STUDIES ON THE PHYSICO-CHEMICAL AND MICROBIOLOGICAL QUALITY OF IMMERSION CHILLED BROILER CUT UP PARTS TREATED WITH CERTAIN ADDITIVES

R. Sangwan and N. Khanna
Department of Animal Products Technology, CCS Haryana Agricultural University, Hisar - 125 004, India

ABSTRACT

A study was conducted to improve the quality of broiler leg and breast cuts during immersion chilling. Treatment of cuts with tetrasodium pyrophosphate and sodium chloride ($T_1$) in chill water significantly ($P<0.05$) improved WHC and shear force value when compared to the cuts treated with lactic acid and potassium sorbate ($T_2$) and control group. Moisture per cent was significantly higher ($P<0.05$) in $T_1$ group in both the cuts when compared to $T_2$ and control group. The ash per cent was higher in $T_1$ group than that of control group. The protein and fat per cent did not vary among the samples of different groups. Both $T_1$ and $T_2$ groups showed improved microbiological status and extended the shelf life by 5 and 2 days, respectively when held at $4 \pm 1^\circ C$ in comparison to the control group.

INTRODUCTION

It is a well known fact that contamination of meat starts from the abattoir during the process of slaughtering and its subsequent handling which in turn is governed by the existing hygienic condition over there. Chilling and subsequent freezing have long been the main methods for inhibiting the growth of bacteria and delaying the spoilage of fresh foods (Pandey and Sisodia, 1982). During processing, immersion chilling is an important step of meat processing technique. Brant (1973) reported that during immersion chilling bacteriological load is reduced. Preservation of poultry carcasses by use of edible acids has been demonstrated by several workers. Organic acidulants and potassium sorbate have been extensively used as a dip or spray for extending the storage life of poultry at low temperature (Patterson et al., 1984). Polyphosphates have the advantage of reducing cooking loss and microbial population, delaying development of oxidative rancidity and improving the water holding capacity (Kutty, 1981). However, a perusal of literature on the topic did not reveal much information on the effect of addition of chemical additives in chilling tank on the physico-chemical properties and microbiological quality of cut up parts of poultry at the end of processing. Since, these properties influence the quality of meat for the development of further processed products, it was considered with exploring the effect of immersion chilling with selected additives on certain quality characteristics of broiler meat cuts.

MATERIAL AND METHODS

Thirty broilers of same age group maintained under similar conditions of feeding and management schedule were slaughtered as per the standard procedure (Mountney, 1976). Eviscerated carcasses were washed with tap water, drained and then divided into three groups often each. Leg and breast cuts were made from each carcass as per the procedure outlined by Panda (1982). Each group contained both leg and breast cuts. The control group ($C$) was immersed in the plain ice water (1:1) whereas, those of $T_1$ and $T_2$ groups were dipped in the ice water containing tetrasodium pyrophosphate (5%) + sodium chloride (2.5%) and lactic acid (2%) + potassium sorbate (2%), respectively. The immersion chilling of broiler cut up parts was done for 4 hours at a...
temperature of 4±0.5°C, followed by draining the samples for 10 minutes. Meat cut samples after chilling were analyzed for proximate chemical composition as per the methods described by AOAC (1995). Procedure described by Bouton et al. (1971) was used to measure the pH and that by Prost (1954) for water holding capacity. The shear press value of meat samples was determined by using Warner Bratzler shear press. Meat samples were cooked in water bath at 75±1°C for 1 hour (Bouton et al., 1977). After cooling, the meat samples were cut to a size of one cm with the help of corer. The shear force was applied perpendicular to fibre direction and deflection in the needle was noted as shear force value in kg/cm². Microbiological quality of leg and breast cut samples was assessed for standard plate count, coliforms count and faecal enterococci count by using standard methods described by APHA (1993) and USDA (1974). To determine the shelf life, at the end of immersion chilling, both the leg and breast cuts were packaged in polyethylene bags at 4±0.5°C and stored until spoilage occurs. The microbial load was estimated at two days interval upto 6th day of storage and thereafter daily upto 12 days.

The data were subjected to statistical analysis using randomized block design and the differences between treatment means were calculated by Duncan’s multiple range test (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

The results pertaining to pH, water holding capacity (WHC) and shear force value of broiler cut up parts have been presented in Table 1. It is found that the pH of leg and breast cuts was significantly different (P<0.05) in all the groups. T₁ group had significantly higher pH followed by control and T₂ groups. This higher pH in T₁ might be due to effect of polyphosphates. Other workers also found rise in meat pH when polyphosphate was used (Pandey and Mahapatra, 1982; Shults and Wierbicki, 1972). The trend with regard to water holding capacity was also similar. Shults and Wierbicki (1973) observed that higher level of phosphate concentration had additional effect on the swelling or WHC, especially in the presence of sodium chloride. Mendiratta and Panda (1992), Pandey et al. (1992), Panda and Khanna (1994) reported that at lower pH, the water holding capacity proportionately decreased.

