

# EFFECT OF ILLITE AND LOESS ON GROWTH PERFORMANCE AND IMMUNE CHARACTERISTICS IN FINISHING PIG

J. H. RYU<sup>1</sup>, Y. S. Choi<sup>1</sup>, J. K. Lee<sup>1</sup>, J. T. Jeong<sup>1</sup>, J. S. Choi<sup>2</sup> and Y. I. Choi<sup>1\*</sup>

<sup>1</sup> Department of Animal Science, Chungbuk National University, Cheongju Korea 361-763

<sup>2</sup> Department of Swine Science & Technology Center, Gyeongnam National University of Science and Technology, Jinju Korea, 660-758

\*Corresponding author email: yangilchoi@chungbuk.ac.kr

**Abstract** - This study was conducted to investigate the effect of illite and loess supplementation on growth performance and immunity of finishing pigs. A total of 60 pigs were used to 6 groups with 3 replications. The 6 treatments were as follows. T1 (Basal diet for total period), T2 (Early growth 0.8% illite, late growth 0.5% illite), T3 (Early growth 0.8% illite, late growth 1.0% illite), T4 (Early growth 0.8% illite, late growth 1.5% illite), T5 (Early growth 0.8% illite, late growth 2.0% illite), T6 (Early growth 0.8% loess, late growth 1.5% loess). During the experiment periods, ADG (Average daily gain) values in T5 and T6 were higher than the other treatments. FCR (Feed conversion ratio) values in T3, T4 and T5 groups showed lower level compared to the T1. In the values of hormone and immune, there were no significant differences in contents of IGF-1, Ig, WBC, NE, LY, MO and EO among the treatments during both former and latter growth periods ( $p>0.05$ ), but, the immunity of pigs fed with illite and loess tended to increase. As a result, supplementation of illite and loess increased the values related to growth performance and immunity of growing pigs. Therefore, it was concluded that the illite and loess could be used as a natural additives on pig diet.

**Key Words**- Growth performance, Immunity, Illite and Loess

## I. INTRODUCTION

Illite is a representative clay mineral in soil and is classified as a major mineral along with kaolinite and smectite. It comprises non-expandable octahedral particles less than 2-4  $\mu\text{m}$  in size and includes minerals such as mica that are rich in aluminum. Illite is either generated in K-feldspar or muscovite by the weathering of rocks, or formed by the diagenesis of smectite at low temperatures. Because its physical state and the crystallinity of particles are diverse, its physicochemical properties are also diverse (Park and Jang, 2007). Its chemical properties, illite serves a variety of functions, such as heavy metal adsorption, toxic gas absorption,

antibacterial and antiviral activities, and generation of anions and far-infrared rays (Lee and Lim, 2013). And illite supplementation in pigs has effectively reduced the incidence of diarrhea, disease prevalence, and mortality, and increased body weight and feed efficiency (Kondo *et al.*, 1968; Torii, 1977). Loess refers to soil formed by the weathering of rocks. Loess accounts for about 10% of the earth's surface and is distributed across various continents. Thus, it has played a central role in agriculture for a long time, particularly in areas of dense populations (Hwang *et al.*, 2006). Loess has a multi-porous structure, and is utilized in a variety of sectors because of its functions of general adsorption/desorption, buffer action, ion exchange, infrared radiation, and heavy metal adsorption (Seo *et al.*, 2014).

Therefore, this study conducted to evaluate the effects of feeding illite and loess on growth performance and immunity in finishing pigs.

