The effect of feed transportation and an automatic feeding system on the physical and chemical quality of pelleted feed for broiler chickens

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SUMMARY

The effects of feed transportation and the use of an automatic feeding system on chemical-physical characteristics of pelleted feed for broiler chickens at the final stage of production were evaluated. Samples were collected in two consecutive days and in two different poultry houses, both equipped with the same type of automatic pan feeding system. The samples were collected at the exit of the pelletizer dryer (PEL), at the exit of the bulk truck (CAM) and at 0 (LIN0), 50 (LIN50) and 100 (LIN100) meters of the feed line, for analysis of water activity, dry matter, mineral matter, crude protein, Embrapa Pelletizing Evaluation Method, Pellet Durability Index, as well as coarse and fine percentages. It was used a complete randomized block design (DCB) with five treatments (collection points) and five replicates. The results indicate that the physical feed quality was negatively affected by transportation, with increased (P<0.05) water activity, fine particles (P<0.001) and mineral matter at the beginning of the feed line. There was no change in crude protein levels in the dry and natural matter of the diet (P>0.05). Feed truck unloading at the silo is the main factor affecting its physical quality causing greater pellet breakdown and demixing.

INTRODUCTION

Constant advances in many aspects of animal production provided better results in poultry farming. Despite them, most of the productive expenses of the activity have been related to animal feeding, representing more than 60-70 % of its total cost. According to Paiano et al. (2014), the maximum nutritional utilization of food depends on numerous factors involved on feed production, especially the mixture.

Pelletization is a mechanical process that combines food particles using high temperature (80 - 90 °C) and steam, with the objective to form pellets resilient to transportation and handling (Cardeal et al., 2014), leading to low amounts of fine particles (Amerah et al., 2007), related to feed fragmentation and abrasion resis-
Samples of pelleted feed were collected at different points, from the pelletizer dryer up to the end of the feeding line (100 m) and made of corn, soybean meal, degummed soybean oil, dicalcium phosphate, calcitic limestone in addition to vitamin and mineral premixes. The samples were collected on two different days and at two different farms of 100 x 12 m poultry houses equipped with automatic pan type feeders of the same brand, with the feed being distributed by a helical system coupled to a metal tube of 7.5 cm in diameter. Distance between the feed mill and the farm in average was 30 km and 60 % of this journey was made trough tarmacked road while the remaining 40 % was made of dirt. Chemical and physical analyses involved the samples being collected at five points: pelletizer dryer exit (PEL), point from the feed truck exit in the farm’s feed bin (CAM), in the first feeder (LIN0), 50 meters (LIN50) and 100 meters up (LIN100) the feeding trough line. Procedure used was random block design (RBD) with five treatments (collection points) and five repetions with approximately 1000 g of feed each.

Thus, the aim of this study was to evaluate the effects of feed transportation and an automatic feeding system on chemical and physical characteristics of broiler chicken pelleted feed.

**MATERIAL AND METHODS**

**Sampling**

Figure 1. Average values for PDI and total thick and thin. The transport and unloading activity by truck is the factor of greater breakdown of pellets, demonstrated by the inversion of the lines in the point LIN0; PEL – exit of the pelletizer dryer; CAM – Truck exit; LIN0 – Beginning of the feeding trough line; LIN50 – 50 m; LIN100 – 100 m along the feeding trough line (Valores medios para PDI, grosor y delgadez total. La actividad de transporte y descarga por camión es el factor de mayor descomposición de los pellets, demostrado por la inversión de las líneas en el punto LIN0; PEL – salida del secador de pelletizadores; CAM – Salida del camión; LIN0 – Inicio de la línea de canal de alimentación; LIN50 – 50 m; LIN100 – 100 m a lo largo de la línea de la vaguada de alimentación).

**PDI = 0.0012 \times MEP^2 - 0.0064 \times MEP + 88.728**

- Thick
- Thin
- PDI

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ing in an electromagnetic agitator (Tamis® - Bertel) device for 30 seconds, with 60 vibrations per cycle. Sieves at size Tyler 5 (4.00 mm), Tyler 8 (2.36 mm), Tyler 10 (2.00 mm) and a bottom tray (0 mm), were used to quantify the percent of thin (Figures 1 and 2).

### EVALUATION OF THE PELLET QUALITY

Following the screening, the percentages of feed retained in each sieve were calculated. MEP (Embrapa Pelletizing Evaluation Method - %) was obtained using the percentage retained in the 4 mm sieve, in accordance to Schmidt et al. (2004). The PDI – Pellet Durability Index value (%) was also calculated according to the equation $PDI = 0.0012 \times \text{MEP}^2 - 0.0064 \times \text{MEP} + 88.728$ ($R^2 = 0.958$), as described by Schmidt et al. (2004).

