DPI-MA-S-0701GF

Opportunities for Micro-Aid® when Fed in Combination with Distillers Dried Grains with Solubles to Improve Nutrient Utilization and the Fertilizing Value of Swine Manure[1]

Introduction

The continued expansion of ethanol production as a renewable energy fuel has altered the landscape of both grain usage and livestock nutrition. Specifically in the livestock sector, rising feed costs, as well as the increased availability of distillers dried grains with solubles (DDGS) have resulted in greater dietary usage. The purpose of this experiment was to evaluate the effects of feeding DDGS and Micro-Aid® both on the pig and within the waste management system.

Materials and Methods

To accomplish the experimental objective, 24 barrows (Newsham Choice Genetics) were used in a 2 x 2 factorial arrangement of treatments and allotted randomly by initial body weight (average = 135 lb) to four dietary treatments in a randomized complete block design. The four dietary treatments were obtained by combining 0 or 20% DDGS with 0 or 62.5 ppm Micro-Aid® Feed Grade Concentrate: 1) 0% DDGS and 0 ppm Micro-Aid®; 2) 0% DDGS and 62.5 ppm Micro-Aid®; 3) 20% DDGS and 0 ppm Micro-Aid®; and 4) 20% DDGS and 62.5 ppm Micro-Aid®. Diets were corn-soybean meal based and formulated on an available amino acid and available phosphorus (0.30%) basis. Dietary available lysine and metabolizable energy were 0.85% and 1,530 kcal/lb, respectively. Phytase was added to all diets at 400 FTU/kg, which was assumed to release 0.08% available phosphorus. Feed allowance was approximately 3.5% of the pig's body weight and offered twice per day. Pigs were individually housed in stainless steel metabolism pens that allowed for the total but separate collection of feces and urine. After a 15-day adjustment period to the metabolism pen and their respective diet, all feces and representative samples of urine were collected throughout the 6-day collection period, which was divided into two 3-day collection periods. Fecal and urine samples from the first three collection days were used to determine the effects on manure volume and nutrient excretion, while samples from the second 3-day collection period were used in an in vitro pit model.

The in vitro pit model entailed mixing the feces (dry matter basis) and urine from each animal in the ratio determined from the final 3-day collection period to provide a slurry mixture of approximately 8% dry matter. Approximately 2 L of this slurry mix provided the initial seed manure for each model pit (3.78 L). The remaining slurry was allocated in 38 mL amounts and frozen for later use. Three days per week during the 56-day study, slurry was thawed to room temperature and introduced into the model pits to simulate the continual addition of feces and urine during production. From each model pit, headspace air and manure samples were collected periodically and analyzed for nutrients and gas production.

The experimental design of this experiment allows one to evaluate the effects of Micro-Aid® and DDGS in two ways: 1) within the pig; and 2) within the pit (i.e., waste management system). Consequently, the results are presented in this manner.

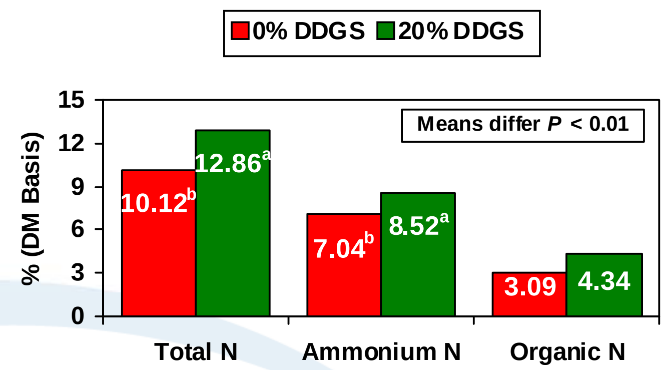
[1] This experiment was conducted by a Major Midwestern Swine Feed and Research Company and Purdue University, West Lafayette, IN, USA.

