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The protective effects of encapsulated butyric acid and zinc on grower swine under heat stress conditions[1]

ABSTRACT

Heat stress can result in muscle damage, oxidative stress and death, but possibly its most common impact is on the gastrointestinal tract[3]. The combination of heat stress and the decrease in feed intake associated to stress can result in severe losses. Those losses can be minimized with a proactive approach.

The objective of this study was to evaluate the protective effects of an encapsulated source of butyric acid and zinc (BPZ) on swine performance and intestinal integrity during heat stress. Pigs were assigned to either a diet containing BPZ or control diet without the supplementation. The pigs were fed for a total of 38 days, in which the last 7 days they were under heat stress. During the heat stress period, BPZ pigs had significant improvement in weight gain and feed:gain. In addition to improvements in intestinal integrity measurement, the study showed the butyric acid and zinc pigs had higher feed intake and maintained a higher growth rate during the heat stress period. BPZ fed pigs gained 1.78 kg more body weight than the control pigs, an improved growth performance during the 38 day period.

Introduction

Heat stress has a significant impact on agricultural animals and most of the negative effects are related to damage to the intestine[3]. Certain short chain fatty acids and essential minerals have critical roles in maintaining the intestinal barrier. Specifically, butyric acid increases the expression of tight junction proteins and the proliferation of epithelial cells[6,7] in addition to being an epithelial energy source. Zinc plays an important role in the upregulation of tight junction proteins in intestinal cells and increases the microbial diversity of the intestine[4,5]. Together, butyric acid and zinc have the ability to yield a gut health product with synergistic modes of action.

Methods and Materials

The experiment was conducted at the Iowa State University swine nutrition farm in Ames, Iowa. The encapsulated butyric acid and zinc was added to the feed at the level indicated in Table 1.

Table 1. Inclusion levels of feed additives for pigs over a period of twelve weeks.

Treatment	Feeding Level
Negative Control (NC)	150 ppm zinc
NC + BPZ	2181 ppm butyric acid + 819 ppm zinc in a 60% fat matrix

Twenty four gilts weighing approximately 35 ± 1 kg were used for the study (n=6/trt) in a randomized complete block design. Pigs were on the respective feed for 24 days before being moved into metabolism crates. After 7 days of adaptation to the metabolic crates at 20 °C, the animals were then subjected to a biphasic heat stress. For 8 days, the day time temperature was 30-32°C and 28° C at night. Temperatures were maintained at 32˚C on the fourth day of challenge due to the pigs acclimating to the elevated temperatures. At the end of the 7 days (heat stress period), 6 pigs from each group were euthanized. Ileum and colon tissues from each pig were collected and placed in Ussing chambers. An Ussing chamber acts similar to intestine under *in vivo* conditions. Permeability characteristics of the intestine under *ex vivo* characteristics were studied, which helps in assessing the permeability and integrity of the intestine.

Results

BPZ pigs had a numerically higher ADG compared to the control group during the pre-heat stress period which was significant during the heat stress period (Fig. 1). BPZ pigs had a numerically higher ADFI in the pre-heat stress and heat stress periods.

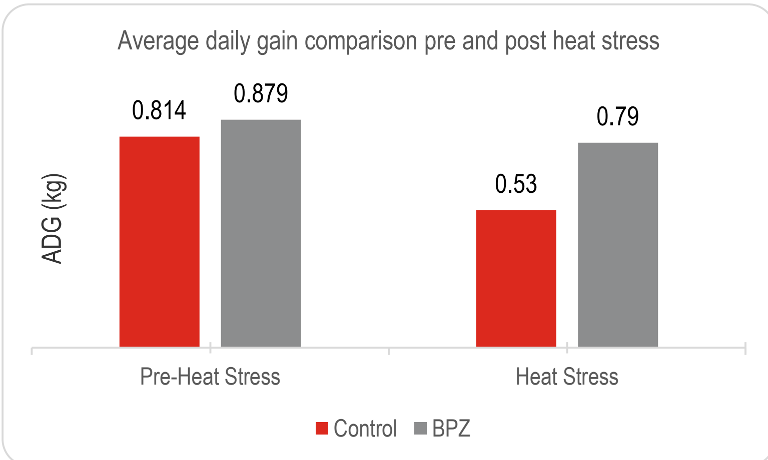


Figure 1. Average daily gain (ADG) of grower pigs supplemented with encapsulated butyric acid and zinc prior to and after heat stress. * Indicates the value is significantly different from control, (P<0.05).