### RESULTS

The water activity was significatively higher (Table I) in samples collected at 50 and 100 meters from the feeder line (LIN50 and LIN100), when compared to those collected at the exit of the dryer (PEL). The dry matter was lower in LIN50 compared to PEL and the CAM. There was an increase ($P<0.05$) in the average values of mineral matter of the samples collected at the beginning of the feed line (LIN0) when compared to those collected at the truck output (CAM), with subsequent reduction, evidenced by the difference between LIN0 and LIN100 points (beginning and end of the line). There were no significant differences for crude protein on dry and natural matter ($P>0.05$).

Physical changes were observed in all treatments (Table II). The retention in the sieve 4.00 mm (MEP) reduced ($P<0.001$) between the samples collected at the pelletizer dryer exit (PEL) and unloading of the feed by the truck to the farm’s feed bin (CAM), while along the feed line no changes were observed.

Percentage of feed retained in the 2.00 mm sieve was higher ($P<0.001$) at the points along the feed line compared to the two initial points (Table II). In addition, the percentage of feed retained at the beginning of the line (LIN0) was lower than the retention of samples collected at 100 meters from the feed line (LIN100). Percentage of thick and thin particles had an inverse behavior before and after the beginning of the feed line (Figure 1), represented by difference ($P<0.001$) between the proportion of the particles thick and thin.

### DISCUSSION

<table>
<thead>
<tr>
<th>Collection points</th>
<th>WA</th>
<th>DM</th>
<th>MM</th>
<th>CPDM</th>
<th>CPNM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEL</td>
<td>0.598 b</td>
<td>89.07 a</td>
<td>4.55 b</td>
<td>19.17</td>
<td>17.11</td>
</tr>
<tr>
<td>CAM</td>
<td>0.605 ab</td>
<td>89.11 a</td>
<td>4.50 b</td>
<td>19.34</td>
<td>17.23</td>
</tr>
<tr>
<td>LIN0</td>
<td>0.603 ab</td>
<td>88.82 ab</td>
<td>5.26 a</td>
<td>19.61</td>
<td>17.37</td>
</tr>
<tr>
<td>LIN50</td>
<td>0.609 a</td>
<td>88.64 b</td>
<td>4.89 ab</td>
<td>19.17</td>
<td>16.99</td>
</tr>
<tr>
<td>LIN100</td>
<td>0.610 a</td>
<td>88.95 ab</td>
<td>4.69 b</td>
<td>19.11</td>
<td>17.00</td>
</tr>
<tr>
<td>p Value</td>
<td>&lt;0.05</td>
<td>&lt;0.01</td>
<td>&lt;0.05</td>
<td>0.056</td>
<td>0.072</td>
</tr>
<tr>
<td>CV (%)</td>
<td>0.99</td>
<td>0.29</td>
<td>8.95</td>
<td>2.86</td>
<td>2.90</td>
</tr>
</tbody>
</table>

Different letters in the same column differ statistically between themselves by Tukey test (5%); Coefficient of variation (CV); PEL – exit of the pelletizer dryer; CAM – Truck exit; LIN0 – Beginning of the feeding trough line; LIN50 – 50m; LIN100 – 100m along the feeding trough line.
Table II. Mean values obtained for the feed retention percentage in the 4.00 mm sieves (MEP); 2.36; 2.00 mm; total thick, totals thin (<2.00 mm) and PDI at the different collection points (Valores medios obtenidos para el porcentaje de retención de pienso en los tamices de 4.00 mm (MEP); 2.36; 2.00 mm; total grueso, totales delgados (<2.00 mm) y PDI en los diferentes puntos de recogida).