Results and Discussion

Effects of Micro-Aid® and DDGS within the Pig

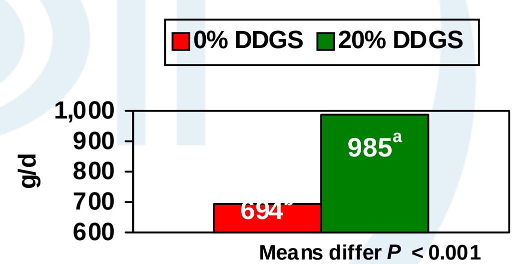
Although the protein content of DDGS is greater than 25%, the amino acid balance is poor. Thus, use in swine rations may require synthetic amino acid supplementation, as was done in this study. One advantage of the high protein content of DDGS is the subsequent increase in nitrogen (N) compounds of fresh manure and resulting greater fertilizer value. As previously mentioned, slurry samples (i.e., feces and urine) were used in the in vitro pit model; thus, slurry samples from day 0 would be representative of feces and urine freshly excreted by the pig. Figure 1 indicates that the inclusion of 20% DDGS in the diet increased ($P < 0.01$) total N by 27%, ammonium N by 21%, and organic N by 41%. This increase in N compounds makes the fertilizer value of the manure even greater, especially as the costs of commercial fertilizer continues to escalate.

Figure 1. Day 0 Slurry Samples of In Vitro Pit Model



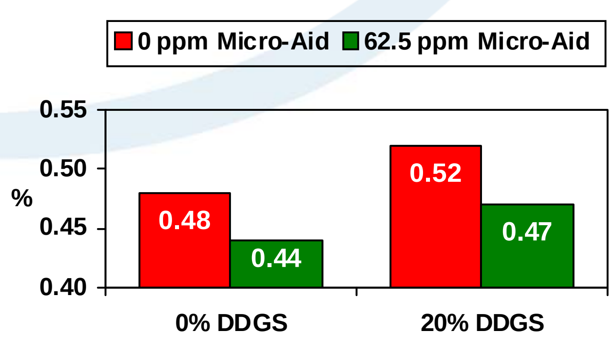
The increase in N compounds of manure is primarily attributed to the greater fecal matter excretion due to DDGS. Although the diets were formulated to be isocaloric, the inclusion of 20% DDGS in the diet increased crude fiber content by almost 1%, with an especially large increase in neutral detergent fiber (greater than 3.5%). An increase in dietary fiber will lead to greater manure excretion. Results from the present study indicate that including 20% DDGS in the diet increased ($P < 0.001$) fecal matter excretion by 42% (Figure 2), which will significantly alter pit composition and generate greater solids accumulation in the storage system.

Figure 2. Fecal Excretion Weight (DM)



The concern with the high protein content of DDGS is that excess protein can lead to greater generation of intestinal ammonia, which is normally absorbed from the colon and detoxified via reconversion to urea in the liver and excreted in urine via the urea cycle. Interestingly, Micro-Aid® supplementation to diets containing either 0 or 20% DDGS reduced urinary N concentration by 10.6 or 9.1%, respectively, when compared with the same diet without Micro-Aid® (Figure 3). This reduction in urinary N concentration is due to the positive impact Micro-Aid® has on promoting a healthier gastrointestinal tract environment to improve N utilization. Previous research has demonstrated that

