Zinc oxide at low supplementation level improves productive performance and health status of piglets

J. Morales,*1 G. Cordero,* C. Piñeiro,* and S. Durosoy†

*PigCHAMP Pro Europa SL, Spain; and †ANIMINE, Sillingy, France

ABSTRACT: Use of ZnO at high doses (3000 ppm) for diarrhea prophylaxis in piglets is widely extended in postweaning Spanish diets, in compliance with the national veterinary regulation. However, European feed legislation limits total dietary Zn to a maximum of 150 mg/kg of complete feed. The objective of this study was to compare a new potentiated form of ZnO, HiZox (Animine), at nutritional level (150 ppm) with pharmacological dosage (3000 ppm) of regular ZnO in starter diets on the productive performance and health status of piglets in a medium-low health status farm. A total of 144 pigs at weaning (28 d of age) were distributed in 6 piglets/pen and 12 pens/treatment. In the prestarter phase (28 to 42 d of age), all pigs received the same commercial feed, including 3000 ppm ZnO. In the starter phase (42 to 63 d of age) (T1) included 3000 ppm of regular ZnO (2500 ppm Zn), and (T2) was supplemented with 110 ppm Zn from potentiated ZnO (HiZox). Average daily feed intake, ADG, G:F, and pig-MAP serum concentration, an acute phase protein commonly used as unspecific biomarker of disease or other acute phase reactions, were measured at 42 and 63 d of life. Pen of 6 piglets was the experimental unit and data were analyzed using the GLM procedure of SAS version 9.0. Piglets fed with T2-HiZox had improved ADG and G:F (P< 0.001) compared to piglets fed with T1-ZnO. In addition, at 63 d of age, the T2 group had a lower pig-MAP serum concentration than T1 group (1.71 vs. 0.95 μg/mL; P< 0.05) indicating higher health status in the T2 group. In conclusion, in low-medium sanitary conditions and in compliance with European regulation, HiZox significantly increased piglet growth compared to pharmacological dosage of regular ZnO in the starter phase. This can be explained by a better health of pigs expressed by a lower level of inflammatory protein pig-MAP.

Key words: health status, piglets, pig-MAP, zinc oxide

INTRODUCTION

In the last decades, research efforts have focused on ZnO at high doses (3000 ppm) for diarrhea prophylaxis in piglets (Carlson et al., 2008). Its use in postweaning diets is widely popular in Spanish swine herds, in compliance with the national veterinary regulation. European feed legislation limits total dietary Zn to a maximum of 150 mg/kg of complete feed.

Acute phase proteins (APP) have been used as unspecific biomarkers of disease or other acute phase reactions (Piñeiro et al., 2009). In the case of pigs, the most interesting APP in terms of its use as a biomarker is the pig-MAP (Heegaard et al., 2011). Monitoring the concentration of APP can provide an objective measure of the health status of animals and herds (Murata et al., 2004). The concentration of APP has been shown to be proportional to the severity of the underlying condition, and therefore they can be used to measure the presence and also the extent of the disease (Petersen et al., 2004). The study was conducted to compare a new potentiated form of ZnO, HiZox (Animine), at nutritional level (150 ppm) with pharmacological dosage (3000 ppm) of regular ZnO in starter diets on the productive performance and health status of piglets measured by pig-MAP serum concentration in a medium-low health status farm.

MATERIALS AND METHODS

Animals and Experimental Diets

A total of 144 pigs (50% male) at weaning (28 d of age) were distributed in 6 piglets/pen (0.30 m²/
piglet) and 12 pens/treatment. In the prestarter phase, all pigs received the same commercial feed, containing 3 kg ZnO/T of complete feed. In the starter phase, 72 piglets received feed supplemented with 110 ppm Zn from potentiated ZnO (T2-HiZox). The composition of the feed was typical wheat (Triticum aestivum)—barley (Hordeum vulgare)—corn (Zea mays)-based diets and nutritional values of feeds were net energy 2400 kcal/kg, crude protein 18%, crude fiber 4.4%, and lysine 1.20%. All diets were offered ad libitum to animals throughout the experiment.

