Effect of Chlorinated Water Spray on Microbiological Quality and Shelf Life of Mutton at Refrigerated Storage

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ABSTRACT
Spray washing of mutton carcasses with 1, 25 and 50 ppm chlorinated water at 1 and 3 kg/cm² pressures to improve the microbiological quality and shelf life of mutton stored at refrigeration storage was investigated. Chlorinated water spray of 50 ppm concentration at 3 kg/cm² pressure showed highest reduction in counts than other chlorine-pressure combinations. The shelf life of control mutton samples was 4 days and increment in shelf life observed by 2 days and 3 days for samples spray washed with 1 and 25 ppm chlorinated water, respectively, irrespective of pressure, while at 50 ppm concentration at 1 and 3 kg/cm² pressures the shelf life was enhanced by 4 and 5 days, respectively. The spoilage microbial flora of mutton samples was dominated by mesophilic as well as psychrophilic organisms.

Keywords: Carcass washing, chlorinated water, microbial quality, mutton.

Introduction
Rapid industrialization and modernization has resulted into more demand for protein-rich food from the consumers especially in the urban areas. Meat and meat products have become popular in working class of society mainly due to its nutritional richness, hunger quenching ability and ease in preparation. However, hygienic practices adopted in many of the slaughterhouses in India are far from satisfactory and thus, results in production of meat with poor microbiological quality. Tropical climate and traditional meat practices further add to the contamination making meat more vulnerable to the spoilage. Therefore, the major emphasis of meat research in India should be to reduce the microbial load, to increase the shelf life and to assure the safety of the meat for the importing countries as well as for the indigenous consumers.

Considering the present environment under which the animals are slaughtered and processed, an application of carcass sanitizers was thought as a practical approach in production of safe and good quality meat. The present work was carried out to study the prevalent microflora of mutton, reduction in pathogenic and spoilage microorganisms on application of chlorinated water sprays at different pressures and to suggest a suitable technique for carcass washing for field level to increase the shelf life of mutton.

Materials and Methods
Carcass washing
Seven average sized freshly slaughtered sheep carcasses were hanged on overhead rail system in modern meat processing plant located in Vashi, Navi Mumbai. One carcass was kept untreated (control) and remaining carcasses were washed with 1 ppm, 25 ppm and 50 ppm chlorinated water using 1 and 3 kg/cm² pressures, respectively. Six carcasses after spray washing were allowed to drain, hygienically deboned and...
200 gm each of deboned meat sample was aseptically packed in different poly packs. In similar manner, meat samples from untreated carcass (control) were also collected and brought to the laboratory on ice. Meat samples from each treatment along with the untreated control were stored at refrigeration (5-7 °C) temperature till complete spoilage. The study was repeated on six different occasions.

Analysis of samples

Sensory and microbiological analysis of mutton samples was carried out immediately after washing and subsequently after 2, 4, 6, 7, 8, 9 and 10 days of storage. The sensory characters viz., colour was scored according to six point standardized scale and the odour was scored as per the four point standardized scale prescribed by Woolthus and Smulders (1985) and Acuff et al. (1987) by a four member sensory panel.

For microbiological analysis, the meat samples were subjected to total viable count (TVC) and differential counts of pathogenic and spoilage organisms adopting standard procedure (Speck, 1984) and counts expressed as log_{10}CFU/g. For isolation of pathogenic and spoilage organisms, meat homogenate samples were inoculated in appropriate medium and incubated at 37°C/44°C for 24 h depending upon the organism. Bacteria were isolated and identified on the basis of cultural, staining, morphological characteristics and biochemical as well as sugar fermentation reactions as per standard procedures prescribed by Cowan and Steel (1970) and Sneath et al. (1986). For Salmonella spp., samples were pre-enriched in buffered peptone water, enriched in Rappaport Vassiliadis broth and inoculated on pre-formed semisolid plates of Rappaport Vassiliadis medium (Vassiliadis et al., 1981).

Results and Discussion

The initial mean total viable count of control mutton samples was $5.68 \pm 0.09$ log CFU/g which was reduced to $5.63 \pm 0.13$ and $5.32 \pm 0.16$; $5.28 \pm 0.09$ and $5.20 \pm 0.13$; and $5.15 \pm 0.06$ and $5.08 \pm 0.07$ log CFU/g after spraying with 1, 25 and 50 ppm chlorinated water at 1 and 3 kg/cm² pressures, respectively with acceptable colour and odour (Fig. 1). Similar findings were also reported by Vijaya Rao et al. (1983) and Fliss et al. (1991) for fresh mutton. Animals, although have a normal or natural microflora that is established very early in life, the counts invariably depends upon sanitary practices in the abattoir, the butchers and their evisceration techniques, equipments, and the cross contamination occurring during processing (Silliker et al., 1988).

As shown in Fig. 1, the control samples indicated comparatively higher counts, which were slightly reduced after spray washing of carcasses with 1 ppm chlorinated water followed by 25 ppm chlorinated water which were further reduced with 50 ppm chlorinated water spray washing. Lillard (1980) also stated that total aerobic count of $4.60 \log_{10}$/g of untreated carcasses reduced to $3.55$ and $3.83 \log_{10}$/g after treating carcasses with 25 and 34 ppm chlorinated water. Kuttinarayan and Soman (1985) observed 24.8, 29.9 and 77.9 per cent reduction of aerobic bacterial load after treatment with 10, 20 and 50 ppm chlorine solution on beef carcasses.