Figure 3. Urinary Nitrogen Concentration



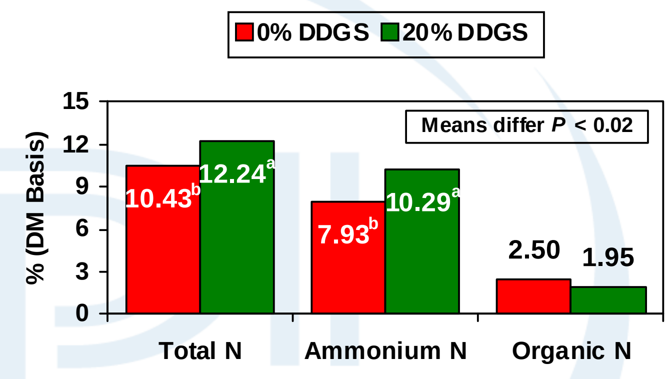
RESEARCH SUMMARY

Micro-Aid® functions to promote a healthier gastrointestinal tract environment, including reducing intestinal ammonia that could subsequently damage absorptive tissue and increase tissue turnover and maintenance costs. This improvement in dietary nutrient utilization due to Micro-Aid® was also noted in other nutrients, including phosphorus. Micro-Aid® reduced fecal phosphorus concentration in diets containing 0% DDGS by 11.9% (0.74 vs. 0.84%). This reduction in fecal phosphorus concentration is consistent with previous reports. Furthermore, a reduction in fecal phosphorus concentration helps widen the N to phosphorus ratio (N:P) of manure and create a more ideal ratio that more closely match the plant's requirements. A more ideal N:P ratio in the manure benefits producers whose land-application rates are regulated by phosphorus by allowing them to spread more manure to land and better meet the N requirement of corn, which is normally the first limiting nutrient. More N supplied by the manure also minimizes the amount needing to come from a commercial fertilizer source. As well, a more ideal N:P ratio in N-based manure application strategies minimizes more phosphorus being applied than can be taken up by the crop.

Effects of Micro-Aid® and DDGS within the Pit

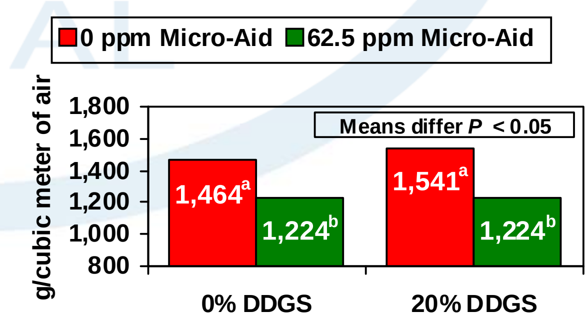
Results of slurry samples on day 56 in the in vitro pit model would be representative of the effects of Micro-Aid® and DDGS on manure while it is stored in a pit or another type of waste management system. Similar to the freshly excreted manure samples (day 0 values)), manure of pigs fed 20% DDGS had greater total N (17%) and ammonium N (30%); however, organic N was 22% less (Figure 4). Feeding DDGS increases total manure N and fertilizer value, but there is a shift in N compounds from the organic to the ammonium form, which is a less stable form that has greater storage loss potential.

Figure 4. Day 56 Slurry Samples of In Vitro Pit Model



As was expected from the dietary inclusion of 20% DDGS, aerial ammonia emissions were increased by 5.3% (Figure 5: 1,541 vs. 1,464 g/cubic meter). However, the benefit of Micro-Aid® in reducing aerial ammonia is well documented. The present experiment further supports that fact as aerial ammonia was reduced ($P < 0.05$) after 56 days in the pit model, irrespective of DDGS inclusion level. Micro-Aid® supplementation reduced aerial ammonia by 16.4 and 20.6% in diets containing either 0 or 20% DDGS, respectively. If the pit model study had been extended for a time period similar in length to the wean-to-finish period, the reduction in aerial ammonia due to Micro-Aid® would have been even greater and closer to the 44% average reduction reported by 19 other experiments.

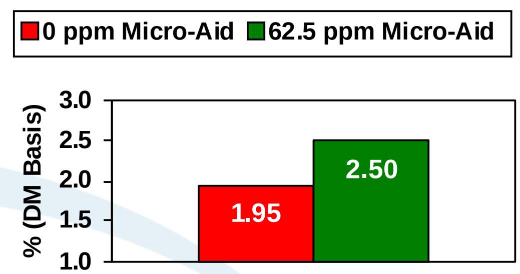
Figure 5. Aerial Ammonia



A decrease in the conversion of ammonium N to readily volatile ammonia will minimize the N lost during storage in the waste management system and help to increase the total N concentration in manure and its overall fertilizing value. Micro-Aid® proved beneficial in improving manure fertilizing value as evidenced by an increase in the organic N concentration of slurry samples on day 56 (Figure 6). Micro-Aid® supplementation increased the organic N concentration 28% compared with diets receiving no Micro-Aid®. Organic N is a more stable form that is less susceptible to volatilization and loss of fertilizing value.

