Quantitative Studies on the Variations in Feeding Activity of Chickens

II. Effect of the Physical Form of the Feed on the Feeding Activity of Laying Hens*

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In a study on the effect of pelleting of feed on the rate of food passage of birds, Jensen et al.1) reported that the time spent at the feed trough was apparently reduced in the birds fed pelleted ration as compared with those fed mash. Wood-Gush and Gower2) studied the relationship between feeding behavior of domestic cocks and feed deprivation periods in relation to the form of feed. They found that when feed was offered in the form of pellets there was a tendency for the amount of feed consumed and the pecking rate to be greater after a 48-hour deprivation while there were no differences between these measurements when the feed was offered in mash form. There is, however, little information with respect to the relationship between the diurnal behavioral pattern in feeding of chickens and the physical form of feed offered.

The present studies, using a newly constructed recording apparatus for measuring the feeding activity of chickens, were conducted to determine the effect of the physical form of the feed on the diurnal feeding pattern of laying hens.

Materials and Methods

Eight Single Comb White Leghorn hens, 16 months of age, weighing 2.0 to 2.4 kg, were reared in individual wire cages and given each of the following five different forms of diets: (1) Mash A; An ordinary type of commercial mash ration for layers, (2) Mash B; A reground mash ration, prepared from Mash A by passing through a plate mill with 16 mesh screen, having a fine and uniform particle size, (3) Pellet A; A hand-made pelleted ration prepared from Mash B by pressing through a 5mm die of a meat chopper for domestic use, (4) Pellet B; A commercial pelleted ration having a diameter of ca. 5 mm, and (5) Crumbles; Coarsely ground pellets prepared from Pellet B. The chemical composition and the distribution of the particle size of these diets are presented in Tables 1 and 2.

The experiment was divided into five periods. As the experimental period progressed, each of above five diets was given successively to the same birds. Prior to the period of collection of data for 5 days, the birds were accustomed to each of the diets for 8

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days. During both preliminary and experimental periods, the birds were given individually 200 g of the diet once daily at 8:00 a.m., and allowed to feed *ad libitum*. Water was made available at all times. The light tight compartment in which the birds were kept was illuminated by means of 100 watt white lamps to provide 14 hours (5:00 a.m. to 7:00 p.m.) of continuous light daily. The mean light intensity was approximately 32 luxes as measured 30 cm above the bottom of the cages.

Although an attempt to control the ambient temperature and humidity was not made, these were recorded continuously during the experimental periods. The average ambient temperatures and the relative humidity during each of the five experimental periods were: 15.2°C, 60% for Period 1 (Mash A); 17.2°C, 55% for Period 2 (Mash B); 18.3°C, 54% for Period 3 (Pellet A); 20.3°C, 58% for Period 4 (Pellet B); and 20.8°C, 55% for Period 5 (Crumbles).

The average body weight and the rate of egg production of the birds during these experimental periods are given in Table 3. All of the differences among these mean values were not statistically significant.

Quantitative data on the diurnal changes in feeding activity were obtained with individual birds by the use of two sets of the apparatus that provides a continuous

### Table 1. Chemical composition of diets

<table>
<thead>
<tr>
<th></th>
<th>Mash A and Mash B</th>
<th>Pellet A</th>
<th>Pellet B and Crumbles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>11.3%</td>
<td>10.2%</td>
<td>9.1%</td>
</tr>
<tr>
<td>Crude protein</td>
<td>18.1</td>
<td>18.0</td>
<td>16.2</td>
</tr>
<tr>
<td>Crude fat</td>
<td>3.4</td>
<td>3.3</td>
<td>3.9</td>
</tr>
<tr>
<td>NFE</td>
<td>53.6</td>
<td>54.4</td>
<td>57.1</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>4.3</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Crude ash</td>
<td>9.3</td>
<td>9.6</td>
<td>10.0</td>
</tr>
</tbody>
</table>

