**The effect of feed supplemented with different levels of sodium bentonite and aluminum silicate on physiological performance of broiler**

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Abstract

 270 day old chicks were distributed in each treatment randomly into six treatments and three replicates (15 birds in each replicate) and used a standard feed. 1% or 2% levels of either sodium bentonite or aluminum silicate and their combination was added into the pellet diet treatments For 35 days. The results showed that the levels of 1% or 2% (T2, T3) sodium bentonite and their combination (T6) were significantly (p<0.05) improved body weight and weight gain as compared with control, T4 and T5. Cumulative feed intake and feed conversion ratio were significantly (p<0.05) decreased at treatments T2, T3 and T6. Protein digestibility, protein efficiency, viscosity and production index were increased significantly (p<0.05) in the same treatments (T2, T3 and T6). There was 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 (p<0.05) lower compared with aluminium silicate treatments (T4 and T5). These diets (T2, T3 and T6) had significantly (p<0.05) 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, productive and physiological performance

**Introduction**

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 manufacturing has used various types of pellet binders such as molasses, fats, and steam (Mohammadi Ghasem Abadi *et al*., 2019). In addition, bentonites clays with strong colloidal properties was also used as a pellet binder (Owen *et al*., 2012), it 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 this was confirmed med by many studies (Katouli *et al*., 2010). Sodium bentonite 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). Some studies reported that 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 (Resanović *et al*., 2009 and Gbashi *et al*., 2018).

Alumino 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). Some studies also reported that using alumina 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 administered to investigate the effect of Iraqi bentonite compared with imported aluminum silicate on physiological and production performance.

**Materials and methods**

A total of 270 chicks were randomly divided into six treatments with three replicate groups per treatment and 15 chicks per replicate group. To evaluate the effect of sodium bentonite (S.B) and aluminum silicate (A.S) and their combination in pellet making on performance some digestive and relative organ tract. The chicks in the control treatment were fed a pellet diet, whereas the experimental treatments were fed the same pellet diets containing 1 % S.B (treatment 2). 2 % S.B (treatments 3). 1% A.S (treatment 4). 2 % A.S (treatment 5). 1 % S.B plus 1% A.S (treatment 6). Iraqi S.B and A.S were provided from the local market, the chemical analysis are shown in table 2.

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)

Table (2) Chemical analysis of the sodium bentonite and aluminum silicate

|  |  |  |  |
| --- | --- | --- | --- |
| Sodium bentonite Oxidase  | % |  aluminum silicate oxidase | % |
| Sio2 | 55.9 | SiO2 | 19.41 |
| Fe2o3 | 6.01 | Al2O3 | 20.77 |
| Al2o3 | 13.3 | Fe2O3 | 18.15 |
| Tio2 | 0.80 | Na2O | 3.78 |
| Cao | 5.7 | CaO | 12.11 |
| Mgo | 3.2 | LOI | 17.00 |
| So3 | 0.4 | MgO | 0.62 |
| l.o.i | 12.0 | K2O | 0.14 |
| Na2o | 1.3 | TiO2 | 4.29 |
| K2o | 0.5 |  |  |
| cl | 0.94 |  |  |

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

Treatments were feeds for starter (1-21 days) and grower phases (22-35 days). 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 according to the method described by McDonald *et al*., (1995). 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, france). Ileum digesta was collected to measure the viscosity, according to Teitge *et al*., (1991) method dressing percentage was calculated and liver, heart, length of intestinal and fabricia were taken Production index was calculated according to the equation of Marcu *et al*., (2013).

**Statistical analysis section**

Data for all parameters were subject to an analysis of variance, the differences between the averages were also tested using the least significant difference (L.S.D) using the SPSS (2013).

**Result and Discussion**

At 14 days of the experiment treatments broiler chicken's live weight, weight gain, feed intake and feed efficiency ratio were had no significant difference table (3, 4). At 28 days and the end of the experiment (35 days) the highest significantly (p < 0.05) body weight and weight gain were seen in 1, 2 % S.A and 1 % S.A combination with 1 % A.S treatments, however, these treatments broiler body weight exceeded the control treatment by (4.7, 7.4 and 3.9)% respectively table 3. Including 1, 2 % sodium bentonite and 1 % S.B 1 % A.S treatments were showed no significantly (p < 0.05) feed intake except for the accumulative periods than other treatments (Table 4). Low feed efficiency ratio was obtained significantly (p < 0.05) at treatments 2, 3 and 6 at 28, 35 days and the accumulative periods as compared with other treatments.

