DRY POST-PELLET APPLICATION OF HEAT-LABILE PRODUCTS TO LIVESTOCK DIETS

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Summary

Post pelleting application of heat-labile enzymes and bacteria was evaluated in a commercial setting. A product containing phytase and *Lactobacillus plantarum* was applied to pellets after fat coating. The fines were separated from the whole pellets in order to determine the amount of product that adhered to the pellets. In this study, 98.6% of the enzyme activity remained adhered to the pellets while only 1.4% was associated with the fines. When the feed was separated into fines and pellets, there was no difference between *L. plantarum* counts in the complete feed and in the screened pellets.

I. INTRODUCTION

Many nutrients, enzymes, and microorganisms currently available are not stable through the conditioning and processing conditions associated with pelleting and extrusion of feeds for livestock and poultry (Chae and Han, 1998; Vanderval, 1979). Vitamins, such as folic acid and niacin, are the first to be destroyed as pelleting temperature reaches 60°C. Many enzymes tend to lose activity past 75°C. However, temperatures above 95°C are often applied to reduce bacterial load in the feed and make harder pellets. There are many factors to consider when evaluating whether an enzyme or microbe survives feed processing as described by Spring *et al.* (1996). The major variables include: temperature, moisture, time, pH, pressure, and feed composition. To overcome the loss of enzyme activity, post-pelleting (processing) application techniques have been used in recent years.

Engelen and van der Poel (1999) state that the only way to fix additives to feed is to spray them on as a liquid. They argue that a powder will not adhere to a feed and will result in separation of the additive into the fines. With those thoughts being shared by many, it is not surprising that the most successful application method to date is liquid spray. However, there are many disadvantages to liquid spray applications such as the effects of temperature on liquids, clogging of spray nozzles and calibration of minute amounts of liquid onto relatively large volumes of feed. The possibility of adding dry enzymes to feed post pelleting was explored by Edens *et al.* (2002). In their study, they used a simple device to apply enzyme to feed in either dry form or with the addition of an oil spray. Even with relatively high CV's for application, the bird performance in terms of feed conversion, Phosphorus (P) reduction in excreta, and growth rate were equal to that of a liquid-sprayed phytase when compared across experiments.

The objective of this study was to determine the post-pellet adhesion of a powdered phytase product and bacteria to pellets.

II. MATERIALS AND METHODS

The test material contained 1000 PU/g of phytase activity and 8.7 log10 cfu *Lactobacillus plantarum* /g. Product was applied immediately after fat coating into a screw conveyor at a rate of 250 g/min. The feed flow rate was approximately 15 tonne/h. A control blank sample was taken prior to treatment with the enzyme/bacterial preparation. Ten replicate samples were taken at each of three treatment locations:

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1. Complete feed (CF) as it entered a storage bin at the end of the screw conveyer;
2. Screened pellets from load out, and
3. Fines screened from load out.

The feed contained 1.3% fines. The feed was assayed for phytase activity under conditions of pH 5.5 and 37°C in the presence of phytic acid for 60 minutes. Phosphorus release was determined colorimetrically. One PU is the μmol of P released per minute under the conditions of the assay.

*Lactobacillus plantarum* (*L. plantarum*) counts were enumerated after appropriate dilutions, in peptone water, using the pour-plate technique in MRS agar and incubated aerobically for 3 days at 30°C. The number of lactobacilli was expressed as the log_{10} per ml of feed sample. Bacterial counts were log transformed to fit a normal distribution prior to analysis by a univariate general linear model analysis of variance (GLM-ANOVA). Significant differences (P<0.05) between the feed samples were compared by Tukey’s post-hoc test (Zar, 1999).