### Table 2. Distribution of particle size of diets

<table>
<thead>
<tr>
<th>Meshes per square inch</th>
<th>Mash A</th>
<th>Mash B</th>
<th>Pellet A</th>
<th>Pellet B</th>
<th>Crumbles</th>
</tr>
</thead>
<tbody>
<tr>
<td>5—</td>
<td>0.0%</td>
<td>0.0%</td>
<td>68.4%</td>
<td>100.0%</td>
<td>1.1%</td>
</tr>
<tr>
<td>5—9</td>
<td>4.4</td>
<td>0.0</td>
<td>29.1</td>
<td>0.0</td>
<td>47.1</td>
</tr>
<tr>
<td>9—14</td>
<td>29.5</td>
<td>1.9</td>
<td>1.6</td>
<td>0.0</td>
<td>28.0</td>
</tr>
<tr>
<td>14—35</td>
<td>39.5</td>
<td>62.9</td>
<td>0.3</td>
<td>0.0</td>
<td>17.4</td>
</tr>
<tr>
<td>35+</td>
<td>26.6</td>
<td>35.2</td>
<td>0.6</td>
<td>0.0</td>
<td>6.4</td>
</tr>
</tbody>
</table>

### Table 3. Average body weight and rate of egg production of birds during experimental periods

<table>
<thead>
<tr>
<th>Experimental period</th>
<th>Dietary treatment</th>
<th>Body weight</th>
<th>Rate of egg production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mash A</td>
<td>2.18±0.17* kg</td>
<td>72.3±3.3* %</td>
</tr>
<tr>
<td>2</td>
<td>Mash B</td>
<td>2.27±0.21</td>
<td>70.9±4.5</td>
</tr>
<tr>
<td>3</td>
<td>Pellet A</td>
<td>2.20±0.15</td>
<td>73.8±4.6</td>
</tr>
<tr>
<td>4</td>
<td>Pellet B</td>
<td>2.32±0.20</td>
<td>76.2±1.6</td>
</tr>
<tr>
<td>5</td>
<td>Crumbles</td>
<td>2.21±0.19</td>
<td>71.8±4.0</td>
</tr>
</tbody>
</table>

* SD
record of the changes in feed intake and the time spent eating. Details concerning the mechanical structure of the apparatus and the procedures of the measurements have been previously reported\textsuperscript{3}).

The data were subjected to statistical analysis and tested for significance by Tukey's test as modified by Snedecor\textsuperscript{4}).

**Results and Discussion**

Daily feed intake and the time spent eating during the experimental periods are summarized in Table 4.

It will be seen that daily feed intake was not appreciably affected by the form of feed offered. There was, however, clear evidence that the birds receiving pellets spent less time at the feed trough than those receiving mash. Statistical analysis of the data shows that the differences among the mean values of the time spent eating (Mash A vs. Pellet A and Pellet B, and Mash B vs. Pellet A and Pellet B) were significant at the 5\% level. It is evident then that the rate of eating, as expressed in the amount of feed consumed per unit of the time spent eating, was markedly increased when the birds received pellets.

The time spent eating in the birds receiving Crumbles was intermediate between the values obtained with the birds receiving mash and those receiving pellets. Each of the differences among these values (Crumbles vs. Mash A, Mash B, Pellet A and Pellet B) was significant at the 5\% level. In addition, although the difference was not statistically significant, there was a tendency for the time spent eating to be decreased in the birds receiving Pellet B as compared with those receiving Pellet A. This may be related to the fact that Pellet A, hand-made pellets, include a certain amount of smaller particles of feed as seen in Table 2. In this connection, the percentages of the time spent eating during the 14 hours of the total daily light period were calculated as 64\% for Mash A, 69\% for Mash B, 22\% for Pellet A, 15\% for Pellet B and 36\% for Crumbles. These results basically agree with the work reported by Jensen* et al.* \textsuperscript{11) who observed that the birds (broiler chickens) required more than three times as many minutes to consume a similar quantity of feed when fed mash as compared with pellets.

Plate 1 shows the examples of the charts in which the cumulative intake of feed (ordinate) and the periods of the time spent eating (partial vertical vibrations) were recorded with the lapse of time (abscissa) within a single day.

