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MASS TRANSFER DYNAMICS DURING SALT BRINING OF RABBIT MEAT

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MASS TRANSFER DYNAMICS
DURING SALT BRINING OF RABBIT MEAT

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ABSTRACT

The objectives of this work were to investigate the changes in mass transfer, myofibril proteins structure, textural properties and water holding capacity of rabbit meat salting in different brine concentration. Rabbit meat were wet-cured for 24 h in five brine solutions having concentrations, i.e. 5%, 10%, 15%, 20% and 25% NaCl (w/w). Results show that the weight gain and water content decreased and the sodium chloride content in meat samples increased with increasing brine concentration.

Key words: rabbit meat, mass transfer, brine concentration.

INTRODUCTION

In the last 50 years, the world production of rabbit meat has increased by 3.4 fold to 1.78 million tons in 2013. China is currently the leading producer of rabbit meat (727000 t in 2013) in the world (FAOSTAT). Because of its high digestibility, medium-low juiciness, low-calories, low cholesterol, high degree of unsaturated fatty acids, lowest fatty feeling in the mouth and tenderness, rabbit meat fits well the contemporary consumer (Nakyinsige et al. 2015). Rabbit meat products, such as chansi-cured rabbit, water-boiled salted rabbit and cold rabbit, are traditional meat products in southwest china. The saying ‘no rabbit, no feast’ was used to describe the important role of rabbit meat for the diet of this part.

In the present study, mass transfer and sodium chloride diffusion of rabbit meat during wet-curing in different brine concentrations were studied.

MATERIALS AND METHODS

Raw material
Two hundreds and forty frozen longissimus dorsi (LD) from Hyla rabbit were obtained from Chongqing College Research Center for Animal.

Curing and sampling
The frozen meat samples were thawed at +4° C for 18h before use. they were cut into 5±0.5g units (2cm×1cm×1cm), individually weighed, and then immersed in five brine solutions (5%, 10%, 15%, 20% and 25% NaCl (w/w)) at the ratio of 1:3(meat: brine) for wet-curing at 4° C.

Analytical determinations
The salt content of brine and rabbit meat was measured using the titration method of silver nitrate solution (National Standard of China (GB/T5009.44-2003). Water content was determined by oven drying the samples to constant weight at 104±1° C (Deumier et al., 2003).
RESULT AND DISCUSSION

In the present study, the total weight, water and sodium chloride weight changes can be calculated by means of following equations (Du et al., 2010).

\[
\Delta M_t^o = \frac{M_t^o - M_0^o}{M_0^o} \times 100(\%) \tag{1}
\]

\[
\Delta M_t^w = \frac{M_t^w \cdot x_t^w - M_0^w \cdot x_0^w}{M_0^w} \times 100(\%) \tag{2}
\]

\[
\Delta M_t^{NaCl} = \frac{M_t^{NaCl} \cdot x_t^{NaCl} - M_0^{NaCl} \cdot x_0^{NaCl}}{M_0^{NaCl}} \times 100(\%) \tag{3}
\]

\(M_t^o\) and \(M_0^o\) are the rabbit meat weight at sampling time \(t\) and 0, \(x_t^{NaCl}\) and \(x_0^{NaCl}\) are the sodium chloride contents in the samples, and \(x_t^w\) and \(x_0^w\) are the water contents in the samples, at sampling times \(t\) and 0, respectively.

As shown in Fig. 1, the brine concentration significantly affected the total weight changes of the rabbit meat during the salting process. The weight increase of the rabbit meat increased with decreasing brine concentration, and the rabbit meat brined in the saturated brine (25% NaCl w/w) produced the lowest process yield.

![Figure 1: Overall weight changes in the five brines during salting](image)

The water and sodium chloride weight changes of samples are shown in Figs. 2. The higher brine concentration was the higher sodium chloride content and the lower water content in rabbit meat was. The sodium chloride content increase with increasing brine concentration, while the water content of meat decreased with increasing brine concentration. For each of the five brines, sodium chloride content increased with the increasing brining time. The water content in meat increased in low brine concentrations with the increase of brining time, while it decreased in high brine concentrations.