## II. MATERIALS AND METHODS

Sixty, three-week cross hybrid growing pigs (LYD) were selected from the progeny of a Landrace and Yorkshire (LY) F1 sow and a Duroc (D) boar. Illite and loess were provided as powdered livestock products by Woosung Feed Company Ltd. The feeding experiments were conducted at the experimental pigpen (T1: basal diet for total period, T2: early growth 0.8% illite + late growth 0.5% illite, T3: early growth 0.8% illite + late growth 1.0% illite, T4: early growth 0.8% illite + late growth 1.5% illite, T5: early growth 0.8% illite + late growth 2.0% illite, T6: early growth 0.8% loess + late growth 1.5% loess) at Woosung Feed Company from July to November 2007. The initial and final body weights of each individual were measured. For each pigsty, the amount of feed supplied at each feeding and the amount of remaining feed was recorded, after which the final body weight was measured. The feed conversion ratio was calculated by dividing the average feed intake of each pigsty by the

average body weight gain. Immunity-boosting substances and hormones in blood samples collected from the carotid artery of the experimental animals were assessed by blood analysis center (Iwonimsangeomsa, Seoul, Korea).

### III. RESULTS AND DISCUSSION

The growth performance of finishing pigs supplemented with illite and loess is presented in Table 1. Although no significant differences were observed among the various treatment groups in the measurements (Total body weight gain, average daily gain and feed conversion ratio) under study, total body weight gain in all illite-supplemented groups was greater than that in the T1 group. In addition, the average daily gain in all illite-supplemented groups was greater than that in the T1 group and was highest in the 2.0% illite supplementation group. On the other hand, because of the increased body weight gain, the feed conversion ratio also showed improvement in the 1.0%, 1.5%, and 2.0% illite supplementation groups, with the most favorable results in the 1.5% supplementation group. Total body weight gain and average daily gain were higher in the loess supplementation group (1.5%), compared to the T1 group, and even higher than the respective values in the illite supplementation groups. The feed conversion ratio in the loess supplementation group was similar to that in the 1.5% illite supplementation group.

Table 1. Effect of dietary illite and loess supplementation on growth performance of finishing pigs

Treat-ments*	T1	T2	T3	T4	T5	T6
<sup>1</sup> IBW (kg)	52.50 ±6.44	50.50 ±5.86	50.55 ±5.51	50.56 ±5.88	50.78 ±4.15	50.35 ±5.15
<sup>2</sup> FBW (kg)	101.70 ±13.52	106.67 ±6.89	107.50 ±5.34	107.56 ±7.04	106.78 ±6.22	111.10 ±6.37
<sup>3</sup> TBW (kg)	49.20 ±9.34	55.17 ±4.94	56.95 ±6.50	57.00 ±8.56	56.00 ±5.01	60.75 ±7.08
<sup>4</sup> ADG (kg)	0.72 ±0.14	0.76 ±0.12	0.79 ±0.10	0.77 ±0.14	0.82 ±0.08	0.85 ±0.06
<sup>5</sup> FCR	3.26 ±0.67	3.26 ±0.40	3.19 ±0.41	3.10 ±0.74	3.16 ±0.40	3.14 ±0.27

\*T1(Basal diet for total period), T2(Early growth 0.8% illite, late growth 0.5% illite), T3(Early growth 0.8% illite, late growth 1.0% illite), T4(Early growth 0.8% illite, late growth 1.5% illite), T5(Early growth 0.8% illite, late growth 2.0% illite), T6(Early growth 0.8% loess, late growth 1.5% loess)

<sup>1</sup>) Initial body weight, <sup>2</sup>) Final body weight, <sup>3</sup>) Total body weight,

