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Effect of Feed Supplemented with Different Levels of Sodium Bentonite and Aluminum Silicate on Physiological Performance of Broiler

Qutaiba Jasim Gheni. Alfred S. Karomy and Tarek Ibrahim Maged

College of Agriculture, University of Basrah, Basrah, Iraq
E-mail: qutiba.chemi@uobasrah.edu.iq

Abstract: This study aimed to determine the effect of supplement different level of sodium and aluminium silicate on some physiological performance of broiler. Two hundred and seventy chicks of commercial Ross 308 one day old were used in experiment and the chicks were individually weighed and randomly distributed into six treatments and three replicates (15 birds in each replicate). Chicks in the first treatment were fed on a standard diet (control) (T1) while second and third treatment addition 1%, 2% sodium bentonite to standard diet (T2,T3), fourth and fifth treatment addition aluminium silicate 1 %, 2% (T4,T5) and their combination (1% sodium bentonite and 1% aluminium silicate) in sixth treatment (T6). Sodium bentonite and their combination significantly improved body weight and gain as compared with control. Cumulative feed intake and feed conversion ratio were significantly decreased at treatments T2, T3 and T6. Protein digestibility, protein efficiency, viscosity and production index were increased significantly in the same treatments (T2, T3 and T6). There were no significant differences among all treatments regarding the dressing percentage, pancreas and fabricia percentage. The liver percentage and rate of feed passage in T2 and T3) and their combination (T6) were significantly lower compared with aluminium silicate treatments (T4 and T5). These diets (T2, T3 and T6) had significantly increased serum total protein and decreased glucose level. The obtained results revealed that using 1% and 2% sodium bentonite and their combination with aluminium silicate in broiler pellet diets had a beneficial effect on performance and some of physiological traits measured.

Keywords: Broiler, Sodium bentonite, Aluminium silicate, Physiological

Pelleting is one of the most important methods used by the feed manufacturing industry to improve farm animal performance. The commercial poultry industry relies upon pellet feeding for improving the poultry performance (Chehraghi et al 2013), reducing selective feed and destructing the pathogenic organisms (Corzo et al 2011). Feed used various types of pellet binders such as molasses, fats, and steam (Mohammadi et al 2019). In addition, bentonites clays with strong colloidal properties was also used as a pellet binder (Owen et al 2012), and possesses the ability to prohibit the pathogenic bacteria in the gut of birds instead of using antibiotics as feed additives, thereby eliminating successfully the negative effects of residual antibiotics in poultry production on human health (Prvulovic et al 2008, Marshall and Levy 2011).

Sodium bentonite is a clay of tri-layered aluminum silicate as its exchangeable cation. Poultry feed supplemented propped with bentonite was able to enhance growth performance and reduce feed efficiency ratio (Katouli et al 2010) and was used as detoxification agent or for inactivation of mycotoxin of contaminated materials, thus it cannot be absorbed from the digestive tract (Pappas et al 2014, Ejiofor et al 2021). The bound aflatoxins will be then excreted in the feces (Gul et al 2017). Mycotoxins had the ability to reduce the immunity of birds and damage for some organs and thereby causing the negative impact in the body weight of poultry. Aluminum silicate compounds were able to prevent and reduce mycotoxicosis in chickens, turkeys, and quails. Moreover, alumina silicate compounds can use as health indices by alternating the hepatic enzymes in the blood (Gilani et al 2016). Using aluminum silicate as adsorbents agent to reduce or decrease the toxicity of contaminated feed in the animal by-products. Therefore, the bioavailability was decreased through animal's gastrointestinal tract (Singh and Mandal 2018). The current study was conducted to investigate the effect of Iraqi bentonite compared with imported aluminum silicate on physiology and production performance.

