis for the enumeration as per the methods outlined by ICMSF (1983). The following viable cell counts were performed by the spread-plate method after 10 fold serial dilutions in 0.1% (W/V) peptone solution: aerobic total counts on Plate count agar, fecal coliform counts on violet red bile lactose agar, Staphylococcus count on Baird-Parker agar and streptococcus count on KF Streptococcal agar supplied by HIMEDIA. The plates were incubated at 37°C for 18-24 h before counting. Microbial counts were then transformed and represented as log 10 cfu g^{-1} of the sample.

In addition to the above-mentioned counts, 25 g samples were analyzed for the presence or absence of *Salmonella* sp. For selective isolation of Salmonella enriched (in buffered peptone water) sample was streaked into Bismuth Sulphite Agar (BSA) and subcultured into Xylose Lysine Deoxycholate (XLD) agar and Salmonella-Shigella (SS) agar plates. The inoculated plates were incubated for 48 h at 37°C. The bacterial isolates obtained from the samples were purified by re-streaking them on the media used for their isolation and were characterized by different biochemical tests.

RESULTS AND DISCUSSION

The Mean±SE values of Total Viable Count (TVC), Staphylococcus, Streptococcus and fecal coliforms from chicken meat procured from different processing conditions viz., NS, MF, SOF and PP are shows in Table 1-4.

Table 1: Mean±SE values of Total Viable Count (TVC) of chicken meat obtained from different processing conditions in bangalore city

Processing condition	Breast	Thigh	Overall mean
NS	5.248±0.072^{a}	5.338±0.071^{a}	5.248±0.072^{A}
MF	4.337±0.093^{b}	4.414±0.094^{b}	4.376±0.093^{B}
SOF	4.093±0.094^{bc}	4.110±0.110^{c}	4.102±0.102^{C}
PP	3.842±0.102^{cd}	3.903±0.105^{c}	3.873±0.104^{D}
Overall mean	4.380±0.090^{NS}	4.440±0.095^{NS}	-

Table 2: Mean±SE values of Staphylococcus count of chicken meat obtained from different processing conditions in Bangalore city

Processing condition	Breast	Thigh	Overall mean
NS	4.116±0.101^{a}	4.362±0.065^{a}	4.239±0.083^{A}
MF	3.682±0.071^{b}	3.923±0.118^{b}	3.803±0.095^{B}
SOF	3.662±0.071^{b}	3.888±0.095^{b}	3.775±0.083^{C}
PP	3.525±0.083^{b}	3.719±0.095^{b}	3.622±0.089^{D}
Overall mean	3.746±0.082^{X}	3.973±0.093^{Y}	-

Table 3: Mean±SE values of Streptococcus count of chicken meat obtained from different processing conditions in Bangalore city

Processing condition	Breast	Thigh	Overall mean
NS	4.075±0.066^{a}	4.116±0.068^{a}	4.096±0.067^{A}
MF	3.767±0.112^{b}	3.844±0.101^{ab}	3.806±0.107^{B}
SOF	3.714±0.091^{b}	3.830±0.102^{ab}	3.772±0.097^{C}
PP	3.650±0.088^{b}	3.657±0.089^{b}	3.654±0.088^{D}
Overall mean	3.802±0.089^{NS}	3.862±0.090^{NS}	-

Table 4: Mean±SE values of fecal coliforms in chicken meat obtained from different processing conditions in Bangalore city

Processing condition	Breast	Thigh	Overall mean
NS	1.675±0.153^{a}	1.824±0.152^{a}	1.750±0.15^{3A}
MF	1.391±0.161^{ab}	1.412±0.143^{ab}	1.402±0.152^{B}
SOF	1.292±0.169^{ab}	1.349±0.158^{ab}	1.321±0.164^{C}
PP	1.007±0.161^{b}	1.107±0.152^{b}	1.057±0.157^{D}
Overall mean	1.341±0.161^{NS}	1.423±0.151^{NS}	-

Means bearing different superscripts (a-d) and overall means bearing different superscripts (A-D) within columns differ significantly in Table 1-4. NS-Non-Sophisticated, MF-Moderate Facility, SOF- Sophisticated, PP-Processing Plants

Total Viable Count (TVC): The analysis of variance revealed a highly significant difference ($p<0.01$) for TVC of chicken meat obtained from different processing conditions whereas no significant difference ($p>0.05$) existed between breast and thigh regions. Higher counts were observed in meat obtained from NS outlets irrespective of the sample collection site and chicken meat obtained from poultry processing unit recorded the lowest value.

Staphylococcus count: Among the processing facilities, chicken meat obtained from PP recorded lowest count overall followed by SOF, MF and NS. The analysis of variance revealed a highly significant difference ($p<0.01$) for staphylococcus count from different processing conditions as well as a highly significant difference among the meat obtained from thigh and breast region. Thigh samples recorded higher counts compared to the breast muscle.

Streptococcus count: The analysis of variance revealed a highly significant difference ($p<0.01$) for streptococcus

count with respect to meat obtained from different processing conditions with the counts decreasing with increase in the facilities and handling of the carcasses. However, no significant difference ($p>0.05$) could be observed between thigh and the breast samples with respect to Streptococcal counts.