<sup>4</sup>) Average daily gain, <sup>5</sup>) Feed conversion ratio

The hormonal and early immune characteristics of finishing pigs supplemented with illite and loess is presented in Table 2. Although no significant differences were evident in IGF-1 levels (a hormone involved in growth promotion of pigs), increased levels were observed in the groups supplemented with illite at levels above 1.0%. There was a trend of increased immunoglobulin (Ig, or immune protein) levels in the illite-supplemented groups, particularly in the >1.0% supplementation groups; however, these differences were not statistically significant. Although no significant differences were observed in the white blood cell (WBC) count, higher counts in the illite-supplemented groups were recorded in comparison to the T1 group, particularly in the 1.5% and 2.0% illite-supplementation groups. WBCs were divided into NE (neutrophils), LY (lymphocytes), MO (monocytes), and EO (eosinophils), of which NE and LY were the major WBCs. NE are involved in defense against exogenous infectious materials, and the NE count was higher in the illite supplementation groups, compared to the T1 group. Similar levels of other WBC types were observed among the treatment groups. The loess supplementation group (1.5%) yielded higher levels of IGF-1 and Ig, and higher WBC and NE counts in comparison to the T1 group. These results were similar to those of the 1.0% illite supplementation group.

Table 2. Effect of dietary illite and loess supplementation on hormone and early immune of finishing pigs

Treat-ments*	T1	T2	T3	T4	T5	T6
<sup>1</sup> IGF-1 (ng/ml)	309.40 ±63.90	304.10 ±78.10	315.49 ±45.40	324.10 ±66.6	335.90 ±65.00	326.30 ±89.50
<sup>2</sup> Ig (mg/ml)	1.45 ±0.27	1.48 ±0.35	1.57 ±0.35	1.56 ±0.25	1.56 ±0.24	1.48 ±0.41
<sup>3</sup> WBC (K/μl)	17.40 ±3.70	20.50 ±4.90	19.40 ±3.10	21.80 ±2.80	21.90 ±3.90	20.20 ±3.50
<sup>4</sup> NE (K/μl)	13.20 ±3.50	16.30 ±4.50	15.00 ±2.10	17.60 ±2.40	17.50 ±3.60	15.60 ±4.60
<sup>5</sup> LY (K/μl)	3.70 ±1.10	3.60 ±1.50	3.80 ±1.80	3.50 ±1.10	3.80 ±1.60	3.90 ±1.40
<sup>6</sup> MO (K/μl)	0.50 ±0.20	0.60 ±0.20	0.60 ±0.30	0.60 ±0.20	0.50 ±0.20	0.70 ±0.20
<sup>7</sup> EO (K/μl)	-	-	-	-	0.10 ±0.10	-

\*T1(Basal diet for total period), T2(Early growth 0.8% illite, late growth 0.5% illite), T3(Early growth 0.8% illite, late growth 1.0% illite), T4(Early growth 0.8% illite, late growth 1.5% illite),

T5(Early growth 0.8% illite, late growth 2.0% illite), T6(Early growth 0.8% loess, late growth 1.5% loess)

<sup>1)</sup> Insuline-like growth factoc-1, <sup>2)</sup> Immunoglobulins, <sup>3)</sup> White blood cells, <sup>4)</sup> Neutrophils, <sup>5)</sup> Lymphocytes, <sup>6)</sup> Monocytes, <sup>7)</sup> Eosinophils

The hormonal and late immune characteristics of finishing pigs supplemented with illite and loess is presented in Table 3. The IGF-1 and Ig levels recorded in latter measurements of all treatment groups were higher than those recorded in former measurements (Table 3). IGF-1, IG, WBC, and NE levels were higher in the illite-supplemented groups, particularly the 1.0%, 1.5% and 2.0% groups; however, this difference was not statistically significant. The LY, MO, and EO counts were similar among the treatment groups. Although there were no significant differences in the loess supplementation group (1.5%), IGF-1 hormone, Ig, WBC, and NE counts were higher compared to the T1 group. These results were similar to those of the illite supplementation groups. In the present study, illite- and loess- supplemented diets improved the health status of pigs by removing harmful gases and microbes from the intestines, and increasing Ig levels, most likely via far-infrared radiation.