Shear force values of leg and breast muscles of T₁ group were significantly (P<0.05) lower than the control as well as the T₂ group. Perhaps this was due to increase in pH and WHC in the above group of samples. Klose et al. (1963) and May et al. (1963) found that polyphosphate treated samples were more tender than control samples when chilled in polyphosphate and sodium chloride solution. Peterson (1977) also indicated that the tenderizing effect of polyphosphate was due to slowing down of the rate of the postmortem pH drop. However, the shear force values in case of T₂ batch were non-significantly higher than the control group. This might be due to the effect of lactic acid, which lowered the pH and WHC of the meat. Mountnery and O’Malley (1965) also stated that the surface of muscle became hard, leathery and glistening as a result of protein denaturation when subjected to acid treatment. Marroitt and Argonosa (1989) have also proclaimed that lactic acid treatment while restructuring beef resulted in increased collagen stability, total collagen content and the shear force value.

In general the mean values of pH and WHC were significantly (P<0.05) higher in leg cut as compared to breast cut but the reverse was the trend with respect to shear force. The results regarding pH for leg and breast cut were of the similar trend as reported by Pandey et al. (1992); WHC of cuts were consistent with Panda and Khanna (1994) and shear force
Table 1. Effect of different additives on the physico-chemical properties of meat cuts during immersion chilling

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cut</th>
<th>pH</th>
<th>WHC %</th>
<th>Shear force value (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Leg</td>
<td>6.55±0.05</td>
<td>71.13±0.18</td>
<td>1.25±0.06</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>6.20±0.00</td>
<td>68.72±0.61</td>
<td>2.57±0.08</td>
</tr>
<tr>
<td>T₁</td>
<td>Leg</td>
<td>6.88±0.04</td>
<td>76.77±0.45</td>
<td>0.47±0.02</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>6.53±0.03</td>
<td>73.85±0.68</td>
<td>1.33±0.02</td>
</tr>
<tr>
<td>T₂</td>
<td>Leg</td>
<td>5.42±0.04</td>
<td>67.66±0.45</td>
<td>1.40±0.06</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>5.27±0.07</td>
<td>63.07±0.40</td>
<td>2.73±0.02</td>
</tr>
<tr>
<td>CD 5%</td>
<td></td>
<td>0.15</td>
<td>1.58</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Means±SE in column with different superscripts are significantly (P<0.05) different; C = Control; T₁ = 5% tetrasodium pyrophosphate + 2.5% sodium chloride; T₂ = 2% lactic acid + 2% potassium sorbate.

Table 2. Effect of different additives on proximate composition (%) of meat cuts during chilling

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cut</th>
<th>Moisture (%)</th>
<th>Protein %</th>
<th>Fat(%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Leg</td>
<td>70.69±0.66</td>
<td>18.60±0.44</td>
<td>8.19±0.31</td>
<td>0.94±0.02</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>71.26±0.62</td>
<td>21.19±0.29</td>
<td>4.05±0.11</td>
<td>1.11±0.16</td>
</tr>
<tr>
<td>T₁</td>
<td>Leg</td>
<td>73.66±1.02</td>
<td>17.92±0.08</td>
<td>7.92±0.08</td>
<td>1.74±0.05</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>74.60±0.98</td>
<td>20.97±0.14</td>
<td>3.89±0.15</td>
<td>1.96±0.13</td>
</tr>
<tr>
<td>T₂</td>
<td>Leg</td>
<td>69.20±0.95</td>
<td>18.08±0.20</td>
<td>7.98±0.18</td>
<td>1.55±0.07</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>70.82±0.73</td>
<td>20.95±0.28</td>
<td>3.92±0.08</td>
<td>1.78±0.08</td>
</tr>
<tr>
<td>CD 5%</td>
<td></td>
<td>2.66</td>
<td>0.94</td>
<td>0.54</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Means±SE in column with different superscripts are significantly (P<0.05) different; C = Control; T₁ = 5% tetrasodium pyrophosphate + 2.5% sodium chloride; T₂ = 2% lactic acid + 2% potassium sorbate.

Values for cuts with Evans et al. (1976).

Compositional changes with respect to moisture, protein, fat and ash due to different treatments have been shown in Table 2. The findings depicted that the per cent moisture both in leg and breast cuts was found to be significantly (P<0.05) higher in T₁ when compared to the control as well as T₂ groups. It has been pointed out by Lyon and Magee (1984) that there was significant increase in the moisture content of the hen meat samples when they were soaked in the solutions of sodium chloride, or polyphosphate or both due to the synergistic effect of salt and polyphosphate, which ultimately improved the hydration. Similar findings were also observed by Klose et al. (1978) and Lyon (1983). No significant difference in moisture content was observed between the T₂ and control group in both the cuts. It is clear from the results that there was no significant difference in the protein and fat percentage of leg and breast muscles between control and treated groups. With respect to ash content, no significant difference was found between the T₁ and T₂ in both the cuts but the treatments showed significantly higher (P<0.05) value than the control ones. Perhaps this was due to the salt and phosphate content in the treated samples as reported by Lyon (1983) and Lyon and Magee (1984).

