Effect of Washing on Quality Improvement of Mechanically Deboned Chicken Meat

Cho Cho Thein* and Kanithaporn Vangnai2

ABSTRACT

Mechanically deboned chicken meat (MDCM) is obtained from the skeletal bone tissue by forcing under high pressure through a sieve to separate the bone from the edible meat tissue. MDCM is suitable for food industry to produce variety of processed meat products because of its nutritional components, functional properties and low cost source for the production. However, a major problem encountered with products manufactured with MDCM is very susceptible to oxidation because of high content of lipids and heme compounds which lead to dark meat color, undesired textural properties and unpleasant odor due to rancidity of fat. In our study, MDCM was washed with 0.5% sodium chloride solution to improve quality. The various ratios of MDCM and 0.5% sodium chloride at 1:1, 1:2 and 1:3 were studied. From the results, it could be concluded that washing with 1:2 MDCM/NaCl represents the best treatment to improve the quality of MDCM given yield of 57.3%. With this treatment, the color of MDCM was improved and approximately 40% of crude fat was removed while myofibrillar protein remained unchanged.

Key Words: Mechanically deboned chicken meat, Washing, Sodium chloride

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INTRODUCTION

Nowadays the consumption of chicken meat and its products are increasing throughout the world. The increase demand of cut-up parts and the requirement of further processing have provided significant amount of leftover parts on the carcass to be used for mechanically deboning (Perlo et al., 2006). Mechanically deboned chicken meat (MDCM) is obtained from the skeletal bone tissue by forcing under high pressure through a sieve to separate the bone from the edible meat tissue. MDCM is suitable for food industry to produce variety of processed meat products because of its nutritional components, functional properties and low cost source for the production. However, a major problem encountered with products manufactured with MDCM is very susceptible to oxidation because of high content of lipids and heme compounds which lead to dark meat color, undesired textural properties and unpleasant odor due to rancidity of fat (Al-Najdawi and Abdullah, 2002).

In order to overcome lipid oxidation and make better use of MDCM in meat products, many attempts have been done. Previous research has indicated that the washing techniques available could be applied to improve the qualities of MDCM. Shahidi et al. (1992) reported that the MDCM washed with water and then with 0.5% sodium chloride or 0.5% sodium bicarbonate were effective for washing of MDCM. However, the yield of washed MDCM was low (approximately 40%). Min and Lee (2004) reported that MDCM washed using 0.5% sodium chloride with two washing cycles and then washed with water were effective for removal of fat and increased the lightness of the washed meat. However, the crude protein content of washed MDCM was low (approximately 9%) and protein was washed out during the washing. It was possible that the ratio of MDCM and solution and washing cycle were not suitable. The aim of our study was to study the ratios of MDCM to improve yield and qualities of washed MDCM. The 0.5% sodium chloride was selected as washing solution in this study.

MATERIAL AND METHOD

MDCM was produced in a commercial processing plant and kept under freezing condition. The MDCM was thawed at 4°C before washing. The washing solution was 0.5% sodium chloride with various ratios of MDCM and washing solution of 1:1, 1:2 and 1:3, respectively. After washing, the meat slurry of each treatment was centrifuged at a relative centrifugal force of 1450 rpm for 30 min using basket type centrifuge (Chonracha Co.,LTD. Thailand). The MDCM centrifuged without adding the washing solution (centrifuged MDCM) was also prepared. Washing solutions were removed by aspiration. Washed MDCM was collected and determined for yield, color, fat and protein contents and protein extractability.
1. **Determination of % yield**

   The yield was determined by dividing washed MDCM collected after centrifugation by MDCM (before washing) and multiplying by 100 (Dawson et al., 1988).

   \[
   \text{% Yield} = \frac{\text{Washed MDCM weight} \times 100}{\text{Unwashed MDCM weight}}
   \]

2. **Color measurement**

   Instrumental color values of sample were determined using colorimeter (Minolta CM.3500d, Konica Minolta Holding Ind, Tokyo, Japan) by reflectance. Hunter Lab parameters (L*, a*, b* values) were obtained using a D65 illuminant at 10° observation (Shahidi et al., 1992).