MATERIAL AND METHODS

A total of 270 chicks were randomly divided into six treatments with three replicate per treatment and 15 chicks per replicate group. To the effect of pellet of sodium bentonite (S.B) and aluminum silicate (A.S) and their combination on performance of some digestive and relative organ tract was evaluated. The first group was provided a control diet (T1) without any addition while the second group containing 1% sodium bentonite (T2), third group 2% sodium bentonite (T3),

the fourth and fifth group contain 1%, 2% aluminum silicate (T4 and T5) respectively the sixth group combination 1% sodium bentonite and 1% aluminum silicate (T6). Iraqi S.B and A.S were obtained from the local market and chemical analysis was done (Table 2). All treatments were feeds for starter diet for 1-21 days and thereafter during grower phases (22-35 days) as mentioned in Table 2. Feed and water were given ad libitum. All the diets were made up to meet the requirements of chickens as suggested by NRC (1994). Both experimental diets are presented in Table 1. Chickens were monitored daily for signs of morbidity and mortality. Body weight, weight gain, feed consumption and feed conversion ratio were recorded at 14, 28 and 35 days. At the end of the experiment, the passing time was measured the time between different intake and outer color feces appear. Protein efficiency ratio was measured (McDonald et al 1995). And Protein digestibility was determined by digestibility trail AOAC (2005). Passage rate was calculated by divided length of intestinal (cm) / passage time (minute) (Mobini, 2011). At the end of the experiment three birds from each replicate were randomly selected to slaughtered, 2 ml blood samples were collected and centrifuged at 3000 rpm for 20 min. the serum was stored at -20 c° until analyzed for glucose, total protein, cholesterol and urea were measured using commercial kits (Biolabo SA). Ileum digesta was collected to measure the viscosity (Teitge et al 1991) dressing percentage was calculated and liver, heart, length of intestinal and fabricia were recorded Production index was calculated according to the equation of Marcu et al (2013).

Statistical analysis: Data for all parameters were subject to an analysis of variance using the SPSS (2013).

Table 1. Composition of the broiler starter and finisher experimental diets

Ingredients (%)	Starter phase 1 - 21 days	Finisher phase 22-35 days
Corn	44.5	50
Soybean meal	32	23
wheat	16	18.5
Concentrate protein 40 %	4	3
Calcium carbonate	2	1.5
*Vitamins and minerals premix 29% (protein)	1	1
Sunflower oil	0.5	3
Determined analysis		
Crude protein %	23.1	19.2
M.E/kg	2956	3213
Calcium %	1.1	0.8
Phosphorus available	0.5	0.4

*Premix content. (Crude protein 29, Crude Fat 2, Crude Fiber 0.34, Moisture 2.68, Crude Ash 51.05, Calcium 6.45, Phosphorus 7, Phosphorus Avail 12.9, Sodium 5.3, Chloride 6.4, M.E. (Calc) 1817.96 (KCAL/KG), Lysine 11.7, Dig. Lys 12.77, Methionine 10.4, Dig Meth 10.44 Meth+cyst 10.46, Dig. M+C 11.52, Tryptophan 0.07, Dig. Tryp 0.22, Thereonine 2.8, Dig. Threonine 3.87, Isoleucine 0.24, Dig. Isoleucine 1.32, Valine 0.27, Dig. Valine 1.52, Arginine 0.4, Dig. Arginine 1.17) % Vitamins added. (A, D3, E, B1, B2, B6, B12, Biotin, Niacin, Folic Acid, K3, Calcium D- Pantothenate, Choline Chloride and Choline). Element added. (Fe, Cu, Mn, Zn, I and Se)

RESULTS AND DISCUSSION

At 14 and 28 days of the experiment treatments broiler chicken's live weight and weight gain, feed intake and feed efficiency ratio had no significant difference (Table 3, 4). At end of the experiment (35 days) was significantly better in 1 and 2 % S.B and 1 % S.A + 1 % A.S and percent the broiler body weight increase over control was 4.7, 7.4 and 3.9 respectively. Addition of 1, 2 % sodium bentonite and 1 % S.B + 1 % A.S showed no significantly feed intake (Table 4). Low feed significantly resulted in low efficiency ratio at 28, 35 days and the accumulative periods as compared with other treatments. The A.S. at 1 and 2% did not differ from control in cumulative FCR and was better than rest of the treatments. The supplementation of diet by S.B increased retention time and decreased significantly passage rate of diets with 1, 2 % S.B and 1 % S.B +1 % A.S (Table 5). The fecal analyzed the chicks fed with 1, 2 % S.B and 1 % S.B + 1 % A.S, showed significantly increased protein digestibility as compared to control by 10.52, 12.47 and 11.1 % respectively (Table 5).