<table>
<thead>
<tr>
<th>Collection points</th>
<th>Sieves (mm)</th>
<th>Total thick</th>
<th>Total thin</th>
<th>PDI***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.00</td>
<td>2.36</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>PEL</td>
<td>37.45 a</td>
<td>37.21 b</td>
<td>2.82 c</td>
<td>77.49 a</td>
</tr>
<tr>
<td>CAM</td>
<td>20.09 a</td>
<td>50.06 a</td>
<td>2.97 c</td>
<td>73.12 a</td>
</tr>
<tr>
<td>LIN0</td>
<td>6.63 c</td>
<td>34.19 b</td>
<td>4.22 b</td>
<td>45.05 b</td>
</tr>
<tr>
<td>LIN50</td>
<td>4.79 c</td>
<td>42.83 a mx</td>
<td>4.72 a mx</td>
<td>52.35 b</td>
</tr>
<tr>
<td>LIN100</td>
<td>4.65 c</td>
<td>42.11 a mx</td>
<td>4.94 a</td>
<td>51.71 b</td>
</tr>
<tr>
<td>P Value</td>
<td>&lt;0.001</td>
<td>0.0041</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CV (%)</td>
<td>33.33</td>
<td>21.96</td>
<td>14.05</td>
<td>16.91</td>
</tr>
</tbody>
</table>

a, b, c Different letters in the same column differ statistically between themselves by Tukey test (5%); Coefficient of variation (CV); PEL – exit of the pelletizer dryer; CAM – Truck exit; LIN0 – Beginning of the feeding trough line; LIN50 – 50 m; LIN100 – 100 m along the feeding trough line. ***According to Schmidt et al. (2004).

Changes in the mineral content demonstrate a detrimental effect that feed transportation may exert on pellet integrity and feed quality. Our results indicate a significant increase of minerals at the beginning of the feeding line, corroborating with Cardinal et al. (2014), who reported the same effect on the first feeder. This increase in the mineral matter percentage can be related to a decrease in the percentage of healthy material (thick) from the first feeder (LIN0) and a consequent accumulation of thin, consisting of higher-density particles that comprise the minerals in the feed, sourced from minerals such as calcitic limestone and dicalcium phosphate. Klein (1999) considered the desmixing points within the actions of the screw threads, screens, lifts and feed bins (free fall) as critical. This fall can result in particles being separated, which is a process influenced by difference in the specific weight that is due to the characteristics of the WA material. Faiano et al. (2014) reported that ingredients with excessively different physical characteristics can segregate and promote demixing of the feed, which may explain the results obtained during this study. In a study performed by Scheideler (1995) for evaluate pellets quality, the percentages of thick in the feed mill pellet cooler, transportation through feed truck and feeding troughs, can deteriorate and induce the end of process, reach 66.6, 48 and 41.5%, low values than those found in our study (77.49, 73.12 and 45.05 %) at the same collection stages, respectively.

Although few used, water activity (WA) proved to be an important tool in the quality control of feed. No information has been found in the literature on the routine use of this parameter and, possibly, our study provide the first investigation with pellet fed. According to Reid & Fenema (2010), feeds with the same water content differ significantly in terms of perishability due the intensity differences with which water is associated the non-aqueous components, lower WA cause deterioration of microorganisms and hydrolytic reactions developing. Even at the end of the feeding trough the WA value found (0.61) was not conducive to microorganism development. According to Aqualab (2016), substrates containing levels of WA lower than 0.6 preclude the growth of any microorganism, while levels above 0.61 to 0.87 WA allow the deterioration of food by the action of some xerophilic fungi and, from 0.88 to 0.97 WA is advantageous to most pathogenic bacteria. Our study revealed levels close to 0.6 WA remaining below the critical range.

Despite changes in pellet integrity, there were no significant changes in crude protein levels (Table 1). A plausible explanation for this could be that corn and soybean meal, which are the main contributors for providing crude protein in the feed have lower densities of the calcitic limestone and dicalcium phosphate, responsible for the bulk of the mineral matter in the feed used in this study. According to Lima & Nones (1997), ingredients such as corn and soybean meal have average densities of 0.75 and 0.68 g/cm³, respectively, which are lower values than those found in vitamin and mineral premixes (1.18 g/cm³). However, Clark et al. (2007) indicate that because it comes from different sources, the crude protein is not considered a great indicator of quality mixture.

The methodology created by Schmidt et al. (2004) for evaluate pellets quality by of MEP showed an application different in compared official method (PDI). According to Cardeal et al. (2014) the PDI value does not show the real situation regarding the relationship between whole pellets and thin offered to animals as feed on the farm, which is demonstrated by MEP. Therefore, the PDI is a good method to evaluate pellet resistance in the feed mill, because there is high correlation with the MEP, which proved to be best method to evaluate the condition of the pellet in the field.

Feed composition was negatively affected by the transportation process, with a variation in water activity, mineral and dry matter trough the feeding line. Pellet quality was also negatively affected, with higher impact at the interval between truck exit and the beginning of the feeding line. In addition, there was no variation on crude protein levels in the dry and natural matter from the feed.

BIBLIOGRAPHY