![Figure 2: Changes of water (A) and sodium chloride (B) in rabbit meat in the five brines](image)

According to Leng et al. (2012), a pseudo-diffusional transportation was assumed where the weight
changes were related to the square root of time. Following equation for the weight changes throughout brining time was fitted to the experimental data.

\[
\Delta M_i^t = 1 + k_1 + k_2 \times t^{0.5} \tag{4}
\]

The slope term \((k_2)\) is concerned to the kinetics of the total weight changes in terms of process yield. The independent term, \(k_1\), describes what happens at the beginning of the brining process, affected by pressure gradients and called HDM (hydrodynamic mechanisms) (Andrés et al., 2002).

Figure 3 shows the yield \((\Delta M_i^{\text{to}})\) as a function of the square root of brining time. The equation coefficients, period of time fitted and the fitting correlation factors are shown in Table 1.

![Figure 3: Plot of sample overall weight changes \((\Delta M_i^{\text{to}})\) vs the square root of time \(t^{0.5}\) (h)](image)

**Table 1: Dynamics parameters for total, water and NaCl weight changes adjusted to Eq. \((4)\) \((k_1\) and \(k_2\)), and fitting correlation factors \((p < 0.05)\).**

<table>
<thead>
<tr>
<th>Brine concentration</th>
<th>(k_1)</th>
<th>(k_2)</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta M_i^{\text{to}})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>2.2419</td>
<td>4.0481</td>
<td>0.9187</td>
</tr>
<tr>
<td>10%</td>
<td>1.3347</td>
<td>4.0321</td>
<td>0.9434</td>
</tr>
<tr>
<td>15%</td>
<td>-0.1447</td>
<td>3.004</td>
<td>0.9539</td>
</tr>
<tr>
<td>20%</td>
<td>-1.2251</td>
<td>1.1457</td>
<td>0.9678</td>
</tr>
<tr>
<td>25%</td>
<td>-2.3343</td>
<td>-0.9907</td>
<td>0.7919</td>
</tr>
<tr>
<td>(\Delta M_i^{\text{w}})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>0.4572</td>
<td>3.4546</td>
<td>0.9181</td>
</tr>
<tr>
<td>10%</td>
<td>-2.6134</td>
<td>3.5966</td>
<td>0.9586</td>
</tr>
<tr>
<td>15%</td>
<td>-3.966</td>
<td>1.2937</td>
<td>0.6114</td>
</tr>
<tr>
<td>20%</td>
<td>-5.222</td>
<td>-0.9814</td>
<td>0.3359</td>
</tr>
<tr>
<td>25%</td>
<td>-7.8793</td>
<td>-3.0964</td>
<td>0.6511</td>
</tr>
<tr>
<td>(\Delta M_i^{\text{NaCl}})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>2.8593</td>
<td>2.6193</td>
<td>0.7868</td>
</tr>
<tr>
<td>10%</td>
<td>2.7431</td>
<td>2.1372</td>
<td>0.7334</td>
</tr>
<tr>
<td>15%</td>
<td>2.164</td>
<td>1.8184</td>
<td>0.7404</td>
</tr>
<tr>
<td>20%</td>
<td>0.9801</td>
<td>1.5351</td>
<td>0.8182</td>
</tr>
<tr>
<td>25%</td>
<td>0.0348</td>
<td>0.7448</td>
<td>0.7974</td>
</tr>
</tbody>
</table>

Regarding the total weight changes \((\Delta M_i^{\text{to}})\), \(k_2\) values gradually increased with decreasing brine concentration. The same tendency for \(k_2\) values was also obtained in water weight changes \((\Delta M_i^{\text{w}})\) and sodium chloride weight changes \((\Delta M_i^{\text{NaCl}})\), respectively. With regard to \(k_1\) values, they had the same trend as \(k_2\) values. Moreover, higher values of \(R^2\) calculated from Eq. \((4)\) revealed that the linear relation of the equation of five brine concentrations were good. Significant correlations \((p < 0.05)\) were got for every sample.

**CONCLUSION**

The brine concentration significantly affected the total weight, water and sodium chloride changes of the rabbit meat during salting process. The weight gain and water content decreased and the sodium chloride content in meat samples increased with increasing brine concentration. The experimental data for brining of rabbit meat closely fitted the model previously proposed.
ACKNOWLEDGMENTS

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