The Height of the Firm Albumen as a Measure of Its Condition

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The importance of determining the condition, or consistency, of the firm albumen in the study of the interior quality of eggs has been discussed in a previous paper by the authors (1935). A score for this condition was described and illustrated, and the conclusion was reached that this score should be reduced to a physical measurement. It is the purpose of this paper to describe such a measurement.

In applying the score for the "observed condition" of the firm albumen, the pictures of the vertical elevation (silhouette) of the opened eggs representative of each score bore out the observation apparent from other work with egg quality that there was a strong relationship between the score for the observed condition and the vertical height of the firm albumen at the plateau or level surface of this layer.

This relationship is logical, since the mass of the firm albumen of excellent condition is concentrated about the yolk, thus covering a relatively small area and possessing considerable vertical height. In the eggs with progressively poorer condition of firm albumen, this layer becomes more liquid in consistency, thus spreading over a greater area and becoming lower in height. According to the work of Alquist and Lorenz (1932), this is due to the gradual weakening, or disappearance, of the fibrous structure of ovomucin which is presumably responsible for the consistency of the firm layer of albumen.

Fig. 1. Tripod micrometer used for determining the height of the firm albumen of eggs.

In order to make this measurement of height, a special apparatus was devised. This device was similar to the tripod micrometer, shown in Figure 1, which was later adapted for this purpose. The legs of the tripod are 4½ inches apart to enable the measurement of the height of the firm albumen sac without rupturing it. A special tip has been applied to the micrometer to provide a rounded, easily cleaned surface for contacting the albumen.

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Now with the Department of Agricultural Economics and Farm Management.
In this study, 396 eggs of varying age were individually weighed to the nearest gram and then broken out on a clean plate-glass surface. The score for observed condition of the firm albumen was taken, and the height of the firm albumen was measured at two points, on opposite sides of the yolk when possible, using care to avoid the chalazae (Figure 2). These measurements were taken on the plateau, or plane surface, of the firm albumen. In eggs possessing firm albumen of exceptionally fine condition, no plateau existed. A break in the outline of this layer was discernible, however, at a point where the plateau would presumably occur as the egg deteriorated in condition, and the measurements were taken on the lower side of this break (Figure 2, egg score, 1.0). The heights recorded were checked within 0.2 mm. and were averaged. After a little experience, this usually required only the two readings.

A simple Pearsonian correlation between the observed condition and the height of the firm albumen was then calculated. The correlation table is shown in Table 1. The distribution of the data indicates that the score for observed condition is not quite linear, since there was a break in the trend at a score of 2.00. This substantiates the observations of the writers that the score is not sufficiently finely divided between 1.00 and 2.00 and should contain more readings between these points. In spite of this, a correlation of high significance, \( r = -0.934 \pm 0.06 \), was found between the observation and the measurement, indicating excellent agreement, the greater the height, the better (smaller) being the score.

It seemed possible that a more accurate measure would be obtained if the results were weighted for egg size, since in eggs with the same score for condition of firm

![Figure 2: Points on the firm albumen at which height is taken.](image)

<table>
<thead>
<tr>
<th>Observed condition of the firm albumen</th>
<th>1.00</th>
<th>1.25</th>
<th>1.50</th>
<th>1.75</th>
<th>2.00</th>
<th>2.25</th>
<th>2.50</th>
<th>2.75</th>
<th>3.00</th>
<th>3.25</th>
<th>3.50</th>
<th>3.75</th>
<th>4.00</th>
<th>4.25</th>
<th>4.50</th>
<th>4.75</th>
<th>5.00</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of the Firm Albumen in mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
<td>5.0</td>
<td>5.5</td>
<td>6.0</td>
<td>6.5</td>
<td>7.0</td>
<td>7.5</td>
<td>8.0</td>
<td>8.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>13</td>
<td>17</td>
<td>23</td>
<td>24</td>
<td>32</td>
<td>37</td>
<td>34</td>
<td>42</td>
<td>56</td>
<td>42</td>
<td>25</td>
<td>28</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>396</td>
</tr>
</tbody>
</table>

Table 1.—Correlation table between the height and the observed condition of the firm albumen.
albumen, the larger egg would tend to have a greater albumen height. Accordingly, a weighted height was obtained on the same eggs by adjusting the height measurement to the basis of a 56.7 gm. (2 oz.) egg by the following formula:

\[
\text{height in mm.} \times \frac{56.7}{\text{weight of eggs in gms.}}
\]

The simple correlation was again determined and the value of \( r \) was \(-0.934 \pm 0.008\). This was very slightly less significant than that reported for the simple height. The distribution of the data and the variation in height in the same score classes were nearly identical. Thus, the simpler measurement was fully as accurate as well as more rapid.

The fact that the weighted height is no more accurate than the simple height may be explained by the probability that, in eggs with firm albumen of better condition, the tendency for the height of the firm albumen of any given score to be greater in the larger egg than in the smaller one tends to be counterbalanced by the leveling effect of the increased mass. In eggs with firm albumen of poor condition, neither of these forces is effective, since the volume of firm albumen tends to decrease with poorer condition below the score of 3.00, and since that layer simultaneously spreads out sufficiently to nullify the effect of mass. In all classes of eggs, therefore, weighting the height for egg size would tend to introduce rather than to eliminate any possible error. On the basis of these results, it is concluded that the simple height of the firm albumen layer is satisfactory as a measure of the condition of that layer.

Since this study was completed, Botsford (1935) has reported a relationship in the use of this measurement in place of the score for observed condition of firm albumen in some studies on market eggs.

Another method for making a similar measurement, the “albumen index,” has been proposed by Heiman and Carver (1936). This is the ratio of the height to the average diameter of the firm albumen. This measurement, however, presents serious difficulties in determining the diameter accurately on eggs in which the firm albumen sac is ruptured and on which the outline is very irregular or, in poorer eggs, indistinct. The method described here is not subject to this error and, therefore, possesses distinct advantages over that of the above investigators.

In laboratory work, the measure of the height of firm albumen may well supplement the score for the observed condition of this layer, since it may be definitely measured, largely eliminating the human factor. For practical work, where speed of operation and simplicity are desired, the score for observed condition is a rapid, relatively accurate method of classifying the quality of the firm albumen but the determination of height offers a means whereby the observer can check his judgment against a more definite measure than a photograph.

**SUMMARY**

A correlation of \(-0.934 \pm 0.006\) was found between the score for the observed condition of the firm albumen of the egg and the vertical height of this layer. The height, therefore, is an accurate as well as a rapid aid in determining the condition of the firm albumen.

**References**


Heiman, V. and J. C. Carver, 1936. The albumen index as a physical measurement of observed egg quality. Poultry Sci. 15, 141-148.