Table 3. Effect of dietary illite and loess supplementation on hormone and late immune of finishing pigs

Treatments*	T1	T2	T3	T4	T5	T6
<sup>1)</sup> IGF-1 (ng/ml)	436.60 ±66.70	442.60 ±57.30	439.59 ±97.10	460.90 ±58.20	467.70 ±64.90	443.80 ±82.60
<sup>2)</sup> Ig (mg/ml)	1.50 ±0.26	1.72 ±0.30	1.83 ±0.38	1.77 ±0.13	1.67 ±0.18	1.63 ±0.17
<sup>3)</sup> WBC (K/μl)	18.10 ±3.10	18.50 ±1.40	19.40 ±2.30	19.40 ±3.30	20.30 ±4.70	19.10 ±3.70
<sup>4)</sup> NE (K/μl)	12.40 ±2.60	12.50 ±1.30	13.70 ±1.40	14.00 ±3.40	14.90 ±3.10	13.40 ±3.70
<sup>5)</sup> LY (K/μl)	3.70 ±1.10	3.80 ±1.30	3.80 ±1.00	3.50 ±1.30	3.40 ±1.10	3.80 ±1.40
<sup>6)</sup> MO (K/μl)	1.10 ±0.40	1.10 ±0.30	0.90 ±0.20	1.00 ±0.40	0.90 ±0.20	1.00 ±0.20
<sup>7)</sup> EO (K/μl)	0.90 ±0.20	1.10 ±0.20	1.00 ±0.20	0.90 ±0.20	1.00 ±0.40	0.90 ±0.20

\*T1(Basal diet for total period), T2(Early growth 0.8% illite, late growth 0.5% illite), T3(Early growth 0.8% illite, late growth 1.0% illite), T4(Early growth 0.8% illite, late growth 1.5% illite), T5(Early growth 0.8% illite, late growth 2.0% illite), T6(Early growth 0.8% loess, late growth 1.5% loess)

<sup>1)</sup> Insuline-like growth factoc-1, <sup>2)</sup> Immunoglobulins, <sup>3)</sup> White blood cells, <sup>4)</sup> Neutrophils, <sup>5)</sup> Lymphocytes, <sup>6)</sup> Monocytes, <sup>7)</sup> Eosinophils

## V. CONCLUSION

As a result, in comparison to the T1 group, TBW and ADG were increased in the illite-supplemented groups, in addition to which the FCR was improved. Superior results were observed particularly in the group supplemented with 1.5% illite. Hematological analysis revealed that hormonal levels and immune characteristics were improved by illite supplementation. IGF-1, a hormone that promotes growth, and immunoglobulin and WBC levels, which increase immune activity, were higher in the groups supplemented with illite in comparison to the T1 group. Therefore, feeding illite and loess improves growth performance and immune characteristics of finishing pigs.

## ACKNOWLEDGEMENTS

This study was supported by Woosung Feed Company Ltd.

## REFERENCES

1. Hwang, H. Z., Kim, J. G., & Yang, J. H. (2006). A study on the chemical properties and strength development of regional Hwnagto. Korea Institute of Ecological Architecture and Environment Journal 6(2): 11-18.
2. Kondo, J., & Wagai, B. (1968). Experimental use of clinoptilolite-tuff as dietary supplements for pigs. Yotonkai May: 1-4.
3. Lee, C. E., & Lim, N. G. (2013). The fundamental study on water-purification and hardened cement paste strength in mortar using functionality illite. Journal of the Regional Association of Architectural Institute of Korea 15(2): 181-188.
4. Park, C. W., & Jang, Y. S. (2007). Soil and fertilizer. Korean Society of Soil Sciences and Fertilizer.
5. Seo, Y. J., Gil, B. J., Kyoung, J. S., Yoo, B. S., Chang, Y. H., Yu, S. Y., & Lee, Y. S. (2014). Effect of environmetally-friendly red clay-processed materials on quality characteristics of eel. Journal of the Korean Society of Food Science and Nutrition 43(2): 287-292.
6. Torrii, K. (1977). Utilization of natural zeolites in Japan. Natural Zeolites; Occurrence, Properties, Use, 441-450.