Between control leg and breast cuts there was a significant variation (P<0.05) for protein and fat. Fat content was more in leg cuts while moisture, protein and ash content was higher in breast cuts. This was inherent difference among individual cuts. Khanna (1995) observed that spent hen breast meat had significantly more moisture, protein and ash content while fat content was more in leg cut.
Table 3. Effect of different additives on microbial load (log₁₀ CFU/g) of meat cuts

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cut</th>
<th>SPC</th>
<th>Coliform</th>
<th>F. enterococci</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Leg</td>
<td>4.59±0.61</td>
<td>3.75±0.54</td>
<td>3.79±0.51</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>4.55±0.54</td>
<td>3.73±0.26</td>
<td>3.78±0.28</td>
</tr>
<tr>
<td>T₁</td>
<td>Leg</td>
<td>3.90±0.61</td>
<td>2.90±0.41</td>
<td>2.84±0.26</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>3.83±0.12</td>
<td>2.89±0.39</td>
<td>2.82±0.59</td>
</tr>
<tr>
<td>T₂</td>
<td>Leg</td>
<td>3.24±0.28</td>
<td>2.56±0.38</td>
<td>2.71±0.32</td>
</tr>
<tr>
<td></td>
<td>Breast</td>
<td>3.26±0.26</td>
<td>2.54±0.31</td>
<td>2.09±0.23</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td></td>
<td>1.20</td>
<td>1.14</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Means±SE in column with different superscripts are significantly (P<0.05) different;
C = Control; T₁ = 5% tetra sodium pyrophosphate + 2.5% sodium chloride;
T₂ = 2% lactic acid + 2% potassium sorbate.

Microbial status of leg and breast cuts following treatment with pyrophosphate and lactic acid in relation to the control has been given in Table 3. The observations indicated that the average coliforms count and faecal enterococci count was slightly more in leg cut in comparison to breast cut in the control groups, which might be due to higher pH of the leg cut in comparison to the breast. Same was the trend in the treated groups, but the average load was less than the control group. It was found that the treatment T₂ had significant (P<0.05) lower mean values of SPC, faecal enterococci and coliforms as compared to control. Since in treatment T₂, the pH was less than 6.0, the acid appeared to exert their greatest inhibitory effect by killing large number of organisms during chilling and by extending the lag period of growth. Singh et al. (1989) used 2 per cent lactic acid and 2 per cent potassium sorbate dip which caused one log reduction in total viable counts. The findings are in line with the results of Panda (1994) and Pipek et al. (1996).

The reduction in the total bacterial load in polyphosphate treated group during chilling as compared to the control might be due to the fact that polyphosphate salts have been proved to be useful in altering the microbial population of poultry meat (Pandey et al., 1982). Sharma and Panda (1990) also noticed significant (P<0.05) reduction in total bacterial load on the poultry carcasses when treated with phosphate and sodium chloride solution.

Shift in the SPC on the leg and breast cuts, control and treated including their shelf life and keeping quality during the storage at 4±1°C has been shown in Figs 1-2 and 2 for leg and breast cuts, respectively. Based on the findings, both leg and breast cuts could be stored for 6.8 and 11 days in case of control, T₁ and T₂ treatments, respectively. Barnes et al. (1966) and Panda (1971) have indicated in their earlier reports that when the microbial load on the meat tissue exceeds 10⁷/g, development of off odour and slime start developing. Extension of shelf life of T₂ group for 5 days more and T₁ group for 2 days more as compared to control may be due to lactic acid and potassium sorbate and phosphate and sodium chloride used in the study. A marked improvement in the storage life of whole poultry carcasses or portions dipped in 5-10 per cent potassium sorbate solution at 4-5°C has been indicated by Hamm (1986). Sharma and Panda (1990) noticed spoilage changes in phosphate treated groups on 8th day while in control ones on the 6th day at refrigeration storage.

Based on the results it could be concluded that the shelf life of the broiler legs and breasts treated with lactic acid and potassium sorbate is five days (11 days) more and those treated with polyphosphates and sodium chloride is two days more (8 days) as
Fig. 1. Effect of different additives on standard plate count of leg cuts stored at 4±1°C

Fig. 2. Effect of different additives on standard plate count of breast cuts stored at 4±1°C

compared to that of the control samples (6 days) at refrigeration temperature of 4±1°C. The lactic acid and potassium sorbate improved the microbial quality, whereas the polyphosphate and sodium chloride improved the WHC and shear press value of broiler meat.
REFERENCES


