Assessment of Rapid Method for Determining Water Holding Capacity of Meat

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SUMMARY: Assessment was made of the effectiveness of a quick, non-planimetric filter-paper press method for determining the water holding capacity of meat, based on the ratio, M/T, of pressed meat film(M) and total moist area (T) on filter paper, instead of the liquid ring zone. All values determined showed close agreement with those by the latter conventional method. PSE-like meat was prepared and M/T and M were noted to significantly decrease with drop in pH. M and T areas determined planimetrically and by the intersection of axes method were found to show good agreement. The effect of pH(4.2～7.0) on M/T as determined by the intersection of axes method was almost the same as that on water holding capacity determined by the conventional method. It is thus evident that M/T determined by the intersection of axes method can be used for quickly determining the water holding capacity of meat.

INTRODUCTION: Water holding capacity is defined as the ability of meat to retain its own and/or added water under external force such as that by pressing,heating and/or centrifuging. This parameter is related to the texture, tenderness and color of raw meat and juiciness and firmness of cooked meat. Many methods for its determination have reported. Among these, the filter-paper press method, developed by GRAU and HAMM (1953) and subsequently modified by WIERBICKI and DEATHERAGE(1958),is widely used. In Japan,this method is frequently used with slight modification(IKEDA et al.,1987; SHINMURA,1985). In the filter-paper press method, a meat sample is pressed against filter paper at constant pressure, and the area through which water diffuses is measured and water holding capacity is expressed as the percent still retained water of the total moisture content. HOFMANN et al. (1982) recommend that this parameter be expressed as the ratio of M/T of pressed meat film area(M) to total moist area(T), instead of the widely used liquid ring zone (RZ, conventional method). For reference, some pressed profiles obtained by the filter-paper press method are shown in Fig.1 (HAMM,1972). HOFMANN (1982) also used the intersection of axes method to calculate the area of M and T instead of the planimetric method. When M/T is used to determine water holding capacity, no scales are needed to measure sample size and moisture content accurately, as also pointed out by HOFMANN et al.(1982).

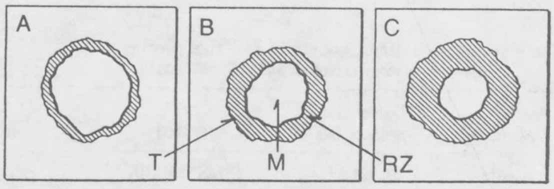

Fig.1: Press profiles as obtained with filter-paper press method. A=very good; B=intermediate; C=poor water holding capacity, T=total moist area; M=meat film area; RZ=liquid ring zone [Cited from "Kolloidchemie des Fleisches"(Hamm,1972)]

This work was conducted to assess the effectiveness of the modified method of HOFMANN et al. to determine the water holding capacity and the results were compared with those by the conventional filter-paper press method.

MATERIALS and METHODS: A freshly cut 400 to 600mg sample of porcine skeletal muscle (M.longissimus thoracis) was placed on filter paper (Toyo No.2, ϕ7cm) and weighed exactly. These were then placed together between two plastic plates (100×100×8mm), and pressed by the meat-press machine with a pressure gage (Chuo Riken Co.Ltd., Tokyo)at 35kg/cm^2 for 1 min(SHINMURA,1985). The plate on the filter-paper side was then immediately removed, and the meat area was outlined on the back side of the paper. M and T were subsequently measured with a planimeter and RZ was determined as their difference. Water holding capacity was determined by the conventional method as follows:

$$\text{Water holding capacity(\%)} = \{1 - RZ(cm^2) \times 9.47(mg/cm^2) \div \text{total moisture(mg) in meat sample}\} \times 100$$

M/T was calculated and compared with that calculated by this method.

PSE-like muscle was prepared by our method (SAKATA et al.,1981; 1983), in which normal porcine muscle of pH adjusted to a lower value (5.4～5.0) was incubated at 40℃ for 90min. The extent of denaturation of muscle protein was estimated based on the transmission value of the sarcoplasm fraction(HART,1962). The resulting PSE-like muscle was measured for water holding capacity by the conventional and M/T methods.

The RZ and M/T were measured for normal porcine muscle by the intersection of axes method(HOFMANN,1982)and compared with the values of these parameters obtained by the planimeter.The relationship between pH and M/T was determined by this method with normal meat of pH adjusted to 7.0 from 4.2.

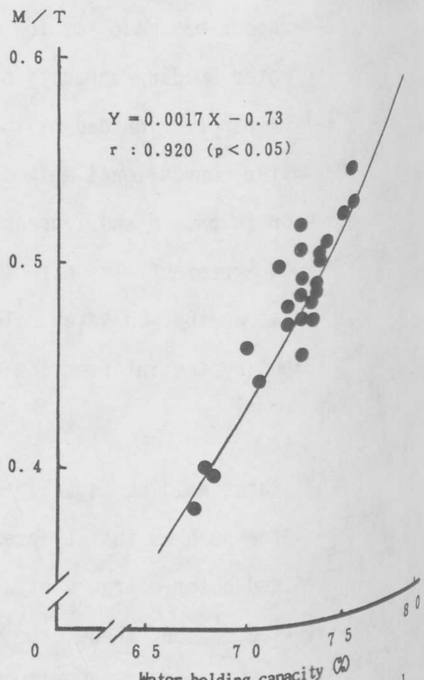

Fig.2: Possitive slope curve of conventional method values plotted against M/T

<u>RESULTS and DISCUSSION</u>: The water holding capacity of meat under conditions specified by the Japanese Agricultural Standard was determined in this study. Determination values of water holding capacity by the conventional and M/T methods gave a curve of significantly positive slope (Fig.2).

