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Effects of Supplementation of Mineral Nano Particles on Weaned Piglet Growth

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Abstract— *In this study, we aimed to evaluate the effect of supplementation of mineral nano particles on piglet growth by assessing the live weight gain, the total feed intake, and the feed conversion ratio. A total of 240 Duroc-Landrace-Yorkshire piglets weaned at 25 days were randomly assigned to 4 treated groups and 1 control group. Piglets of Group I was fed with basal diets supplemented with 1.6 mg/kg nMn, 20 mg/kg nFe, 2 mg/kg nCu, 0.1 mg/kg Co, 0.1 mg/kg nSe, and 20 mg/kg nZn. The nano mineral content of Group II, III, and IV were 2, 4, and 8-fold higher than Group I, respectively. The results showed that the higher concentration of mineral nano particles supplementation (group III and IV) associated with the higher live weight gain. The piglet from group IV showed a highest live weight gain (36.68 ± 0.34 kg) comparing to other groups (P < 0.01). All groups of treatment with mineral nano particles supplementation showed the lower feed conversion ratio comparing to control group. There was no significant difference in the feed conversion ratio of piglet from group I (2.85 ± 0.08), group II (2.69 ± 0.13), group III (2.73 ± 0.03), and group IV (2.69 ± 0.07).*

Keywords— feed conversion ratio, feed intake, mineral nano particles, live weight gain.

I. INTRODUCTION

Minerals play an important role in the nutrition of animal production. Minerals perform digestive and reproductive process and growth of animals [1]. Nano minerals have been considered as the factors could improve bioavailability by the increase in the surface area, higher surface activity, high catalytic efficiency and stronger adsorbing ability [1]. Nano minerals are used for enhancing the bioavailability of minerals in livestock which is helpful in improving growth, production and health status of animals [1].

The previous studies reported that the growth rate was significantly promoted in guinea pigs supplemented 20 ppm commercial nano zinc (30 nm) in the diet [2], or that broiler chicks supplemented with nano zinc at 20, 60 and 100 ppm level had significantly higher weight gains as compared to control birds fed 60 ppm Zn as zinc oxide [3], Tong et al. reported that supplementation of 500 ppm nano ZnO improved average daily gain in weanling pigs [4].

On the other hand, the other studies found that average daily gain was not affected in goat supplemented 20-40 ppm nano zinc oxide [5], or the supplementation of 0-400 ppb Cr loaded Chitosan nanoparticles (Cr-CNP) in the finishing pigs while had no effect on growth performance [6]. The supplementation of 1200 mg/kg nano-ZnOs (about 30 nm) significantly increased final body weight and average daily gain, and 3000 mg/kg ZnO plus colistin sulfate significantly increased average daily gain and decreased diarrhea rate in weaned piglets [7]. However, these studies only used nano minerals separately to assess the effect of them on animal growth. In this study, we used the weaned piglet as the model to assess the effects on growth performance by assessing the live weight gain, the total feed intake, and the feed conversion ratio.

II. MATERIALS AND METHODS

The experiments were approved and conducted according to the guidelines of Department of Animal Health, Ministry of Agriculture and Rural Development, Vietnam.

Animal and experimental design

Five experimental groups were designed from 240 Duroc-Landrace-Yorkshire piglets which weaned at 25 days of age. Each group consisted of 48 piglets. Five groups were received the same basal diet (per kilogram diet) including: corn (55.7 %), extruded soybean (12 %), soybean meal

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(18.3 %), fish meal (4 %), whey powder (4 %), glucose (2 %), vitamin premix (1%). The control group was received commercial mineral premix (1%). Piglets of Group I was fed by basal diets supplemented with 1.6 mg/kg nMn, 20 mg/kg nFe, 2 mg/kg nCu, 0.1 mg/kg Co, 0.1 mg/kg nSe, and 20 mg/kg nZn. The nano mineral content used for Group II, III, and IV were 2, 4, and 8-fold higher than Group I, respectively.

Evaluation of piglet growth

Two parameters were used for evaluation: the feed intake and the live weight of piglet. The feed intake was recorded daily while the live weight was recorded every 60 days. The live weight gain (LWG) for each piglet was calculated by below formula:

$$\text{LW} = \text{body weight (t60)} - \text{bodyweight (t0)}$$

In which, t0 and t60 are the live weights of piglets in day 0 and day 60 of the experiment, respectively.

The total feed intake (TFI) for one piglet was calculated by below formula:

$$\text{TFI} = \sum_{k=0}^{60} \text{FI}(k)$$

In which, FI is the feed intake of piglet for every day.

The feed conversion ratio (FCR) of piglet was calculated by below formula:

$$\text{FCR} = \frac{\text{DMI}}{\text{LWG}}$$

In which, DMI is dry matter intake and LWG is live weight gain.

Statistical Analysis

All experimental data were preliminarily processed by Excel 2007. The statistical analysis was performed using one-way ANOVA where P≤0.05 was considered statistically significant.

III. RESULTS

Effect of supplementation of mineral nano particles on live weight gain of piglet

Fig. 1 showed the live weight gain of piglet in the control and treated groups from 60 days after treatment. The results showed that the live weight gain of piglet was increased from group I to group IV. The piglet from group IV showed the highest live weight gain (36.68 ± 0.34 kg) comparing to other groups (P < 0.01). The live weight gain of piglet from group III (33.84 ± 0.15 kg) was higher than control group and group I and II (P < 0.05). There was no significant difference in the live weight gain between control group (31.96 ± 0.16 kg), group I (32.13 ± 0.17 kg), and group II (31.07 ± 0.60 kg).

