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# Effect of Different Levels of Perlite on Sucrase Mucosal Enzymes Activity in Small Intestine of Broiler Chicks

*Jamshid Ghiasi Ghale-Kandi, Rahim Beheshti, Habib Karamouz, Yahya Ebrahimnazhad, Keyvan Hatefinazhad and Naser Maheri-Sis*

Department of Animal Science, Islamic Azad University, Shabestar Branch, 53815-159 Shabestar, Iran

**Abstract:** Sucrase enzyme is an enzyme responsible for digestion and absorption of carbohydrates in the small intestine and as the effect of perlite administration in the diet of broilers on this enzyme had not been investigated the following study had been designed and performed. An experiment was conducted to study the effects of different levels of perlite on Sucrase enzyme activity of the small intestine in male broilers. The experimental design was arranged as randomized complete bocks in 4 × 2 factorial arrangement of treatment. 180 male broilers of Ross 308 commercial hybrid was designated into 3 groups (0, 2 and 4 %). 3 replicates of 20 birds were assigned to each treatment. Control treatments were fed base diet and groups with the same base diet plus 2 or 4% perlite. Animals were slaughtered after 21, 28, 36 and 42 days and different segments of small intestine (at1,10,30,50,70 and 90% of total length of the small intestine) were taken from each replicates (N=2) Sucrase enzyme activity was measured and recorded. Data were analyzed by SAS ($P<0.05$). As intake of perlite, significantly increased Sucrase enzyme activity at weeks and sites of the small intestine of the broiler chicks ($P<0.05$). It was concluded that perlite administration has significant effect on Sucrase enzyme activity of the broiler chicks.

**Key words:** Perlite · Sucrase · Small intestine and broiler chicks

## INTRODUCTION

Perlite is one of the volcanic, Aluminum- Silicate minerals which are hydrated and clear and in it, there can be found tiny holes. Raw perlite is in transparent and light grey or gloss black and if it is put in the temperature of 871 degrees centigrade will increase 4 to 20 times in volume and will change color to snow white or grey white. Perlite contains has neutral pH and it was confirmed by the official congress of controlling animals' diet in the U.S. and was fit into the chemical recipe of the diet. Its usage as an additive is also confirmed in Europe. Concerning the chemical constituent, point it contains Aluminum and Silicate components [1].

There are limited number of studies on the use of perlite as an adsorbent. The removal of dyes such as methylene blue was reported by Do¢gan *et al.* [2], Methyl violet, by Do¢gan *et al.* [3] and Do¢gan *et al.*[4], victoria blue, by Demirbas *et al.* [5] and metal ions such as copper (II), by Alkan and Do¢gan [6] and cadmium by Mathialagan and Viraraghavan [7] by perlite. Perlite is essentially a metastable amorphous aluminum silicate and has recently been used as an aflatoxin detoxicant and adsorbent in the removal of wastewater and the amount of chloride in blood serum [8].Tangkawanit *et al.* [9] have studied analcime synthesized from perlite for its potential use as an ion exchanger for removal of the toxic metals $Cu^{2+}$, $Ni^{2+}$, $Pb^{2+}$ and $Zn^{2+}$. Glodek [10] experimented the use of perlite in hog feed. A comparison was made between hogs fattened with traditional feeds and those fattened with the same feeds combined with perlite.

It must be especially emphasized that the perlite fed pigs achieved a daily weight gain higher by 197g and duration of fattening lower by 23 days with the same feed utilization as the ration-fed control animals. Sakai and Nagao [11] used three levels of perlite (1, 10, 20%) for 8 weeks for feeding 21 male and 21 female mice and concluded that the mice's behavior, causality and food consumption were not affected by the experimental food and there was no significant change in the parameters related to biochemical components of the blood and urine, the weight of the limbs, autopsy findings and pathology

**Corresponding Author:** Jamshid Ghiasi Ghale-Kandi, Department of Animal Science, Islamic Azad University, Shabestar Branch, 53815-159 Shabestar, Iran

of tissue, however the male mice fed by 10 and 20 percents of perlite, did not grow well; after all, one percent of perlite was reported to be the appropriate dosage for the growth of mice. Scheila [12] and Alkan *et al.* [6] reported that perlite is responsible for dissection of excretion and its absorption through transmission of moisture and it acts like a damper between the earth and the birds and increases the growth along with decreasing the respiratory diseases, thigh scorch and callus in the breast.