Fecal coliform: The analysis of variance revealed a highly significant difference ($p<0.01$) for fecal coliform of meat obtained from different processing conditions whereas no significant ($p>0.05$) difference was observed between the samples obtained from breast and thigh regions. Higher values were observed in thigh meat compared to breast meat. Meat obtained from PP units recorded lowest value for both thigh and breast meat samples followed by brands SOF, MF and NS but no significant difference was found between MF, SOF and PP both in breast as well as in thigh meat.

Prevalence of salmonella: The percent prevalence of *Salmonella* sp. Table 5 in chicken breast muscle from NS, MF, SOF and PP were 65.71, 48.57, 48.57 and 22.86, respectively and that of thigh muscle were 71.43, 51.43, 48.57 and 25.71, respectively. The results of the study revealed that contamination of meat with salmonella decreased with increase in sophistication of slaughter facility and that thigh muscles were highly prone for contamination compared to the breast muscle irrespective of the processing condition. Wide ranges of microorganisms were found to be associated with the meat samples. The result of the present study indicated the presence of high microbial load of TVC, fecal coliforms, Staphylococcus and Streptococcus isolated from chicken meat from different processing conditions. Total plate counts are a widely accepted measure of the general degree of microbial contamination and the hygienic conditions of processing plants (Department of Agriculture, Animal Health and Product, 2004).

The average TVC obtained in the present study was within the range of $\log_{10}$ 3-6 as reported by Murugkar *et al.* (1993) in whole dressed chicken and comparatively lower than the values reported by Pattnaik *et al.* (1997). Meat from thigh region carried higher microbial load compared to that from breast region. These findings were in agreement with Alvarez-Astorga *et al.* (2002) who recorded total bacteria count of 5.79 $\log_{10}$ cfu g^{-1} in chicken drumsticks compared to 5.25 $\log_{10}$ cfu g^{-1} from breast. However, in the study, the mean APC in chicken meat collected in both NS and PP was below the value reported by Amara *et al.*, 1994 (6.56-7.15 $\log_{10}$ cfu g^{-1}). The average count of Staphylococcus in poultry meat was below the number (5.36 $\log_{10}$ cfu g^{-1}) reported by Amara *et al.* (1994). The reason for the high prevalence of Staphylococcus could

Table 5: Prevalence of *Salmonella* sp. in chicken meat obtained from different processing conditions in Bangalore city

	Breast			Thigh		
Processing condition	No. of samples evaluated	No. of positive samples	Prevalence (%)	No. of samples evaluated	No. of positive samples	Prevalence (%)
NS	35	23	65.71	35	25	71.43
MF	35	17	48.57	35	18	51.43
SOF	35	17	48.57	35	17	48.57
PP	35	8	22.86	35	9	25.71

have been the poor personal hygiene of the researchers and the technique used for opening the abdomen. With the technique of hand evisceration predominantly practiced in the traditional shops under study and with infrequent hand washing, a high prevalence of bacteria related to human contact was expected in these samples. Such a high level of contamination with staphylococcus has been associated with increased risk of staphylococcal food poisoning.

Presence of streptococcus in meat and meat product is an indication of fecal contamination and poor hygiene during processing (Mead, 1989). The higher counts observed in meat obtained from the NS outlets may be due to the fact that these carcasses were handled unhygenically whereas those obtained from the processing units were processed under strict hygiene. Fecal coliforms are used as an indicator for evaluation of hygiene during processing. The results were in agreement with Nair *et al.* (1990) who reported coliforms in the range of $\log_{10}$ 2-4 cfu gm^{-1} of meat. The lower counts of coliforms with increase in the level of sophistication could be due to the fact that carcasses from processing facilities are maintained under strict hygiene and cold chain till they reached the consumer (Abu-Ruwaida *et al.*, 1994).

The higher rate of incidence of salmonella could be attributed to lack of proper cold chains, inadequate power supply and low levels of hygiene in retail outlets. The *Salmonella* sp. of the present study has been confirmed by PCR (Ruban *et al.*, 2010). The results were in concurrence with those reported by Padungtod and Kaneene (2006) in chicken carcasses in (57%) and Bao (2005) (42.63%). Similar prevalence was reported by Bajaj in India (69%). Contrary to the findings of the study, lower incidence of salmonella in chicken carcasses have been reported by Bhattacharya *et al.* (2004) (5%), Maharjan (14.5%) and Vaidya *et al.* (2005) (negligible).

CONCLUSION

Chicken meat obtained from retail outlet with minimal facilities (especially those obtained from NS and MF) showed high levels of microbiological contamination and high incidence rates with pathogenic microorganisms compared to those obtained from retail outlets with better facilities and processing units with better hygiene. This

fact makes chicken meat a concern for suppliers, consumers and public health officials worldwide. For this reason efforts should be made so that minimum hygienic measures are in place for raw meat and byproducts production and handling processes and that the consumer is informed of the basic instructions regarding storage temperature, cooking and prevention of contamination and cross contamination. Further care has to be taken for prevention of health hazards of the consumers by adopting proper sanitation, storage and retail practices.

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