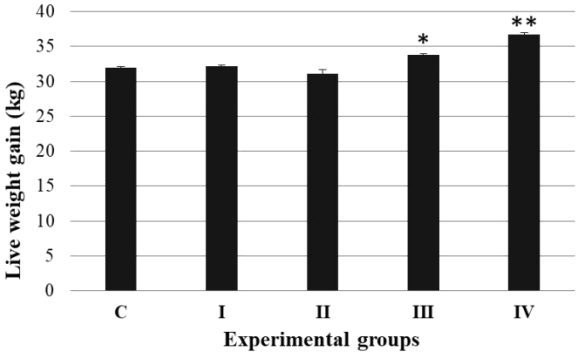

*Fig. 1: Effect of supplementation of mineral nano particles on live weight gain of piglet. **P < 0.01 (group IV) vs. other groups, *P < 0.01 (group III) vs. other groups*

Effect of supplementation of mineral nano particles on total feed intake of piglet

Fig. 2 showed the total feed intake of piglet in the control and treated groups from 60 days after treatment. The results demonstrated that the piglet from group IV exposed a highest total feed intake (98.43 ± 1.36 kg) comparing to other groups (P < 0.05). There was no significant difference in the total feed intake between control group (91.01 ± 0.10 kg) and group III (92.42 ± 0.32 kg). The total feed intake of piglet from group I was 85.90 ± 0.31 kg. The group II exposed a lowest total feed intake (P < 0.05) comparing to other groups.

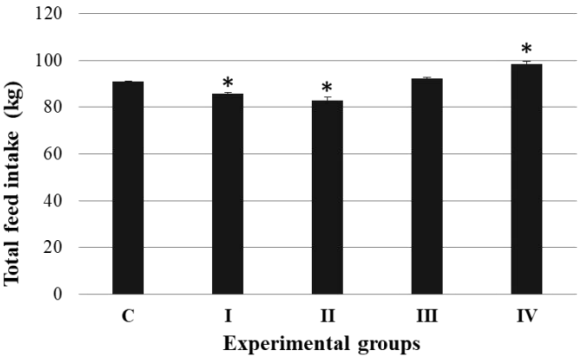

*Fig. 2: Effect of supplementation of mineral nano particles on total feed intake of piglet. *P<0.01 (group III) vs. other groups*

Effect of supplementation of mineral nano particles on feed conversion ratio of piglet

Fig. 3 demonstrated ratio of feed conversion of piglet treated with mineral nano particles. The results showed that there was no significant difference in the feed conversion ratio of piglet from group I (2.85 ± 0.08), group II (2.69 ±

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0.13), group III (2.73 ± 0.03), and group IV (2.69 ± 0.07). The control group showed the highest feed conversion ratio of piglet (2.85 ± 0.08) comparing to other groups ($P < 0.05$).

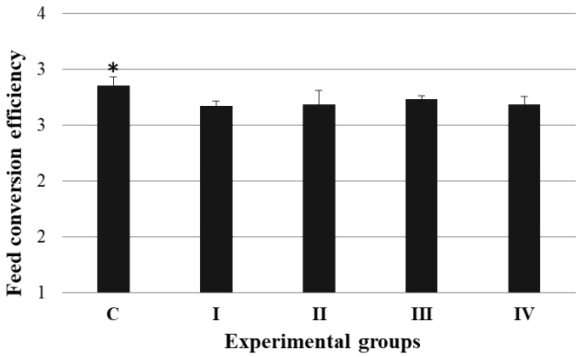

*Fig. 3: Effect of supplementation of mineral nano particles on feed conversion ratio of piglet. *P<0.01 (group III) vs. other groups*

IV. DISCUSSION

Weaned piglets show several important problems such as the weak physiology and immune systems, which are related to susceptibility to infections and diseases, especially diarrhea and growth reducing. The use of additives in feed has been popular as a regulator of the immune system and intestinal microflora, thereby promoting the health and growth performance of piglets after weaning. The supplementation of mineral nano particles for piglet diets has been considered as a useful solution for reducing diseases of piglets and promoting growth performance. In this study, the supplementation of mineral nano particles showed positive effects on live weight gain of piglets. There was no significant difference in the live weight gain between group I, group II and control group, suggested that the supplementation of mineral nano particles with low concentration was not efficient to increase live weight gain of piglets. The live weight gain of piglet of control group was similar to the other study which uses normal mineral ingredients [8]. The higher concentration of mineral nano particles supplementation (group III and IV) exposed the higher live weight gain.

However, the nano mineral content in this study is lower than other studies which applied the high nano mineral content for feed ingredients, such as 600 mg/kg nano-zinc (nZnO) [9], 250 mg/kg copper nanoparticles (nCu) [10], or 100 mg/kg copper nanoparticles [11]. These studies demonstrated that nano mineral supplementation could boost the immune system, reduce the incidence of diarrhea, and promote pig growth, especially weaned pigs.

The feed conversion ratio is an important performance indicator for producers, given its influence on production costs [12]. This defines the feed requirement in kg per kg body weight gain. There are several factors effect on feed conversion ratio including the level of feeding, the energy value of the ration, and the energy concentration of the body weight gains [12]. In the present study, all groups of treatment with mineral nano particles supplementation showed the lower feed conversion ratio. This revealed that mineral nano particles supplementation could increase the level of feeding which leading to reducing feed conversion ratio.

V. CONCLUSION

The present study found that nano mineral supplementation could promote piglet growth, as indicated by an increased live weight gain and the reduced feed conversion ratio.

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