Measurements and Statistical Analysis

All the pigs were weighed individually at the weaning (28 d) and at the beginning of the experiment (42 d) and at d 63. Furthermore, FL, ADG, and G:F were also calculated per pen. Blood from one pig per pen was sampled to analyze pig-MAP serum concentration. Pig-MAP is a plasma glycoprotein of Mr 120K. Although the precise function of the protein remains unknown, beside its possible activity as a substrate of kallikrein (Nishimura et al., 1995), pig-MAP may exert anti-inflammatory activities (Choi-Miura et al., 2000) by its ability to inhibit actin polymerization and phagocytosis of polymorphonuclear cells and may play a role in liver development (Bhanumathy et al., 2002) and placental attachment (Geisert et al., 2003). Pig-MAP was purified from pig acute phase serum as previously described (González-Ramón et al., 1995). Incidence of pathologies and mortality were recorded daily.

A pen of 6 piglets was the experimental unit. Data were analyzed as a completely randomized design using the GLM procedure of SAS (SAS Institute Inc., Cary, NC) including source of Zn as fixed factor in the model. Data shown in tables and graphs are least squares means. Differences between least squares means were tested post hoc by the Tukey-Kramer test. Differences were considered significant if P < 0.05 and were considered as tendencies if 0.05 < P ≤ 0.10.

RESULTS AND DISCUSSION

In the prestarter phase, when pigs received one only feed, productive performance was similar to historic data of the experimental farm, and incidence of disease, including mortality, was especially low. However, in the starter phase, growth performance was poor compared with normal growth performance in the experimental farm, likely due to an outbreak of Escherichia coli-induced diarrhea. The outbreak of diarrhea was not serious and only 3 piglets died during the experimental period, with no differences between experimental treatments (1 and 2 piglets died in T1 and T2 groups, respectively).

In the starter phase, piglets fed with T2-HiZox had improved ADG (424.3 vs. 358.8 g/d; P < 0.001), BW (17.93 vs. 16.51 kg; P < 0.001) and G:F (0.586 vs. 0.694 g/g; P < 0.001) compared to piglets fed with T1-ZnO (Table 1). Feces consistence and percentage of pigs requiring an injectable treatment to treat diarrhea evidenced the presence of the outbreak of diarrhea, but no differences were observed between treatments. On the other hand, serum concentrations of APP and, in particular pig-MAP, increase significantly if health status is affected. Based on previous studies, concentrations over 1.0 μg/mL indicate health status affection. In this experiment, final pig-MAP concentration was greater in T1-ZnO than in T2-HiZox group (1.71 vs. 0.95 μg/mL; P<0.05) (Figure 1), confirming higher health status in this group and associated with growth performance. In addition, pig-MAP is an unspecific biomarker of health, inflammation processes, or stress situations. In this case, higher pig-MAP concentration might also indicate signs of toxicity or adverse effects resulting from high and prolonged doses of Zn oxide in the control pigs.

In conclusion, in medium-low sanitary conditions and in compliance with European regulation, HiZox significantly increased piglet growth compared to pharmacological dosage of regular ZnO in the starter phase. Furthermore, HiZox pigs had lower pig-MAP serum concentration than control pigs, suggesting higher health status.

Table 1. Growth performance in the starter phase (42 to 63 d of age).

<table>
<thead>
<tr>
<th></th>
<th>Final BW, kg</th>
<th>ADG, g/d</th>
<th>G:F, g/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-ZnO</td>
<td>16.51</td>
<td>358.8</td>
<td>0.586</td>
</tr>
<tr>
<td>T2-HiZox</td>
<td>17.93</td>
<td>424.3</td>
<td>0.694</td>
</tr>
<tr>
<td>SEM, n = 12</td>
<td>0.208</td>
<td>7.315</td>
<td>0.0069</td>
</tr>
<tr>
<td>Probability</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Figure 1. Pig-MAP serum concentration (μg/mL) of piglets at 42 and 63 d of age.
LITERATURE CITED