Sucrase is a brush-border enzymes that catalyse the hydrolysis of sucrose to fructose and glucose leads to the digestion of the carbohydrates in the diet. In contrast, increases in mucosal disaccharidase (Sucrase and isomaltase) activity have been described in the hatching chick, with disaccharidases exhibiting an activity peak at 2 days of age [13]. In turkeys jejunal and ileal mucosal disaccharidase activity per gram of mucosa increased between 2 and 14 d of age, then reached a plateau [14]. Few reports on the activity of digestive enzymes are available in turkey.

Researches on chick's performance designated the appropriate perlite level for the diet of broilers to be 1 to 3 percent and for hatching chickens to be 3 percent [1].

In the current research, the effect of perlite on the sucrase enzyme activity in the small intestine of chicken broilers was investigated.

## MATERIALS AND METHODS

**Birds and Diet:** A total number of 180 male broilers of commercial hybrid (Ross 308) was divided into 3 treatment groups (0, 2 and 4 %). Each treatment group was divided into 3 replicates of 20 birds. The Birds in each replicate were kept separately in cages next to each other and on litter. All conditions were the same for all replicates. Chicks' diets were formulated according to the advice of NRC [15]. The control treatment group was fed by basal diet (with 0.0 % level of perlite) through out the experimental period. While, the other two treatment groups fed by basal diet with addition of 2 and 4 % of perlite, respectively. The Birds were provided by the food and water, freely.

**Sample Collection:** In the rearing period, all conditions such as temperature, humidity, light, ventilation and management were appropriate and similar for all treatment groups and in days 21, 28, 35 and 42 of the rearing period, after 3 hours of fasting, 2 broilers from every group (totally 18 chickens on each day of sampling) which had nearly equal to the average weight of each replicate have been chosen and slaughtered. Hastily, samples of 1, 10, 30, 50, 70 and 90 percent of the length of small intestine for analyzing the Sucrase enzyme activity were separated.

**Enzyme Assay:** In the laboratory, using a sensitive scale, 0.05 gram of the mucosal small intestine was weighed and along with 10 ml liter phosphate buffer saline (pH=7) was formed into a homogenized solution using sonic vibracell sonics (*VCX 130 TE USA*) device. Enzyme activity for sucrase was measured according to the procedure of Dahlqvist [19], Hill [17] and Teshfam [18]. It goes without mentioning that for measuring the activity level of sucrase. It was needed to measure total protein in which Pirogallol (calorimetric) method was used [18]. The activity level of each enzyme of each sample is divided into the amount of its total protein so that the activity level of the enzyme, according to the IU in liter/gram protein is reached.

**Statistical Analyses:** Results were statistically analyzed using the linear model of SAS software (2001) and Multivariate Analysis Variance [20]. Comparative analysis of the average of treatments was performed using Duncan's multifunctional method in the random of 5 percent.

## RESULTS

According to Table 3, adding perlite to the diet of the broilers at different ages and to different parts of the small intestine caused variety of influences on the activity of sucrase enzyme. Adding 2% perlite to the diet of the birds

Table 1: Chemical composition of perlite

| Constituent | Percentage present |
|---|---|
| $SiO_2$ | 71-75 |
| $Al_2O_3$ | 12.5-18 |
| $Na_2O$ | 2.9-4.0 |
| $K_2O$ | 4.0-5.0 |
| CaO | 0.5-2.0 |
| $Fe_2O_3$ | 0.1-1.5 |
| MgO | 0.03-0.5 |
| $TiO_2$ | 0.03-0.2 |
| $MnO_2$ | 0.0-0.1 |
| $SO_3$ | 0.0-0.1 |
| FeO | 0.0-0.1 |
| Ba | 0.0-0.1 |
| PbO | 0.0-0.5 |
| Cr | 0.0-0.1 |

Uluatam, 1991. (cited by Dogan *et al.*, 1999)

