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# NOTES

# Relationship Between Water-Holding Capacity of Meats and Microbial Quality[1]

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The water-holding capacity (WHC) of meats is related to the amount of free water released by the meat after physical pressure or force is exerted upon it. The most widely employed method for its determination is the filter-paper press technique first employed by Grau and Hamm (Naturwissenschaften **40**:29, 1953) and modified by Wierbicki and Deatherage (J. Agr. Food Chem. **6**:387, 1958) and others. By the technique of the latter authors, a 500-mg sample of meat is pressed for 1 min on Whatman no. 1 filter paper under 500 psi, by means of a hydraulic press. The free-water area in square inches is determined by subtracting the meat film area from the total wetted area after measurement with a compensating planimeter. Although many studies have been conducted concerning the effect of various parameters on WHC, such as age and sex of animal, *p*H, and metal ions (Hamm, Advances Food Res. **10**:355, 1960), reports on the effect of bacteria or spoilage are wanting.

In the present study, fat-free portions of longissimus dorsi (LD), semimembranous (SM), and semitendinous (ST) muscles were removed from the carcass of a recently slaughtered standard-grade steer, fine-ground in a meat grinder, and placed tightly wrapped in aluminum foil in a refrigerator or an incubator at 6 or 30 C, respectively, and sampled daily until frank spoilage or putrefaction set in. Fresh chicken-breast muscle was obtained from a whole, fryer-size chicken and treated similarly.

As all four samples of meat aged and spoiled, free water area (determined by the method of Wierbicki and Deatherage) decreased in a linear manner, whereas the total bacterial numbers increased (Fig. 1, 2, 3, and 4). WHC was closely correlated with bacterial numbers, being significant at the 1% level in Fig. 1 ($r = -0.940$), at the 0.1% level in Fig. 2 ($r = -0.843$), and between the 5 and 10% levels in Fig. 3. The ST samples were judged organoleptically unfit for consumption on the 13th day of holding; LD samples reached this stage in 16 days, and chicken samples in only 4 days. As the meats underwent spoilage, *p*H values increased slightly but not enough to account for the increase in WHC. The increased WHC was not the result of dehydration upon refrigerated storage because the total moisture content was constant throughout the holding period, as determined by the loss in weight of 1-g samples overnight at 104 C. The possibility that ageing or autolytic enzymes were responsible for increased WHC is negated by the fact that meat infused with 10 ppm of chlortetracycline (CTC) and held at 30 C showed a much lower bacterial count and higher WHC after 3 days compared with control meat from the same muscle (Fig. 4). Portions of the same muscle held at 6 C for 6 days without CTC gave a free water area of 2.43 in.$^2$. The injection of CTC into beef just prior to WHC determination has no direct effect on WHC.

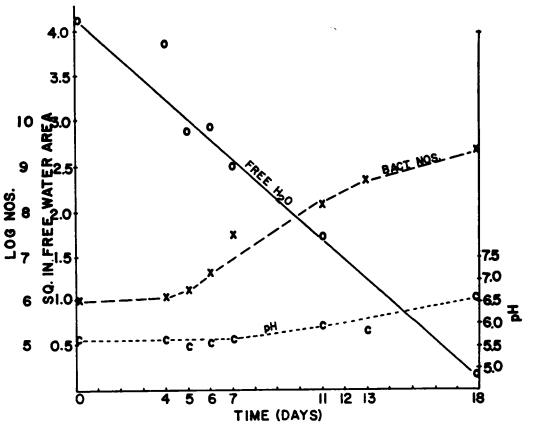


FIG. 1. *Water-holding capacity, bacterial numbers, and pH of ground semitendinous muscle held 18 days with periodic sampling. Bacterial numbers were determined on Tryptone Glucose Extract Agar with incubation at 30 C for 3 days.*