III. RESULTS AND DISCUSSION

The complete feed samples were slightly lower in phytase activity than the load out, though not significantly so (Table 1). A total of 98.7% of the enzymatic activity remained on the pellets (Table 2). The activity in the fines was not as high as has been reported with spray systems which have been shown to have fines with three times the amount of activity as the screened feed (Engelen and van der Poel, 1999). The coefficient of variation was highest in the complete feed most likely because this was nearest the application point. As the feed proceeded to load out and was further mixed, there was a reduction in the variability of enzyme activity. Traditionally there had been a rule-of-thumb 15% acceptable C.V. for enzyme application. This was proven to be an unreliable, arbitrary number in a study demonstrating that birds were still able to perform satisfactorily with an application C.V of 103% (Harter-Dennis, 2000).

Table 1. Phytase activity in complete feed and components (Means of 10 duplicate samples)

<table>
<thead>
<tr>
<th></th>
<th>Complete feed</th>
<th>Load out</th>
<th>Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU/kg</td>
<td>1770a</td>
<td>1979a</td>
<td>2209b</td>
</tr>
<tr>
<td>CV., %</td>
<td>20.7</td>
<td>12.8</td>
<td>1.9</td>
</tr>
</tbody>
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Means in row with different superscript differ (P<.05)

The feed evaluated in this study was of very high pellet quality as indicated by its high percentage of pellets (98.7%) (Table 2). The weighted phytase activity in the pellets and fines is calculated simply by the percent of each fraction multiplied by the activity in each and divided by 100. The liquid addition evaluated by Engelen and van der Poel (1999) showed that nearly 24% of the enzyme activity was in the fines. However, in the current study, only 1.4% of the total activity in the feed was "lost" in the fines (Table 2). It is clear that pellet quality has a major influence on distribution of the enzyme activities in the fines and the pellets, which probably explains the vast difference between the current results and that of Engelen and van der Poel (1999).
Table 2. Weighted phytase activity with feed separated into pellets and fines.

<table>
<thead>
<tr>
<th></th>
<th>Pellets</th>
<th>Fines</th>
<th>Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Distribution, %</td>
<td>98.7</td>
<td>1.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Activity, PU/kg</td>
<td>1953</td>
<td>29</td>
<td>1982</td>
</tr>
<tr>
<td>% of Phytase Activity</td>
<td>98.6</td>
<td>1.4</td>
<td>100.0</td>
</tr>
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</table>

In their study, Engelen and van de Poel (1999) hypothesize that the high amount of fines shown in their study (8.9%) may have been due to the addition of water and thus resulting in higher water activity. This, in turn, resulted in a decrease in pellet hardness and a concomitant decrease in pellet durability. They concluded that based on the three-fold increase in enzyme activity in the fines compared with the pellets that enzyme absorption in the pellet is very small when applied as a liquid.

In addition to enzyme activity, the feed was also analyzed for bacterial adhesion to the pellets. The test material contained $8.7 \log_{10} \text{ cfu} \ L. \ plantarum \ /g$ (SE = 1.18) and therefore, theoretically the pellets should have received $5.7 \ log_{10} \text{ cfu} \ L. \ plantarum \ /g$. Counts of $L. \ plantarum$ in the complete feed and load out did not differ significantly (SE = 0.09) (Figure 1). A higher recovery was identified in the fines ($P = 0.01$) due to the greater surface area available. The control feed, which did not receive the treatment, contained $3.8 \ log_{10} \text{ cfu} \ lactic \ acid \ bacteria \ /g$, which was significantly lower ($P < 0.05$) than treated feed.

![Figure 1. L. plantarum counts (log_{10} cfu g^{-1}) from feed samples (n = 10) taken at three locations during the feed pelleting process.](image)

IV. IMPLICATIONS

Based on these findings, it is anticipated that a variety of other important, heat-labile, feed additives, such as vitamins, may be applied to pelleted or extruded feeds with this technology. The addition of dry enzymes and microorganisms to post-pelleted feeds opens opportunities for probiotics, competitive exclusion bacteria, and yeast cultures to be effectively applied to animal feed.
REFERENCES