3. **Crude fat content**

   Crude fat content is determined by solvent extraction method using Soxtec system HT 1043 and fat content of samples were extracted by petroleum ether. The extracted fat is dried in hot air oven at 125°C to a constant weight according to AOAC official method (2000).

4. **Crude protein content**

   Crude protein content of each sample was calculated from total nitrogen (N) content determined by automate Kjeldahl method according to AOAC official method (2000).

5. **Determination of total soluble protein, sarcoplasmic protein and myofibrillar protein**

   Determination of total soluble protein, sarcoplasmic protein and myofibrillar protein were based on method described by Joo et al. (1999). Sarcoplasmic protein was measured by homogenizing 2 g of sample with 20 ml of ice-cold 0.025M phosphate buffer (pH 7.2) to create a homogenate solution. Total soluble protein was extracted by homogenizing 2 g of sample with 40 ml of ice-cold 0.1M phosphate buffer (pH 7.2). Homogenates were centrifuged at 1500 x g for 20 min and then filtered using the Whatman No.1 filter paper. The protein content of the filtrate were determined using the Biuret method (Robinson and Hodgen, 1940). Myofibrillar protein concentrations were calculated by difference between total and sarcoplasmic protein.

   \[
   \text{Myofibrillar protein} = \text{Total soluble protein} - \text{Sarcoplasmic protein}
   \]

**RESULTS AND DISCUSSION**

Yield of washed MDCM depended on the ratio of MDCM and 0.5% sodium chloride (MDCM/NaCl) varying from 64.8% to 51.5% as shown in Table 1. Yield of MDCM washed with 1:1 MDCM/NaCl was significantly higher than MDCM washed with 1:2 and 1:3 MDCM/NaCl (p<0.05). There was no significant difference in yields between 1:2 MDCM/NaCl and 1:3 MDCM/NaCl (p>0.05).
In overall, the yields obtained from our study were higher than previous study by Shahidi et al. (1992) which reported the yield of washed MDCM ranged between 40.9-47.8%. The presence of high lipid content has important implications in the storage, processing, stability and nutritional values of muscle food because it is a reason for the rapid oxidative rancidity. The crude fat content of all treatments were shown in Table 1. All treatments were effective in removing fat from MDCM. The MDCM centrifuged without adding washing solution (centrifuged MDCM) could remove fat from 16.1% to 11.7% compared with unwashed MDCM. For washed MDCM, the result indicated that the crude fat content decreased with increasing the amount of sodium chloride solution. MDCM washed with 0.5% NaCl at the ratio of 1:1, 1:2 and 1:3 could remove the fat by 32.3%, 40.4% and 50.9%, respectively compared with unwashed MDCM.

<table>
<thead>
<tr>
<th>MDCM : NaCl</th>
<th>Yield (%)</th>
<th>Crude Fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwashed MDCM</td>
<td>100a</td>
<td>16.1 ± 0.42a</td>
</tr>
<tr>
<td>Centrifuged MDCM*</td>
<td>80.6 ± 0.57b</td>
<td>11.7 ± 0.60b</td>
</tr>
<tr>
<td>1: 1</td>
<td>64.8± 5.38c</td>
<td>10.9 ± 1.20c</td>
</tr>
<tr>
<td>1: 2</td>
<td>57.3± 3.18d</td>
<td>9.6 ± 0.29d</td>
</tr>
<tr>
<td>1: 3</td>
<td>51.5± 3.71d</td>
<td>7.9 ± 0.58d</td>
</tr>
</tbody>
</table>

abcd Means within row with different superscripts are significantly different (p<0.05).