Table 2: Ingredient and nutrient compositions of experimental diets

| | (1-21 Days) | | | (21-42 Days) | | |
|---|---|---|---|---|---|---|
| | 0% | 2% | 4% | 0% | 2% | 4% |
| Ingredient | | | | | | |
| Corn | 54.5 | 54 | 45 | 62.64 | 39 | 59 |
| SBM (%44) | 34.14 | 34.19 | 35.81 | 27 | 27.7 | 27.7 |
| Oil | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Methionine | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 |
| Lysine | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 |
| Vitamin-premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Mineral-premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| DCP | 1.6 | 1.6 | 1.62 | 1.13 | 1.13 | 1.13 |
| Oyster | 1.44 | 1.4 | 1.33 | 1.48 | 1.44 | 1.39 |
| Salt | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| perlite | 0 | 2 | 4 | 0 | 2 | 4 |
| Starch | 1.06 | 1.41 | 7.37 | 0 | 2.6 | 2.6 |
| Fine Sand | 3.38 | 1.46 | 0.07 | 3.67 | 2.05 | 0.1 |
| Nutrients | | | | | | |
| ME3 (kcal/kg) | 2850.21 | 2850.11 | 2850.14 | 2920.54 | 2920.03 | 2920.03 |
| Protein (Percent) | 20.5 | 20.51 | 20.5 | 18.17 | 18.18 | 18.17 |
| Calcium (Percent) | 0.99 | 0.99 | 0.99 | 0.89 | 0.89 | 0.89 |
| Phosphorus (Percent) | 0.44 | 0.44 | 0.44 | 0.34 | 0.34 | 0.34 |
| ME/Protein | 139 | 138.96 | 139.03 | 160.69 | 160.64 | 160.64 |
| Calcium/ Phosphorus | 2.23 | | 2.23 | 2.56 | 2.58 | 2.58 |

SBM1 = soybean meal; DCP2 = dicalcium phosphate. ME[3] = Metabolisable energy. Per 2.5 kg mineral supplement containing 99200 mg magnesium, 84700 mg zinc, 50000 mg iron, 10000 mg copper, 990 mg Iodine, 200 mg selenium, 250000 ml gram Colin chloride. Per 2.5 kilogram vitamin supplement containing 900000 IU of vitamin A, 200000 IU of vitamin $D_3$, 19000 IU of vitamin E, 200 mg vitamin $K_3$, 18050 mg vitamin $B_1$, 49000 mg vitamin $B_2$ 9800 mg vitamin $B_3$, 29650 mg vitamin $B_5$ 2940 mg vitamin $B_6$ 1000 mg vitamin $B_9$ 15 mg vitamin $B_{12}$ 100 mg biotin, 190000 mg cholin chloride, 1000 mg antioxidant.

Table 3: Comparison of average sucrase activity between treatments in different periods and segments of small intestine in broiler chicks (IU/g protein)

| | 1 % length of small intestine | | | |
|---|---|---|---|---|
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.031±0.028 | 0.061±0.029 [b] | 0.055±0.048 | 0.069±0.052 |
| 2 % group | 0.044±0.015 | 0.126±0.042 [a] | 0.107±0.047 | 0.052±0.022 |
| 4 % group | 0.075±0.034 | 0.059±0.032 [b] | 0.085±0.056 | 0.065±0.038 |
| | 10 % length of small intestine | | | |
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.035±0.09 [b] | 0.072±0.022 | 0.085±0.051 | 0.035±0.009 |
| 2 % group | 0.123±0.042 [a] | 0.086±0.042 | 0.080±0.029 | 0.042±0.017 |
| 4 % group | 0.043±0.018 [b] | 0.071±0.028 | 0.034±0.012 | 0.034±0.014 |
| | 30 % length of small intestine | | | |
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.035±0.006 | 0.071±0.043 | 0.071±0.033 | 0.043±0.020 |
| 2 % group | 0.070±0.039 | 0.093±0.069 | 0.084±0.038 | 0.050±0.043 |
| 4 % group | 0.092±0.061 | 0.063±0.041 | 0.080±0.041 | 0.031±0.011 |
| | 50 % length of small intestine | | | |
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.031±0.028 | 0.093±0.056 | 0.077±0.047 | 0.040±0.022 |
| 2 % group | 0.040±0.018 | 0.106±0.059 | 0.066±0.042 | 0.038±0.015 |
| 4 % group | 0.066±0.033 | 0.055±0.047 | 0.070±0.043 | 0.038±0.035 |