Table 1: Water holding capacity of PSE-like porcine muscle by conventional and M/T methods[1]

Meat Sample	Conventional method (WHC%)	M/T method
Control[2]	$73.40^a \pm 1.17$	$0.548^a \pm 0.015$
PSE-like		
pH 5.4	$66.75^b \pm 0.36$	$0.412^b \pm 0.005$
pH 5.2	$64.25^c \pm 0.99$	$0.357^c \pm 0.003$
pH 5.0	$61.33^d \pm 1.33$	$0.312^d \pm 0.008$

[1] Values within the same column with different superscripts differ significantly ($p<0.05$)
[2] Normal porcine muscle (pH 5.7)

Table 1 shows values for water holding capacity of porcine muscle under simulated PSE conditions, by both methods. The muscle was considered PSE-like,based on transmission values. Muscle incubated at pH 5.0, with a transmission value of about 80%,appeared to have pronounced PSE characteristics(SAKATA et al.,1981). Water holding capacity decreased with reduction in pH during incubation. The data obtained by the two methods showed significant differences. Thus,by these methods,differentiation between normal and PSE meat showed be possible. Fig.3 shows T,M,RZ and M/T obtained for PSE-like muscle. The area of the pressed meat film decreased with decrease in water holding capacity, as shown in Figs.1 and 3. M and M/T significantly decreased with PSE,whereas the total moist area remained essentially unchanged. RZ is thus shown to increase with drop in pH.

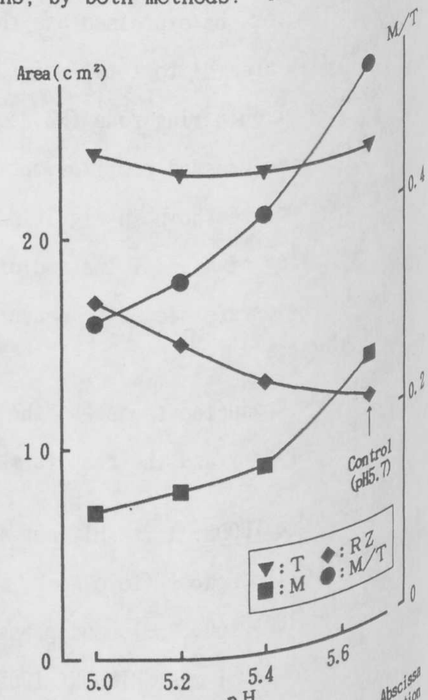

Fig.3: T, M, RZ and M/T of PSE-like muscle. Abscissa indicates pH of muscle just before incubation

M/T by the intersection of axes method was compared with that determined by the planimeter, for 10 normal meat samples (Table 2).

Deviation was the extent of difference, based on the planimetric value as 100. The average M/T by the intersection of axes method was somewhat less than that by the planimeter but there were no significant differences. M and T determined by these methods agreed essentially with those of HOFMANN (1982).

The intersection of axes method was applied to fresh porcine muscle sample, following pH adjustment to 4.2 and 7.0 by lactic acid and NaOH, respectively. As shown in Table 3, at both pH, water holding capacity was significantly higher than that of control muscle (pH: 5.6). Thus, as reported by HAMM (1962), the water holding capacity of meat is minimal around pH 5.0-5.1 and increases above and below this pH.

Based on the results of the filter-paper press method, M/T by the intersection of axes method may be concluded usable for quickly determining the water holding capacity of meat of various qualities.

HONIKEL (1987) states that the water holding capacity of meat is generally considered easy to define but difficult to actually compute. A more detail investigation using many meat samples having varying quality such as with respect to PSE and DFD showed be conducted for more precise determination of this parameter by the filter-paper press method.

Table 2: Comparison between M/T determined by the intersection of axes method and by planimetric method

Meat Sample	M/T PM[1]	M/T IAM[2]	Deviation (%)[3]
①	0.484	0.470	−2.93
②	0.458	0.427	−6.70
③	0.477	0.443	−7.08
④	0.470	0.455	−3.17
⑤	0.507	0.528	4.18
⑥	0.532	0.524	−1.60
⑦	0.545	0.540	−0.84
⑧	0.507	0.501	−1.18
⑨	0.528	0.510	−3.30
⑩	0.521	0.524	0.62
Means ±S.D.	0.503 ±0.028	0.492 ±0.038	−2.20 ±3.14

[1] Planimetric method
[2] Intersection of axes method
[3] {(M/T by IAM − M/T by PM) / M/T by PM} × 100

Table 3: Water holding capacity (M/T) by the intersection of axes method

M/T	pH4.2*	pH5.6	pH7.0*
Means ±S.D.	0.588[a] ±0.049	0.462[b] ±0.036	0.852[c] ±0.046

* Adjusted pH of the meat
a, b, c Values with different superscripts differ significantly ($p<0.01$)

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