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Chemical basis of WHC

• Three types of water in meat
  – Bound water
    • 4-5%, and bound to proteins
    • Remaining tightly bound even during the application of severe mechanical or other physical force
  – Immobilized water
    • Attached to the bound molecules in layers
    • Qualities depending on the amounts of physical force exerted on the muscle
  – Free water
    • Only held by weak surface force
    • Easy to loose during processing

• Water holding capacity
  – Definition
    • The ability of meat to retain its water during application of external forces, such as cutting, heating, grinding, or pressing.

• Importance of WHC
  – Economic loss (e.g. shrinkage of meat, moisture loss, loss of wt)
    • Yield =
    • Drip loss
  – Related to sensory characteristics
    • Juiciness, tenderness, lipid oxidation, overall acceptance
  – For both fresh meat or processed meat
    • Even though might be the different causes
WHC Affecting factors

• Antemortem influences

• Postmortem influences
  – Production of lactic acid
    • pH drop
    • Denaturation of proteins
  – Onset of rigor mortis
    • Changes of cell structure associated with proteolytic enzyme activity

• Net charge effect
  – Isoelectical point (PI)
    • Definition:
      – PI of meat
    • PI vs. WHC (PI vs. Amounts of immobilized water)

• Effect of salt on WHC
  – Salt soluble proteins
    • Actin & myosin
  – Emulsion-type foods
離心法 (centrifuge method)

Five grams of sample were mixed with 10 ml water, placed in a 50 ml centrifuge tube, weighted, vortexed for 1 min, centrifuged for 10 min (2000 g, 15 C; Hitachi Centrifuge, Model SCR20B, Hitachi Koki Co., Ltd., Japan). After pouring the supernatant, it was reweighed and calculated as % water holding capacity = (Weight before centrifuge - Weight after centrifuge)/Weight before centrifuge × 100%.

(Tan et al., 2007)

Example 1

Table 1

<table>
<thead>
<tr>
<th>Yam added (%)</th>
<th>Proximate composition (%)</th>
<th>Water holding capacity (%)</th>
<th>Water activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture</td>
<td>Protein</td>
<td>Fat</td>
</tr>
<tr>
<td>5</td>
<td>38.69 ± 3.33</td>
<td>30.99 ± 3.48</td>
<td>15.32 ± 1.41</td>
</tr>
<tr>
<td>10</td>
<td>33.53 ± 3.36</td>
<td>32.28 ± 3.24</td>
<td>6.29 ± 1.32</td>
</tr>
</tbody>
</table>

1 Means ± SD within the columns having unlike letters (a–d) are significantly different (P < 0.05).

(Tan et al., 2007)
濾紙擠壓法
（Filter paper press method; FPPM）

• 利用 Gran and hamm (1957)，參考 Tasi and Ockerman (1981) 提出測定肌纖維保水力的方法加以修飾

• 在半徑6cm的圓板上，施以固定60 Kg 的力，2 sec × 15 次共30 sec，在上下以雙層濾紙吸附水分後，觀察相近樣品所壓出的水分含量；保水力的測定為簡便也較具代表性的鑑定魚肉品質之方式。另一方面肉樣需先經放置105°C 的烘箱乾燥恆重後測其含水率W%。

• 公式如下：
  - WHC (g-H2O/g-wet material) = Wt2 / Wt1 ×100%
  - Wt1為未擠壓前的肉樣含水量（肉樣初重 ×W%）
  - Wt2為擠壓後的肉樣含水量（擠壓後肉樣重-乾物重）

A note on the relationships between measures of water holding capacity in the M. longissimus dorsi and total drip loss from butchered pig carcasses during storage

Twenty pig carcasses were selected to represent a range of meat quality. The water holding capacity (WHC) of the M. longissimus dorsi (LD) was estimated using several methods and the usefulness of these measures examined to predict the overall loss in weight from the butchered carcasses when jointed and displayed in a manner corresponding to a retail situation. There was a linear relationship between the logarithms of percentage loss in weight of the butchered carcass and days of display time. The total weight loss from the butchered carcasses after 5 days ranged from 2·2 to 6·4% and the best relationship with this weight loss was for WHC assessed by loss of exudate from slices of LD suspended in netting bags for 72 h at 1°C (r = 0·88, P < 0·001). Measures of WHC based on high or low speed centrifugation, or a filter paper press method, gave slightly poorer correlations. However, all WHC methods except low speed centrifugations gave correlations which were better than those with pH measured at 45 min post mortem, or reflectance or Fibre Optic Probe Values at 24 h post mortem.


(Lopez-Bote and Warriss, 1988)
A good reference of WHC

Optimum conditions for determining water holding capacity of beef by the press method

Zhang, Mittal, and Barbut

ABSTRACT

Water holding capacity (WHC) of ground beef was measured by the press method. Three levels of applied force, test duration, sample mass, and salt concentration were investigated. Three types of deformations – plastic, elastic and permanent were used to explain the effects of applied force on WHC. Viscoelastic properties explained the effects of test duration. In general, WHC decreased with additional applied force and test duration, and increased with a larger sample size and salt concentration. Recommended test conditions are: 1 g sample size, 20 kN force for 2 min at a salt concentration of 0, 1 or 2%.

Abstract: The extent to which water holding capacity (WHC) techniques: filter paper press method, drip loss and filter paper method, are related to the sensory juiciness appreciation of pork was studied. Additionally four on-line methods: pH1, FOP1 (light scattering), PQM1 (conductivity) and DDLT (Double Density Light Transmission), were evaluated for their ability to predict WHC and juiciness scores. One-hundred and twenty samples of m. longissimus thoracis et lumborum, from animals of different genotypes, were involved in this study. Only WHC results, determined by the filter paper press method, were significantly correlated with juiciness scores (r=0.24). The results of the filter paper method, either by weighing or visual judging, could not be predicted by the on-line methods. The results of the filter paper press method (F.p.p.-RZ) and drip loss were slightly better correlated with DDLT (respectively, r=0.56 and 0.45) than with PQM1 (r=0.51 and 0.36), FOP1 (r=0.48 and 0.34) and pH1 (r=0.41 and 0.34), although the standard error of estimate of the linear regressions was similar for the four on-line methods. Unfortunately, the on-line techniques incorrectly predicted several WHCs. Juiciness was slightly or not related to the on-line methods. The DDLT technique, which is analogous to the CGM (Capteur Gras/Maigre), an officially accepted carcass grading apparatus in France and Belgium, is as good or better than the classical on-line instruments: pH, FOP and PQM, in predicting WHC.

(Van Oeckel et al., 1999)