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Research Article

The Effect of Feed Supplemented with Different Sodium Bentonite Treatments on Broiler Performance

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Abstract: The present study was conducted to determine the effect of rations containing different sodium bentonite treatments on broiler performance. The study included 280 broiler chicks (1-day-old) that were randomly allocated to 7 experimental groups designated as follows: A (control); B and C (0.5% and 1.0% sodium bentonite, respectively); D and E (0.5% and 1.0% sodium bentonite + 0.5% and 1.0% gentian violet, respectively); F and G (0.5% and 1.0% sodium bentonite + 0.5% and 1.0% acetic acid, respectively). The experimental diets were given to the broilers for 6 weeks. At the end of the experiment (day 42), weight gain, feed intake, feed conversation ratio, protein efficiency ratio, and protein digestibility were calculated. This study showed that birds fed diets containing sodium bentonite treated with either 0.5% or 1.0% acetic acid had significantly increased ($P < 0.05$) weight gain, feed consumption, protein efficiency ratio, and protein digestibility, as compared to the control and other experimental groups.

Key Words: Sodium bentonite, aflatoxin adsorbent, feed additives, growth performance, broilers

Introduction

Bentonites are clays with strong colloidal properties that absorb water rapidly, which results in swelling and a manifold increase in volume, giving rise to a thixotropic, gelatinous substance. (1). Bentonites are white, light-weight rock deposits composed mostly of salts of hydrated aluminosilicates of sodium (Na), potassium (K), calcium (Ca), and occasionally iron, magnesium, zinc, nickel, etc. These bentonites have a high negative charge and are balanced by cations such as Mg, K, and Na located in the cavities; therefore, they do not react with food/feed ingredients and act as inert material due to their neutral pH or slightly alkaline nature (2). Several studies showed that poultry feed supplemented with bentonite can improve growth performance and nutrient digestibility in broilers (3-7). The present experiment was conducted to investigate the effect of supplementing poultry feed with different sodium bentonite (NaB) treatments on growth performance and protein digestibility in broiler chicks.

Materials and Methods

The study included 280 broiler chicks (1-day-old) that were randomly allocated to 7 experimental treatments. The birds in the control group (treatment A) were fed commercial feed, whereas the experimental groups were fed rations containing supplemental 0.5% NaB (treatment B), 1.0% NaB (treatment C), 0.5% NaB + 0.5% gentian violet (GV) (treatment D), 1.0% NaB + 1.0% GV (treatment E), 0.5% NaB + 0.5% acetic acid (AA) (treatment F), and 1.0% NaB + 1.0% AA (treatment G). The bentonite used was prepared and provided by the Food and Biotechnology Research Center, PCSIR Laboratory, Lahore, Pakistan. Its chemical composition is presented in Table 1. Commercial starter and finisher rations were supplemented and fed to the broilers for 6 weeks. Each treatment contained 40 birds, which were randomly sub-divided into 4 replicates of 10 birds each. At the end of the experiment weight gain, feed consumption, feed conversion ratio (FCR), protein

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Table 1. Chemical composition of bentonite.

Compositional Profile	Percentage
Loss on ignition	9.85
SiO_2	57.85
Al_2O	20.80
Fe_2O_3	3.10
CaO	4.20
MgO	3.01
Na_2O	1.10
K_2O	0.05
pH	7.0
Mean particle size	20 µ

efficiency ratio (PER), and protein digestibility were calculated. PER was measured according to the method described by McDonald et al. (8). Protein digestibility was determined by conducting a digestibility trial in which nitrogen (N) intake was measured along with N voided in feces, which was then compared with N in the ileal digesta. Therefore, 2 birds from each replicate were randomly selected and ileal digesta (from the last 10-cm section of the ileum) was collected according to the procedure described by Annison (9). Fecal samples were also collected during the last 24 h (10), dried at low temperature in vacuum ovens at 55 °C for 48 h, ground through a 0.5-mm screen prior to analysis (11), and then analyzed by proximate analysis, as described by A.O.A.C. (12). The determined chemical composition of starter and finisher rations is presented in Table 2.

Data were then analyzed statistically by complete randomized design and the means differences were compared by Duncan's multiple range test (13).

Table 2. Chemical composition of the experimental rations.

Proximate Analysis	Starter Ration	Finisher Ration
Dry Matter (%)	91.85	91.34
Gross Energy (kcal/kg)	3703.2	3769.3
Crude Protein (%)	19.03	17.50
Crude Fiber (%)	4.60	4.50
Ether Extract (%)	3.67	5.17
Ash (%)	9.41	8.95

Results

Weight gain, feed consumption, and FCR of the birds fed different NaB treatments are presented in Table 3. The data clearly indicate that weight gain in the birds fed treatments F and G, containing 0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively, had greater ($P < 0.05$) weight gain than the birds fed treatment A (control), C (1% NaB), and E (1.0% NaB + 1.0% GV).

Maximum feed ($P < 0.05$) consumption was observed in the birds fed rations containing 1.0% NaB + 1.0% AA (treatment G), while the lowest was noted in the birds in the control group and treatment C (1.0% NaB) (Table 3). Increased weight gain and feed consumption in the birds fed rations F and G (0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively) resulted in slightly improved FCR in comparison to the control and all other treatments (Table 3).