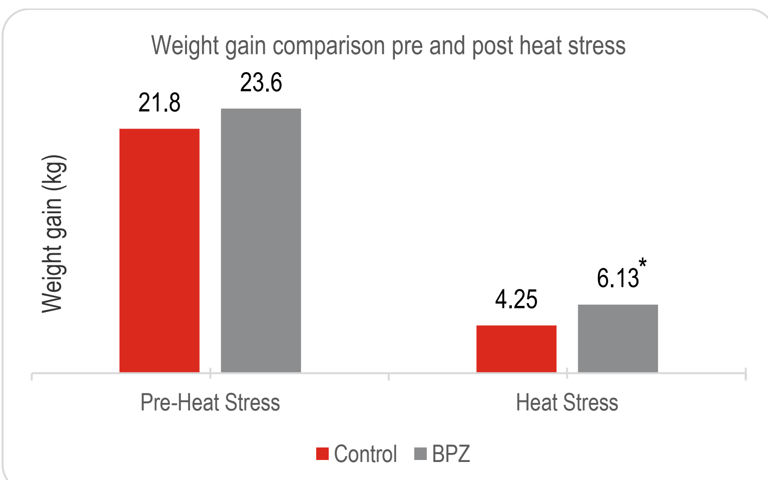


Figure 2. Weight gain of grower pigs supplemented with encapsulated butyric acid and zinc prior to and after heat stress. * Indicates the value is significantly different from control. (P<0.05).

The pigs weighed approximately 35±2 kg when the trial started and completed the trial at 59±2 kg. BPZ pigs weighed approximately 1.8 kg more than control pigs prior to heat stress, and weight gain was significantly higher during the heat stress period (Fig. 2). Gain to Feed was also significantly higher during the heat stress period for the BPZ pigs compared to the control group (Fig. 3).

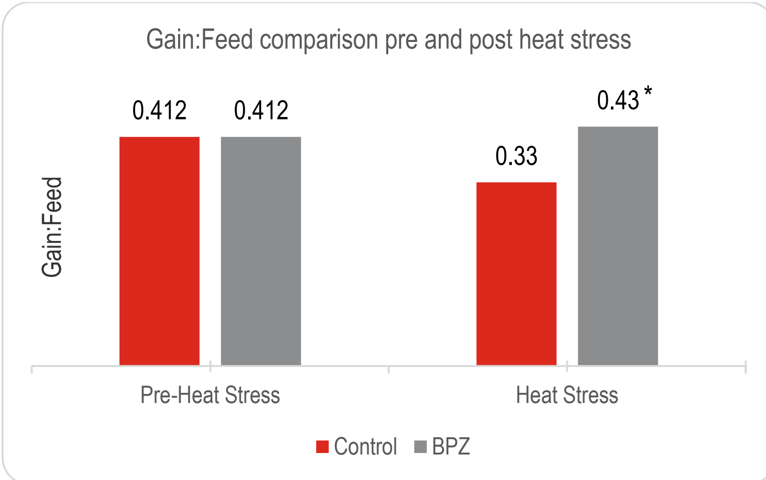


Figure 3. Gain:Feed of grower pigs supplemented with encapsulated butyric acid and zinc prior to and after heat stress. * Indicates the value is significantly different from control. (P<0.05).