<table>
<thead>
<tr>
<th>Experimental period</th>
<th>Dietary treatment</th>
<th>Feed intake</th>
<th>Time spent eating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mash A</td>
<td>110.1±11.7* g</td>
<td>535±120* min.</td>
</tr>
<tr>
<td>2</td>
<td>Mash B</td>
<td>119.6±13.8</td>
<td>576±129</td>
</tr>
<tr>
<td>3</td>
<td>Pellet A</td>
<td>117.6±14.7</td>
<td>183±102</td>
</tr>
<tr>
<td>4</td>
<td>Pellet B</td>
<td>118.4±20.4</td>
<td>127±101</td>
</tr>
<tr>
<td>5</td>
<td>Crumbles</td>
<td>110.4±14.3</td>
<td>305±106</td>
</tr>
</tbody>
</table>

* SD
It will be seen in the example charts that the birds receiving mash were at the feed trough almost continuously during light hours. In marked contrast, the birds receiving pellets were at the feed trough very intermittently and ate a considerable amount of feed in an appreciably short period of pecking. This large difference in feeding pattern between the birds receiving mash and those receiving pellets may be due to the following two facts: When the feed was offered in the granular form, the birds were able to consume a large amount of feed by pecking very few times. Further the birds tended to regulate the feed intake quantitatively at relatively constant intervals.

On the basis of the data from a total of 200 recorder charts (5 days observations on 8 individual birds for each of 5 dietary treatments), diurnal changes in feed intake and the time spent eating were determined. Figures 1 and 2 present a brief summary of the results of the diurnal changes in feed intake and the time spent eating.

In general, it would appear from Figures 1 and 2 that the feeding activity of the birds was found to occur almost exclusively during the hours of light while there seems to be a slight increase in the activity during the dark period when the birds received
Pellet B and Crumbles. It has been shown by Cherry and Barwick\(^3\) for broiler chickens that under adequate conditions (small pens, adequate feed and water, preliminary training) substantial quantities of feed were eaten in the darkness. In the present studies reported here, a great individual variation was found in activity during the dark period, so that there is no statistical evidence that the form of feed has any direct effect on the feeding activity during the dark period.

It was also observed that the birds receiving Mash A had a marked trend for the feeding activity to be increased from 8:00 a.m. to 9:00 a.m. Statistical analysis of mean feed intake in 1-hour periods during the hours of light indicated that feed intake from 8:00 a.m. to 9:00 a.m. was significantly greater than any other 1-hour period \(P<0.05\). This increase in the activity seems to be related directly to the time when the fresh diet was offered to the birds in the morning. As has been mentioned, the feed trough was filled with a fresh diet once daily at 8:00 a.m. In this respect, it was
recognized from observing individual birds that the birds at once began to peck keenly at the large particles of cracked cereals, particularly corn grains mixed in the ration when the birds received Mash A.

By contrast, when the birds received Mash B in which the particle size of feed was made fine and uniform the trend observed in the birds receiving Mash A entirely disappeared. Similarly, no such trend was observed in the birds receiving Pellet A, Pellet B and Crumbles. Therefore, this temporary increase in the activity in the birds receiving Mash A is partly or wholly due to the presence of large particles of feed, such as cracked cereals in the ordinary type of mash ration.

It has been shown by several investigators that chickens prefer relatively large particles of feed to fine ones\textsuperscript{6,7}. Although it has not been conclusively proven in the present study that particle size is the only factor associated with the selective eating of cracked cereals, it is very likely that feeding activity will be facilitated by the presence
of large particles of cereals in the mash ration.

There was a trend, irrespective of the dietary treatments, for the feed intake during the period from 5:00 a.m. to 8:00 a.m. to be decreased as compared with most of the other periods during the hours of light. Although a definite reason for this can not be established it would appear that the decrease in activity in the early morning may be related to the fact that this period was just after the initiation of light hours which commenced at 5:00 a.m. and just before the offering of a fresh diet which was supplied at 8:00 a.m. once a day.

As seen in Figure 1, the feed intake in the birds receiving pellets (both Pellet A and Pellet B) appeared to be decreased during the middle period of light hours. In the birds receiving Pellet A, the feed intake for the hours noon to 1:00 p.m. and 1:00 p.m. to 2:00 p.m. was significantly lower than that for the other 1-hour periods except for the three hours in the early morning from 5:00 a.m. to 8:00 a.m. (P<0.05). Similarly, in the birds receiving Pellet B, the feed intake during the 1-hour periods from 11:00 a.m. to 3:00 p.m. was significantly lower than that of the other periods except for the three hours in the early morning (P<0.05). This trend was also observed in the time spent eating in the birds receiving Pellet A and Pellet B although there was no statistical evidence that the time spent eating was decreased during the middle period of the light hours. A similar diurnal pattern in feeding was observed for broiler chickens by Weaver and Siegel8) who indicated that the feeding activity of the birds was lowest in the middle period of the light hours when feed was provided ad libitum in the limited period of daily light. These authors, however, did not allude to the form of feed used in the experiments, and the relationship between the diurnal pattern in feeding and the form of feed was not discussed in their studies. According to the data shown in Figures 1 and 2, such a diurnal pattern as mentioned above was characteristic only of the birds receiving pellets. This finding would appear to suggest that when birds receive pellets they do not need to peck at the feed very continuously throughout a day, since birds receiving pellets can eat considerably more feed in a given time than those receiving mash. In this respect it is possible that the diurnal pattern in feeding of the birds receiving pellets may resemble "meal eating" (spaced, full meals) rather than "nibbling" (frequent, small feeding) as suggested by Jensen et al.11.