The final benefit noted with Micro-Aid® in the present study was that after 56 days in the pit model, dissolved solids (i.e., soluble solids) as a percentage of total solids was increased by 4.3% due to the inclusion of Micro-Aid® in diets containing 20% DDGS. As previously mentioned, there was a 42% increase in fecal matter excretion because of feeding 20% DDGS, which will significantly alter pit composition and generate greater solids accumulation in the storage system. In a 150,000 gallon manure storage system, the greater breakdown of solids due to Micro-Aid® represents almost 6,500 more gallons of liquefied solids that can be pumped out with greater ease and reduced energy cost.

Figure 6. Organic N



Summary

- One advantage of the protein content of DDGS and the increase in fecal matter excretion associated with its dietary inclusion is the resulting greater amount of total N compounds (i.e. total N = 27%, ammonium N = 21%, and organic N = 41%) excreted in the manure of pigs. Additional value is gained through the enhanced fertilizer value of the manure, especially as commercial fertilizer prices continue to escalate.
- Although DDGS increases total N, it is in a less stable form that is more subject to storage loss and ammonia volatilization. During storage within the waste management system there is a shift in N from the organic form to the ammonium form, which led to a 5.3% increase in aerial ammonia emissions.
- Within the pit, Micro-Aid® stabilizes the N, which reduces storage loss, improves fertilizer value, and reduces ammonia emissions. Micro-Aid® reduced aerial ammonia emissions by 16 to 20% when added to diets either with or without DDGS. This reduction in aerial ammonia emissions with Micro-Aid® is due to a shift from ammonium N to organic N. As well, it is supported by a decrease in urinary N concentration, which is a more readily volatile source of aerial ammonia.
- Minimizing the N loss during storage as a result of ammonia volatilization helps to increase the total N concentration in manure, as well as its overall fertilizing value. Micro-Aid® further enhanced manure fertilizing value as a result of the 28% increase in the organic N concentration of slurry, regardless of DDGS inclusion level in the diet.
- Micro-Aid® promotes a healthier gut environment by reducing intestinal ammonia and subsequent damage to absorptive tissue, which allows for greater dietary nutrient utilization as evidenced by the 12% reduction in fecal phosphorus concentration. A reduction in fecal phosphorus concentration creates a more ideal N:P ratio that more closely matches the plant's requirements and is beneficial in both phosphorus- or N-based manure application strategies.
- The inclusion of 20% DDGS increased fecal matter excretion by 51% and will generate greater solids accumulation in waste treatment facilities; however, Micro-Aid® supplementation resulted in greater breakdown of solids in the pit model, which allows the producer to pump more manure from their waste

management system and create greater storage area for future use, as well as reduce the energy cost required to pump the manure.

- If DDGS can be added to the diet without negatively impacting animal performance, then additional value is gained through the enhanced fertilizer value of the manure. However, the shift from organic to ammonium N increases the risk of aerial ammonia volatilization and storage loss. The addition of Micro-Aid® further enhances fertilizer value through an increase in total N. In addition, Micro-Aid® mitigates potential environmental concerns by increasing the proportion of total N that is in the organic (more stable) form, which reduces storage loss and substantially reduces the increase in aerial ammonia.

Key Take Home Points

1. **Micro-Aid® improves dietary nutrient utilization and reduces volatilization of ammonia, regardless of DDGS inclusion level.**

2. **Micro-Aid® minimizes N loss in the pit by maximizing the shift in N compounds from the ammonium form to the organic form. This improvement in N content, along with a reduction in fecal phosphorus concentration, creates a more ideal N:P ratio in the manure that is better in both phosphorus- and N-based manure application strategies.**

3. **Micro-Aid® increases the breakdown of solids in the pit, which creates more liquefied slurry and allows for greater pumping efficiency, including pumping more manure out and reducing energy cost associated with pumping.**

4. **DDGS increases manure N and fertilizer value, but shifts N from the organic form to the ammonium form, which has greater storage loss potential to aerial ammonia.**

5. **Using Micro-Aid® when feeding DDGS maximizes fertilizer value of manure because of the increase in N compounds and decrease in ammonia volatilization.**