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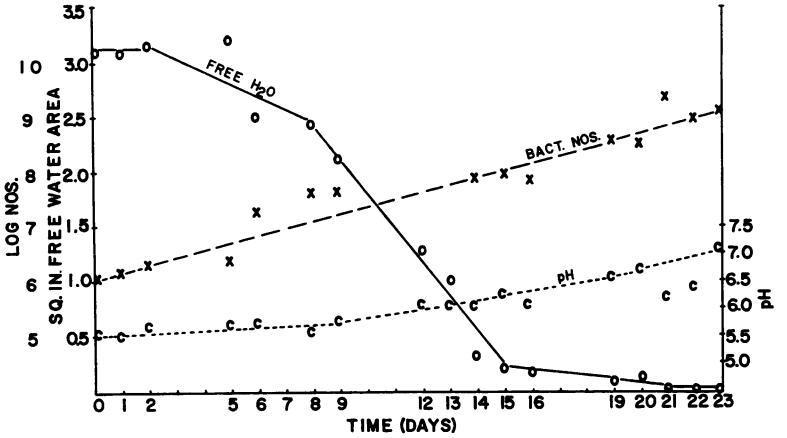


FIG. 2. *Water-holding capacity, bacterial numbers, and pH of longissimus dorsi muscle treated as in Fig. 1.*

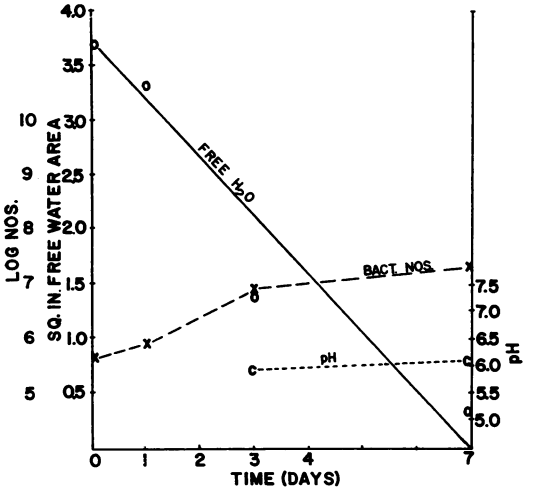


FIG. 3. *Water-holding capacity, bacterial numbers, and pH of ground chicken-breast muscle held for 7 days at 6 C.*

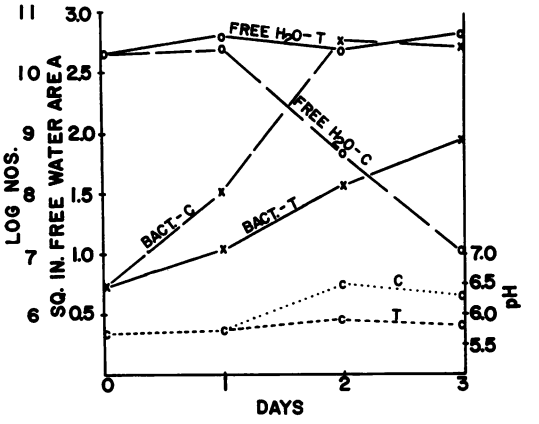


FIG. 4. *Effect of chlortetracycline treatment on bacterial numbers, water-holding capacity, and pH of SM muscle with incubation at 30 C for 3 days. Chlortetracycline was injected into 26-g samples with needle and syringe, followed by thorough mixing of samples. T = chlortetracycline; C = control.*

Neither the steer nor the chicken was given medicaments of any kind prior to slaughter.

Hamm (Advances Food Res. **10**:355, 1960) showed that, immediately after slaughter, beef has a very high WHC, which decreases rapidly and reaches a minimum in 24 to 48 hr. Upon continued storage, WHC increases gradually as tenderness and flavor become optimal. Since proteases added to fresh beef are known to increase its WHC, it is not inconceivable that the increased WHC accompanying incipient spoilage was the result of bacterial proteolysis. An increase in WHC during proteolysis appears to be due to the splitting of peptide bonds, which results in a loosening of protein structure and makes available more water-binding sites.

The nature of the response of WHC to incipient spoilage suggests its possible use in estimating the microbial quality of meats. The extract-release volume phenomenon previously suggested as a rapid technique for indicating microbial quality in beef (Jay, Food Technol. **18**:133, 1964) resembles WHC in many respects, and the combined use of the two techniques may be indicated where rapid results from more than one method are desirable.

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