Mean PER values of the different treatments were not significantly different; however, consistently improved PER was observed in the birds fed treatments F and G (0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively). Protein digestibility data, based on fecal analysis, showed that birds fed 0.5% NaB alone, 0.5% NaB + 0.5% AA, or 1.0% NaB + 1.0% AA had better ($P < 0.05$) protein retention. When the ileal digesta data were analyzed it was found that birds fed 0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively, showed significantly increased protein digestibility (Table 3).

Discussion

Bentonites are excellent aflatoxin binders due their affinity for polar substances. The in vitro experiments conducted by the Pakistan Council of Scientific and Industrial Research Laboratories, Lahore, showed that bentonite bound 90% of the aflatoxins present in feed and made them effective and un-absorbable from the gastrointestinal tract (2). The improvement in weight gain observed in the present study could have been due to the presence of NaB in the diet, which might have increased feed retention time in the gut of the chicks, thus subjecting the nutrients to enzymatic action for quite a long time, or could have been due to the action of bentonite on the enhanced digestibility of certain nutrients. These results are in agreement with previous studies (3,5,14,15) in which NaB significantly improved body weight gain in broiler chicks.

Table 3. Effect of the NaB rations on growth performance and protein digestibility in broiler chicks.

Treatment	Weight gain (g) ± SD	Feed intake (g) ± SD	FCR ± S.D	PER ± S.D	Protein Retention%	
					Fecal Basis ± SD	Ileal digesta basis ± SD
A (Control)	1396.9^{a} ± 25.3	2986.9^{a} ± 34.5	2.14^{a} ± 0.03	2.557^{a} ± 0.03	60.63^{a} ± 1.85	69.91^{a} ± 1.23
B (0.5% NaB)	1450.1^{bc} ± 51.2	3068.3^{ab} ± 30.9	2.11^{a} ± 0.08	2.587^{a} ± 0.10	63.14^{bc} ± 1.84	71.07^{a} ± 1.07
C (1.0% NaB)	1413.4^{ab} ± 19.2	3005.0^{a} ± 27.2	2.13^{a} ± 0.02	2.572^{a} ± 0.03	61.46^{ab} ± 1.70	70.69^{a} ± 0.99
D (0.5% NaB + 0.5% GV)	1446.3^{bc} ± 16.5	3066.7^{ab} ± 63.0	2.12^{a} ± 0.03	2.580^{a} ± 0.04	61.47^{ab} ± 1.83	71.00^{a} ± 1.11
E (1.0% NaB + 1.0% GV)	1416.4^{ab} ± 28.3	3034.7^{ab} ± 39.8	2.14^{a} ± 0.05	2.555^{a} ± 0.06	61.26^{ab} ± 1.08	70.63^{a} ± 1.36
F (0.05% NaB + 0.5% + AA)	1462.9^{c} ± 20.8	3049.4^{ab} ± 30.6	2.08^{a} ± 0.03	2.625^{a} ± 0.03	65.01^{d} ± 1.18	72.82^{b} ± 0.81
G (1.0% NaB + 1.0% +AA)	1484.4^{c} ± 8.80	3107.3^{b} ± 87.7	2.09^{a} ± 0.05	2.602^{a} ± 0.05	67.08^{d} ± 1.08	73.45^{b} ± 1.32

Means with the same superscripts show non-significant differences ($P < 0.5$). NaB: sodium bentonite; GV: gentian violet; AA: acetic acid; FCR: feed conversion ratio; PER: protein efficiency ratio.

Increased feed intake in all treatment groups could be attributed to the presence of NaB in the rations, which can act as a pellet binder and improve not only pellet quality, but also feed intake. These results are supported by previous research (4,14) that found NaB increased feed intake and growth performance in broiler chicks. The high weight gain and feed consumption in the birds fed 0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively, indicates that NaB's qualities can be further enhanced by AA; however further studies are required to investigate the relationship between NaB and AA.

The non-significant differences between the PER values of the different experimental groups may have been due to the fact that NaB mainly acts on feed when in the gastrointestinal tract. This hypothesis can be further supported by our protein retention data indicating that the presence of bentonite prolonged feed passage time and improved nutrient metabolism. The protein retention results of the present study are in agreement with previous findings (2) of improved energy and protein utilization in the presence of bentonite. Differences between ileal and excreta digestibility in the present study clearly demonstrate that amino acid metabolism by hindgut microflora in chickens may be substantial and that digestibility measured in the terminal ileum is a more accurate measure of amino acid availability than that measured in the excreta.

It can be concluded from this trial that NaB alone at the 0.5% level or treated with 0.5% or 1.0% AA can be incorporated into broiler rations for improving growth and feed utilization. Although no statistically significant differences were observed in PER values, PER values increased when birds were fed rations containing 0.5% and 1.0% NaB + 0.5% and 1.0% AA , respectively (treatments F and G). Thus, it can be suggested that NaB + AA improved protein digestion. These results are further supported by the significantly increased protein retention values observed in the birds fed rations containing 0.5% and 1.0% NaB + 0.5% and 1.0% AA, respectively.

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