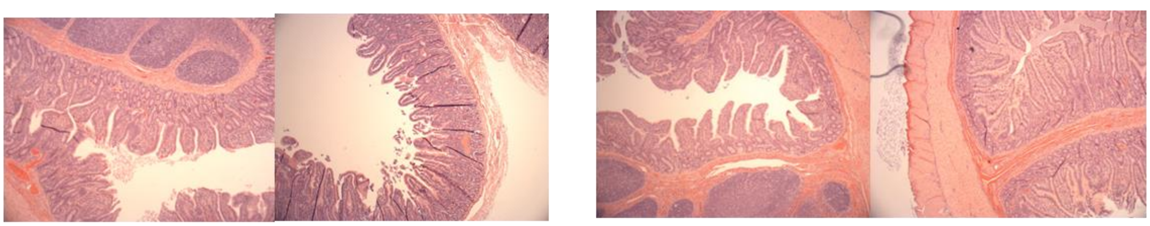
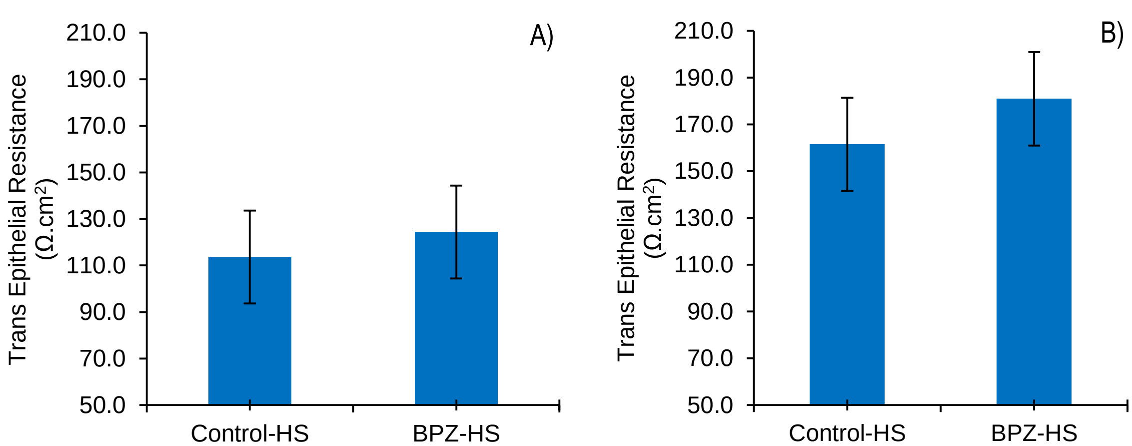


Figure 4. Ileum morphology of control (left) and encapsulated butyric acid and zinc (right) fed pigs after 7 days of diurnal heat stress.[1]

There was a numerical increase in Trans Epithelial Resistance (TER) for BPZ pigs compared to the control for the ileum and colon, indicating that intestinal integrity was improved during the heat stress period (Figure 5A & 5B). In addition, permeability was decreased for BPZ pigs in the ileum and colon compared to control pigs during heat stress (Figure 5C & 5D).



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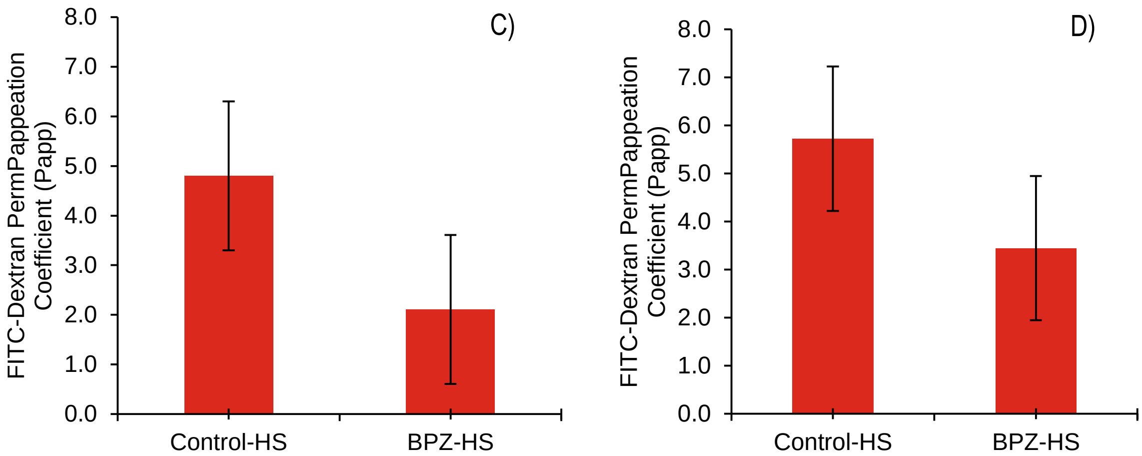

Figure 5. Intestinal health parameters of grower pigs supplemented encapsulated butyric acid and zinc under heat stress (HS) for seven days. TER of ileum (A) and colon (B) and macromolecule permeability of ileum (C) colon (D).

CONCLUSIONS

The data indicates the encapsulated combination of butyric acid and zinc may reduce the negative effects of heat stress on the intestine and improve growth performance. Data from this study indicates the encapsulated butyric acid and zinc fed pigs have higher feed intake and maintain a higher growth rate during the heat stress period. The encapsulated combination of butyric acid and zinc is a suitable feed supplement to support swine health, particularly during stress conditions.

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