Carcass washing at 1 and 3 kg/cm² pressures was also found to be very effective in reducing microbial counts. Initial microbial flora of mutton samples constituted Micrococcus spp., Clostridium spp., Proteus spp., Pseudomonas aeruginosa and Staphylococcus epidermidis in the order of their predominance and similar organisms were also found in the samples spray washed with chlorinated water, but with reduced counts. Cabedo et al. (1996) observed that spray washing reduced not only pathogenic bacteria on carcasses but also all saprophytes and non-pathogenic natural flora present on carcasses.

Incipient changes of spoilage such as slight off odour and slight discolouration were observed after 4 days in control samples stored under refrigeration, while in chlorinated water treated samples similar changes were noted after 6 days, 7 days and 8 and 9 days of storage for 1
ppm, 25 ppm and 50 ppm chlorinated water spray washed samples at 1 and 3 kg/cm$^2$ pressures respectively. A corresponding increase in total viable counts was also observed with evidence of spoilage changes. Mutton samples showed complete spoilage with extreme off odour and greenish discoloration on subsequent day with corresponding bacterial counts 7.84 ± 0.13 for control, 7.85 ± 0.08 and 7.36 ± 0.11 for 1 ppm, 7.41 ± 0.15 and 7.30 ± 0.06 for 25 ppm, and 7.51 ± 0.06 and 7.23 ± 0.13 log CFU/g for 50 ppm chlorinated water at 1 and 3 kg/cm$^2$ pressures, respectively (Fig. 1).

Sensory analysis of the treated and untreated samples depicted in Fig. 2 and 3 revealed that the average colour score of samples on 0th day was 1.45 ± 0.27, 1.51 ± 0.11, 1.53 ± 0.07, 1.61 ± 0.09, 1.64 ± 0.11, 1.66 ± 0.07 and 1.67 ± 0.07 for control and mutton samples spray washed with 1, 25 and 50 ppm chlorinated water at 1 and 3 kg/cm$^2$ pressures, respectively. When incipient spoilage changes were found to be initiated, colour scores were 4.59 ± 0.11, 4.08 ± 0.17, 4.11 ± 0.13, 4.15 ± 0.14, 4.96 ± 0.15 and 3.99 ± 0.16 which reached to 5.48 ± 0.13, 5.64 ± 0.11, 5.71 ± 0.17, 5.82 ± 0.16, 5.84 ± 0.16, 5.38 ± 0.08 and 5.82 ± 0.15 for control and the samples washed with 1, 25 and 50 ppm chlorinated water at 1 and 3 kg/cm$^2$ pressures, respectively. Similarly, an odour of mutton samples was acceptable initially which became unacceptable at the time of frank spoilage with mean scores 3.68 ± 0.08, 3.79 ± 0.14, 3.73 ± 0.16, 3.74 ± 0.17, 3.68 ± 0.33, 3.76 ± 0.14 and 3.69 ± 0.16 for control and the samples washed with 1, 25 and 50 ppm chlorinated water at 1 and 3 kg/cm$^2$ pressures, respectively.

Fresh meats have enough glucose and other simple carbohydrates to support the growth of bacteria up to 8 log organisms/cm$^2$ (Gill, 1976). Once simple carbohydrates have been exhausted, bacteria utilize the free amino acids and related simple nitrogenous compounds as a source of energy resulting in the spoilage of meat with complete discoloration and off odour (Gill and Newton,
The proteolysis is caused by bacteria at the end of logarithmic phase which results in breakdown of proteins to volatile compounds which give obnoxious odour to the meat (Gill and Penny, 1977). Freeman et al. (1976) attributed the spoilage of meat mainly to microbial byproducts and not to autolysis products from the tissue.

The predominant flora isolated at the time of spoilage from control samples constituted *P. aeruginosa*, *Micrococcus* spp., *Alkaligenes* spp. and *Clostridium* spp. whereas for 1 ppm chlorinated water washed samples, it was dominated by *P. aeruginosa*, *Micrococcus* spp., *Alkaligenes* spp. and *S. epidermidis* at both pressures. *P. aeruginosa*, *Micrococcus* spp., *Alkaligenes* spp. and *Clostridium* spp. predominated in samples washed with 25 ppm chlorinated water at both pressures. Chlorinated water (50 ppm) spray washed samples after spoilage had *P. aeruginosa*, *Enterobacter* spp., *Alkaligenes* spp. and *Clostridium* spp. in samples treated at 1 kg/cm² pressure and *P. aeruginosa*, *Alkaligenes* spp., *Clostridium* spp. and *Micrococcus* spp. in 3 kg/cm² pressure washed samples as predominant spoilage flora. *Salmonella* spp. was not isolated from the initial or spoiled, control as well as spray washed mutton samples in the study.

Shelf life of control sample was 4 days and in treated samples it increased by 2 and 3 days in 1 ppm and 25 ppm chlorinated water washed samples irrespective of pressure, while in 50 ppm treated samples it was enhanced by 4 and 5 days with 1 and 3 kg/cm² pressures, respectively.

Thus, it appeared that chlorinated water spraying increased shelf life very effectively and the effect was consistent with increased concentration of chlorine and pressure. Spray washing of carcasses with 25-50 ppm chlorine solution may be recommended for reduction of bacterial load and improvement of keeping quality of mutton, without any adverse effects on acceptability of meat. However, further studies with greater sample size are required.

References