*MDCM which was centrifuged without adding 0.5% NaCl

Meat proteins are classified into sarcoplasmic protein, myofibrillar protein and stroma protein. Sarcoplasmic proteins comprise of glycolytic enzymes and pigments. Myofibrillar proteins comprise of major proteins e.g. myosin, actin, tropomyosin, troponin and actin which are responsible for the conformational structure and eating quality of meat and meat products. In our study, the amount of crude protein, total soluble protein, sarcoplasmic protein and myofibrillar protein were determined in all MDCM samples. Results were shown in Table 2. Crude protein content of centrifuged MDCM (16.3%) was not significantly difference from unwashed MDCM (16.4%). Crude protein contents of all washed MDCM (14.4-14.9%) samples were significantly lower than unwashed MDCM (16.4%). This was due to the reduction of sarcoplasmic proteins which could be washed out by salt solution of low ionic strength. Sarcoplasmic protein contents were reduced from 4.0 mg/ml (unwashed MDCM) to 2.2 mg/ml (washed MDCM with 1:1 MDCM/NaCl) and 1.9 mg/ml (washed MDCM with 1:2 and 1:3 MDCM/NaCl). Myofibrillar protein of washed MDCM were slightly increased than unwashed sample. It
would be expected that the removing of fat and pigments increase of functional myofibrillar proteins (Babji and Gna, 1994). Myofibrillar protein of centrifuged MDCM was not significantly different from unwashed MDCM (p>0.05).

Table 2 Crude protein, total soluble protein, sarcoplasmic protein and myofibrillar protein of MDCM after washing with different ratios of 0.5% sodium chloride

<table>
<thead>
<tr>
<th>MDCM:NaCl</th>
<th>Crude Protein (%)</th>
<th>Total soluble protein (mg/ml)</th>
<th>Sarcoplasmic Protein (mg/ml)</th>
<th>Myofibrillar Protein (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwashed MDCM</td>
<td>16.4 ± 0.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.7 ± 0.86&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.0 ± 0.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.6 ± 0.39&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Centrifuged MDCM*</td>
<td>16.3 ± 0.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.1 ± 0.41</td>
<td>3.1 ± 0.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.1 ± 0.74&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>1: 1</td>
<td>14.8 ± 0.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.6 ± 0.31</td>
<td>2.2 ± 0.38&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.3 ± 0.74&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>1: 2</td>
<td>14.9 ± 0.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.4 ± 0.49</td>
<td>1.9 ± 0.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.5 ± 0.18&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>1: 3</td>
<td>14.4 ± 0.32&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.0 ± 0.72</td>
<td>1.9 ± 0.34&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.1 ± 0.77&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup><sup>a</sup>b</sup> Means within row with different superscripts are significantly different (p<0.05).

<sup>ns</sup> Not significance difference

* MDCM which was centrifuged without adding 0.5% NaCl

The color of unwashed and washed MDCM samples is shown in Table 3. No significant differences (p>0.05) in lightness (L*) and yellowness (b*) values were observed between unwashed and washed MDCM samples. The redness (a*) in washed MDCM with 1:2 and 1:3 MDCM/NaCl significantly decreased (p<0.05) compared with unwashed MDCM. As a result, the redness value of washed MDCM decreased due to removing myoglobin which is heme pigments known to catalyse lipid oxidation. This result agreed with another study by Dawson et al. (1988) who reported that the washing process affected the decrease of redness value of MDCM sample.
Table 3 Color parameters of MDCM after washing with different ratios of 0.5% sodium chloride

<table>
<thead>
<tr>
<th>MDCM : NaCl</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwashed MDCM</td>
<td>59.9 ± 2.36&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>12.7 ± 0.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.90 ± 0.60&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Centrifuged MDCM*</td>
<td>59.3 ± 1.02</td>
<td>11.7 ± 0.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.65 ± 0.39</td>
</tr>
<tr>
<td>1: 1</td>
<td>61.7 ± 1.99</td>
<td>11.6 ± 0.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.38 ± 0.41</td>
</tr>
<tr>
<td>1: 2</td>
<td>62.4 ± 1.53</td>
<td>11.4 ± 0.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.42 ± 0.81</td>
</tr>
<tr>
<td>1: 3</td>
<td>62.0 ± 1.93</td>
<td>11.3 ± 1.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.51 ± 0.30</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Means within row with different superscripts are significantly different (p<0.05).

<sup>ns</sup>Not significance difference

*MDCM which was centrifuged without adding 0.5% NaCl

CONCLUSION

The yield and qualities of MDCM were affected by the ratio of MDCM and 0.5% sodium chloride. It could be concluded that washing with 1:2 MDCM/NaCl represents the best treatment to improve the quality of MDCM with yield of 57.3%. The color of MDCM was improved by this treatment. Approximately 40% of crude fat was removed while myofibrillar protein remained unchanged.

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REFERENCES