In view of the results from the experiment reported herein, it would be of interest to investigate the regulating mechanisms of feed intake in conjunction with the form of feed and the diurnal changes in rate of eating. Further study may be necessary to evaluate the physiological meanings of the diurnal variations in feeding activity.

Summary

In a series of studies on the variations in the feeding activity of chickens, an experiment was conducted to determine the effect of the physical form of feed on the diurnal changes in this feeding activity.

Eight Single Comb White Leghorn hens were reared in individual cages under a 14-hour light-day, and given five different forms of feeds including various type of mash,
pellets and crumbles.

Diurnal changes in feeding activity were determined with individual birds which received each of the experimental feeds by the use of an apparatus that provided a continuous record of the changes in feed intake and the time spent eating.

Although daily feed intake was not appreciably affected by any of the forms of feed, there was clear evidence that the time spent eating was decreased by granulation of the feed. It was observed that the birds receiving mash were at the feed trough almost continuously during light hours while the birds receiving pellets were at the feed trough very intermittently and consumed a considerable amount of feed in an appreciably shorter period of pecking.

When the birds received the ordinary type of commercial mash ration there was a marked trend for the feeding activity to be increased initially after offering fresh mash. This temporary increase in the activity entirely disappeared when the birds received pellets or reground mash ration in which the particle size of the feed was made uniform.

Feeding activity, irrespective of the form of feed offered, was found to occur intensively during the hours of light, but tended to decrease in the early morning. Further, when birds received pellets a marked decrease in activity was observed during the middle period of the hours of light.

It seems apparent from these results that the physical form of feed, particularly the particle size of feed, is an important factor capable of regulating the rate of eating and the intervals of ingestion of feed within a day under condition of ad libitum feeding.

References

鶏の摂食活動の動変に関する研究

II. 産卵鶏の摂食活動における飼料形状の影響

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帯広畜産大学 帯広市

鶏の摂食活動の変動に関する研究の一環として、摂食活動の日内変動におよぼす飼料の形状の影響を検討した。

白色レグホーン種産卵鶏8羽を人工照明（午前5時より午後7時まで1日14時間）下で個体別ケージに収容し、マッシュ、ベレットおよびクランブルの各形状を含む5種の形状の飼料を給与した。各飼料与給与時に、それぞれ摂食活動記録装置を用いて、摂食数および摂食に費やされる時間の変化を連続的に測定し、摂食活動の日内変動の様相を調査した。

1日の飼料摂取量は飼料の形状によってほとんど影響をうけなかったが、摂食に費やされる時間は飼料の固型化によって明らかに減少した。

摂食活動はマッシュ給与時には照明時間内ではなくほとんど連続的に行なわれるのでに対し、ベレット給与時には著しく断続的となり、短時間のつぶさみで相当量の飼料が摂取される。

通常の市販マッシュ給与時には飼料給与開始の当初に摂食活動が著しく活発となることが特徴的に認められる。しかし、この一時的な摂食活動の高まりは、飼料の粒度分布を均一にした微粉砕マッシュまたはベレット給与時には全く消失した。

一般に摂食活動は照明時間内に集中的に行なわれるが、飼料の形状にかかわらず、早朝の照明天候開始時から飼料の更新直前にかけて摂食活動が低下する傾向があり、また、ベレット給与時には、照明天候帯の中日、正午前後に摂食活動の低下する時間帯が認められた。

飼料の物理的形状、とくに粒度分布は摂食速度および摂食活動発現の時間間隔を規律する要因として意味が大きいものと考えられた。

（家禽会誌、10、47〜55、1973）