Table 3: Continued

| | 70 % length of small intestine | | | |
|---|---|---|---|---|
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.041±0.020 | 0.075±0.039 | 0.061±0.040 | 0.036±0.024 |
| 2 % group | 0.062±0.041 | 0.110±0.028 | 0.085±0.044 | 0.050±0.024 |
| 4 % group | 0.106±0.058 | 0.066± 0.040 | 0.089±0.064 | 0.033±0.015 |
| | 90 % length of small intestine | | | |
| | 21 Day | 28 Day | 35 Day | 42 Day |
| Control group | 0.048±0.033 | 0.061±0.032 | 0.114±0.062 | 0.059±0.026 |
| 2 % group | 0.065±0.053 | 0.110±0.049 | 0.101±0.054 | 0.034±0.24 |
| 4 % group | 0.055±0.036 | 0.052±0.034 | 0.088±0.063 | 0.061±0.027 |

a,b Means in the same row that do not have common superscripts differ, P<0.05. (X±SD)

at the age of 21 days demonstrates a significant increase in 10% and age of 28 days demonstrates a significant increase in 1% of the small intestine to that of treatment and control groups (4%), (P<0.05). perlite, hadn't significant effect on sucrase activity In different ages and segments of small intestine

## DISCUSSION

Researches have been conducted on the role of perlite in different animals in a way that perlite is responsible for dissection of excretion and its absorption through transmission of moisture and it acts like a damper between the earth and the birds and increases the growth along with decreasing the respiratory diseases, thigh scorch and callus in the breast [17]. The swine which were fed daily by perlite, were heavier (197 gram) comparing to the control treatment and it resulted in the reduction of the fattening period [10]. Three levels of perlite (1, 10 and 20%) were used for 8 weeks for feeding 21 male and 21 female mice and concluded that the mice's behavior, causality and food consumption were not affected by the experimental food and there was no significant change in the parameters related to biochemical components of the blood and urine, the weight of the limbs, autopsy findings and pathology of tissue, however the male mice fed by 10 and 20 levels of perlite, did not grow well; after all, level 1 of perlite was reported to be the appropriate dosage for the growth of mice [11]. The usage of perlite in the diet of broilers had rendered to decrease of the toxicity of Aflatoxin in the body and the amount of chloride in blood serum [8]. In a research on chicks' turnover, it was designated that the appropriate perlite level for the diet of broilers was 1 to 3 percent and 3 percent for hatching chickens [1].

In this study, we examined the ontogeny of mucosal enzyme activity per IU/gram protein in the different regions of the small intestine broiler chicken was examind. Sell *et al.* [14] found the highest specific activities of several disaccharidases in the proximal jejunum in a study that examined turkey mucosal disaccharidase activity at 2, 7, 14 and 28 days [15]. The differences in activities between intestinal regions in the poult were more pronounced than in the chick [13]. Temporal changes in mucosal enzyme activities per mass differed in the different intestinal regions. Jejunal disaccharidase activity per mass peaked at 2 day posthatch and then decreased to a nadir at 5 to 6 d before increasing. Changes in disaccharidases were less pronounced in other intestinal regions [21].

It seems like perlite provides the neutral pH condition and necessary invirement (absorbent of some ions) for the activity of Amylase enzyme in the intestines. (Amylases are pancreatic and mucosal enzymes that catalyze the hydrolysis of alpha-1, 4-glycosidic linkages of polysaccharides to yield dextrin, oligosaccharides, maltose and D-glucose which are converted by disaccharidases enzymes to glucose to supply the body with energy). Considering the present results, different levels of perlite on the sum of the averages of the activity of sucrase in the small intestine of broiler chicks demonstrateds that adding 2% perlite to the diet of the birds significantly increaseds the activity of sucrase on different days and different parts of the small intestine (P<0.05). Increases the activity of sucrase enzyme causes better digestion of carbohydrates and finally causes the improvement of performance broiler chicks.

In conclusion, based on the present results and literature data, It was suggested that usage 2% of perlite can be used in the broilers diet.

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