Mean protein efficiency ratio (PER), viscosity value and the production efficiency index were significantly affected by the treatments supplement with 1, 2 % S.B and 1 % S.B plus 1 % A.S compared with other treatment (Table 5). The inclusion of S.B to make pellets broiler chickens improved body weight, weight gain, and feed intake and feed efficiency ratio. This may be the action of mineral to enhance the digestibility of

Table 2. Chemical analysis of the sodium bentonite and aluminum silicate

Sodium bentonite Oxidase	Per cent	Aluminum silicate oxidase	Per cent
Sio_2	55.9	SiO_2	19.41
Fe_2o_3	6.01	Al_2O_3	20.77
Al_2o_3	13.3	Fe_2O_3	18.15
Tio_2	0.80	Na_2O	3.78
Cao	5.7	CaO	12.11
Mgo	3.2	LOI	17.00
So_3	0.4	MgO	0.62
l.o.i	12.0	K_2O	0.14
Na_2o	1.3	TiO_2	4.29
K_2o	0.5		
cl	0.94		

(Al-Ajeel et al 2013), (Ahmed et al 2020)

certain nutrition (Katouli et al 2012, Owen et al 2012). Bentonite is clay mineral with strong colloidal properties and the ability to rapidly absorb many times its volume of water. Nutrient digestibility and enzymatic activity of gastrointestinal secretion has been improved by addition of S.B to broiler diets (Wawrzyniak et al 2017). The improvement in weight gain was observed which may be consequent to the presence of S.B in the diet, which might have increased feed retention time in the digestive system of the chicken. Thus the concentration of digestive enzymes will work for a longer period on the nutrients and allows greater benefiting from these nutrients, or may be for the influence on the digestion mechanism for some nutrients due to bentonite effect, and these results agree with the previous study (Pasha et al 2007,

Table 3. Effect of using sodium bentonite, aluminum silicate and their combination in pellet making on body weight and weight gain

Treatment	Body weight/g (Bird age day)			Weight gain/g (Bird age day)			
	14	28	35	1-14	15-28	29-35	1-35
T1=Control	417 ± 3.5	1264 ± 10.3	2011 ± 17.2 b	397 ± 2.3	847 ± 12.3	747 ± 16.5 b	1973 ± 15.1 b
T2=Sodium bentonite 1%	424 ± 2.0	1304 ± 28.5	2106 ± 15.4 a	387 ± 3.5	880 ± 6.5	822 ± 12.3 a	2087± 13.5 a
T3=Sodium bentonite 2%	432 ± 4.1	1309 ± 6.8	2160 ± 9.4 a	394 ± 4.1	877 ± 5.1	851 ± 15.4 a	2122 ± 17.4 a
T4=Aluminum silica1%,	441 ± 2.4	1260 ± 10.3	2021 ± 11.2 b	407 ± 3.6	820 ± 7.5	761 ± 11.3 b	1983 ± 19.2 b
T5=Aluminum silica2%	434 ± 5.3	1248 ± 12.11	2015 ± 18.1 b	396 ± 8.2	814 ± 5.4	767 ± 13.1 b	1977 ± 14.1 b
T6=Sodium bentonite 1% + aluminum silicate 1%	433 ± 4.3	1328 ± 7.5	2090 ± 14.2 a	395 ± 5.11	895 ± 8.11	762 ± 10.2 b	2052 ± 16.1 a
Significance	N.S	N.S	*	N.S	N.S	*	*

*Values within the same column with different letters are significantly (p<0.05)

Table 4. Effect of using sodium bentonite, aluminum silicate and their combination in pellet making on broiler feed intake and their feed conversion ratio

Treatment	Feed intake (g / bird) Bird age (day)			Cumulative	FCR (g feed / g weight gain)			Cumulative FCR
	1-14	15-28	29-35	1-35	1-14	15-28	29-35	1-35
T1=Control	516 ± 15.2	1402 ± 6.2	1240 ± 11.1	3158± 18.7 a	1.34 ± 0.02	1.66 ± 0.05	1.63 ± 0.04 a	1.6 ± 0.04 a
T2=Sodium bentonite 1%	520 ± 11.3	1395 ± 16.1	1177 ± 10.3	3092± 22.3 b	1.35 ± 0.01	1.59 ± 0.04	1.43 ± 0.01 b	1.48 ± 0.03 b
T3=Sodium bentonite 2%	521 ± 13.2	1360 ± 15.3	1217 ± 15.4	3098± 16.2 b	1.35 ± 0.01	1.55 ± 0.01	1.48 ± 0.02 b	1.45 ± 0.05 b
T4=Aluminum silica1%,	540 ± 10.2	1346 ± 12.1	1247 ± 22.1	3133± 14.8 a	1.33 ± 0.03	1.73 ± 0.13	1.63 ± 0.03 a	1.58 ± 0.05 a
T5=Aluminum silica2%	524 ± 9.2	1368 ± 10.6	1280 ± 13.7	3172± 13.6 a	1.33 ± 0.02	1.68 ± 0.06	1.66 ± 0.04 a	1.60 ± 0.03 a
T6=Sodium bentonite 1% + aluminum silicate 1%	515 ± 12.5	1410 ± 28.3	1210 ± 10.2	3035± 15.1 b	1.29 ± 0.04	1.58 ± 0.05	1.45 ± 0.03 b	1.48 ± 0.04 b
Significance	N.S	N.S	N.S	*	N.S	N.S	*	*

*Values within the same column with different letters are significantly (p<0.05)

Table 5. Effect of using sodium bentonite, aluminum silicate and their combination in pellet making on protein digestibility, protein efficiency ratio, viscosity, and production index of their chickens at 35 day of age

Treatment	Protein digestibility (%)	Change from control	Production index	PER	Viscosity Pascal/ (second)	Passage rate
T1=Control	66.2± 1.6 c	0	353± 16.2 b	2.95± 0.03 b	2.97± 0.01 b	2.11± 0.028 a
T2=Sodium bentonite 1%	73.2± 1.8 a	+ 10.52	412.2± 20.7 a	3.17± 0.06 a	3.2± 0.02 a	1.81± 0.031 b
T3=Sodium bentonite 2%	75.7± 1.1 a	+ 12.5	426.7± 18.3 a	3.21± 0.03 a	3.26± 0.04 a	1.78± 0.025 b
T4=Aluminum silica1%,	71.4± 1.4 b	+ 7.3	359.5± 15.8 b	2.94± 0.1 b	2.9± 0.01 b	1.98± 0.011 a
T5=Aluminum silica2%	71.3± 0.9 b	+ 7.1	358.4± 22.1 b	2.92± 0.08 b	2.88± 0.01 b	2.05± 0.023 a
T6=Sodium bentonite 1% + aluminum silicate 1%	74.5± 0.8 a	+ 11.1	395.3± 20.4 a	3.08± 0.08 a	3.02± 0.02 a	1.83± 0.01 b
Significance	*		*	*	*	*

*Values within the same column with different letters are significantly (p<0.05)

Pasha et al 2008). In S.B significant improvement in bird weight (2160 g) was observed as compared with control (2011 g) and weight gain for the T3 and T1 (2122 and 1973 g respectively). S.B. in the forage, can work as a pellet binder and improved the grade of pellet and decreased fodder consumed the amount of feed intake was for T1 and T3 (3158 and 3098 g respectively). Similar trend was observed in earlier studies due to the highly adhesive nature of S.B (Owen et al 2012, Besseboua et al 2018) It was suggested that Na-B absorbs moisture to resist the flow of digesta through the gastrointestinal tract affective negatively the feed intake (Tauqir et al 2001). It may be due to viscosity which absorbs much water and decrease the passage rate of digestion in the intestinal tract (Damiri et al 2012).

Damiri et al (2010) mentioned that the bentonite has used efficiently as feed pellet binder within chicken diets, with the puffiness of bentonite causing a decrease in the rate of feed transited through the digestive tract. The lower passage rate recorded in T3 (1.78) compared with the other treatment, permitting time for more effective utilization the protein retention efficiency (PER). The difference in the experimental transactions averages may be caused at most by the S.B. influence on the diet when in the gut tract. This assumption can be propped by our protein retention data indicating that the presence of S.B prolonged feed passage time and improved nutrient metabolism. S.B which is present in chemical structure increases their binding capacity to feed (Di Gregorio et al 2014). Consequently, an irreversible structure is formed in the digestive tract as a result of interaction between the binding agent and aflatoxins, and the absorption of aflatoxins is limited and this effect ameliorative the production efficiency index (P.E.I). The result of some relative organ weights (relative to body weight) is shown in Table 6. Dressing percentage and the relative weight of the liver decreased significantly in treatments supplement with 1, 2 % S.B and 1% S.B plus 1% A.S as compared with the control (Table 6). Mizzo et al (2005) indicated decline in liver relative weight in addition of 0.3% S.B to the diets. Effect of dietary treatments on blood serum indicate that serum concentrations of total protein had significant differences between treatments of inclusion 1 or 2 % S.B T2, T3 and treatment of 1% S.B plus A.S (T6) compared with control (T1) and 1% or 2% A.S (T4, T5) (Table 7). Treatments T2 and T3 reported a significant decreased in serum glucose 205 and 201 mg/dl, respectively. There were no differences of serum cholesterol and urea between dietary treatments.

Eraslan et al (2006) reported that adding 0.5% of sodium bentonite caused a significant decrease in the blood glucose compared to the control. When the body metabolism increase the density of blood glucose decreased. Therefore

Table 6. Effect of using sodium bentonite, and aluminum silicate in pellet on dressing percentage, and some relative organ percentage of broiler chickens at 35 day of ages

Treatment	Dressing (%)	Pancreas (%)	Fabricia (%)	Liver (%)
T1=Control	73.14 ± 0.23	0.18 ± 0.0.5	0.15 ± 0.01	2.66 ± 0.11 a
T2=Sodium bentonite 1%	74.15 ± 0.18	0.21 ± 0.03	0.14 ± 0.02	2.39 ± 0.06 b
T3=Sodium bentonite 2%	74.22 ± 0.33	0.2 ± 0.01	0.15 ± 0.01	2.25 ± 0.1 b
T4=Aluminum silica 1%,	74.3 ± 0.21	0.19 ± 0.02	0.16 ± 0.02	2.6 ± 0.21 a
T5=Aluminum silica 2%	73.7 ± 0.18	0.21 ± 0.03	0.14 ± 0.03	2.56 ± 0.16 a
T6=Sodium bentonite 1% + aluminum silicate 1%	73.55 ± 0.15	0.22 ± 0.04	0.15 ± 0.03	2.33 ± 0.11 b
Significance	N.S	N.S	N.S	*

*Values within the same column with different letters are significantly ($p<0.05$)

Table 7. Effect of using sodium bentonite and aluminum silicate pellet on some biochemical constituents of blood serum of broiler chickens at 35 day of ages

T1=Control	Protein (g dl^{-1})	Glucose (mg dl^{-1})	Cholesterol (mg dl^{-1})	Urea (g dl^{-1})
T2=Sodium bentonite 1%	3.61 ± 0.12 b	216 ± 2.8 a	144 ± 3.3	2.06 ± 0.29
T3=Sodium bentonite 2%	4.42 ± 0.09 a	205 ± 2.14 b	150 ± 6.6	2.13 ± 0.11
T4=Aluminum silica1%,	4.22 ± 0.11 a	201 ± 3.44 b	141 ± 2.9	2.18 ± 0.13
T5=Aluminum silica2%	3.85 ± 0.06 b	212 ± 2.51 a	140 ± 3.12	2.09 ± 0.19
T6=Sodium bentonite 1% + aluminum silicate 1%	3.87 ± 0.8 b	214 ± 2.66 a	149 ± 5.7	2.15 ± 0.11
Significance	4.29 ± 0.08 a	203 ± 2.8 b	146 ± 4.3	2.11 ± 0.15
T1=Control	*	*	N.S	N.S

*Values within the same column with different letters are significantly ($p<0.05$)

the use of sodium bentonite in the diet will cause an increase in metabolism and more efficient digestion and absorption of nutrients. Dietry inclusion of sodium bentonite had not any effect of cholesterol, urea and some of blood serum lipids (Katouli et al 2010 and Barati et al 2018).

CONCLUSION

Sodium bentonite at 1, 2 % alone, and 1 % S.B + 1 % aluminum silicate can be used in pelleted making diets for improving growth performance, decrease feed intake and enhance feed efficiency ratio. Increased protein digestibility, P.E.R and viscosity, production index, and serum protein were observed in broiler chickens.

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