Table (3) Effect of using S.B, A.S, and their combination in pellet making on body weight and weight gain /g 1 to 35 day of age's ± SE

|  |  |  |
| --- | --- | --- |
| 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 | 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 | 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 | 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 | 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 | 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 | 433 ± 4.3 | 1328 ± 7.5  | 2090 ± 14.2 a | 395 ± 5.11 | 895 ± 8.11  | 762 ± 10.2 b | 2052 ± 16.1 a |
|  | N.S | N.S | \* | N.S | N.S | \* | \* |

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

Data obtained from this experiment indicated that supplementation of diet by S.B increased retention time and decreased significantly (p < 0.05) passage rate of diets contained 1, 2 % S.B and 1 % S.B 1 % A.S (table 5). When the fecal analyzed found the chicks fed 1, 2 % S.B and 1 % S.B plus 1 % A.S, showed significantly (p < 0.05) increased protein digestibility, change from control by (10.52, 12.47 and 11.11) % respectively (table 5).

Table (4) Effect of using S.B, A.S, and their combination in pellet making on broiler feed intake (g / bird) and their feed conversion ratio (g feed / g weight gain) 1 to 35 day of age's ± SE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment | feed intake (g / bird)Bird age (day) | Cumulative | FCR (g feed / g weight gain) | CumulativeFCR |
| 1-14 | 15-28 | 29-35 | 1-35 | 1-14 | 15-28 | 29-35 | 1-35 |
| T1 | 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 | 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 | 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 | 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 | 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 | 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 |
|  | N.S | N.S | N.S | \* | N.S | N.S | \* | \* |

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

Mean protein efficiency ratio (PER); viscosity value and the production efficiency index were significantly (p < 0.05) 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 present study shows that the inclusion of S.B to make pellets broiler chickens improved body weight, weight gain, feed intake and feed efficiency ratio. The reason for this improvement may be the action of mineral to enhance the digestibility of certain nutrition (katouli *et al*., 2012; Owen *et al*., 2012; Hayajneh *et al*., 2020). 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). An improvement in weight gain was noted, 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, it 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; Pasha *et al*., 2008). In which S.B significant Improvement in bird weight and weight gain. Present (S.B) in the forage, can work as a pellet binder and improved the grade of pellet and decreased fodder consumed. These results were approved by the earlier study (southern *et al*., 1994; Owen *et al*., 2012; Besseboua *et al*., 2018) due to the highly adhesive nature of S.B, 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 as shown in table 5, 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, 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 it's 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 (Khan *et al*., 2001). 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 (Moghadam *et al*., 2008), this effect ameliorative the production efficiency index (P.E.I).

 The result of some relative organ weights (relative to body weight) are shown in Table 6. Dressing percentage and the relative weight of the liver decreased significantly (p < 0.05) at treatments supplement with 1, 2 % S.B and 1% S.B plus 1% A.S as compared with the control. 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 were shown in table (7), serum concentrations of total protein had significant differences (p < 0.05) 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). The same treatments (T2, T3) reported a significant (p < 0.05) decreased in serum glucose. Serum of cholesterol and urea had no significant differences between dietary treatments. Eraslan *et al*. (2006) reported that adding 0.5% of sodium bentonite caused a significant (p < 0.05) decrease in the blood glucose compared to the control. When the body metabolism increase the density of blood glucose decreased. Therefore the use of sodium bentonite in the diet will cause an increase in metabolism and more efficient digestion and absorption of nutrients (Sturkie, 2012). 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).

Table (5) Effect of using S.B, A.S, and their combination in pellet making on protein digestibility, protein efficiency ratio, viscosity, and production index of their chickens at 35 day of age's ± SE

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Protein digestibility %** | **Change from control**  | **Production index** | **PER** | **Viscosity****Pascal/ second**  | **Passage rate** |
| T1 | 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 | 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 | 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 | 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 | 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 | 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 |
|  | \* |  | \* | \* | \* | \* |

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

Table (6) Effect of using S.B, A.S, and their combination in pellet making on dressing percentage, and some relative organ percentage of broiler chickens at 35 day of age's ± SE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment | Dressing percentage  | Pancreas % | Fabricia % | Liver % |
| T1 | 73.14 ± 0.23  | 0.18 ± 0.0.5  | 0.15 ± 0.01  | 2.66 ± 0.11 a |
| T2 | 74.15 ± 0.18  | 0.21 ± 0.03 | 0.14 ± 0.02  | 2.39 ± 0.06 b |
| T3 | 74.22 ± 0.33  | 0.2 ± 0.01  | 0.15 ± 0.01  | 2.25 ± 0.1 b |
| T4 | 74.3 ± 0.21  | 0.19 ± 0.02  | 0.16 ± 0.02  | 2.6 ± 0.21 a |
| T5 | 73.7 ± 0.18 | 0.21 ± 0.03 | 0.14 ± 0.03  | 2.56 ± 0.16 a |
| T6 | 73.55 ± 0.15  | 0.22 ± 0.04 | 0.15 ± 0.03  | 2.33 ± 0.11 b |
|  | N.S | N.S | N.S | \* |

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

Table (7) Effect of using S.B, A.S, and their combination in pellet making on some biochemical constituents of blood serum o of broiler chickens at 35 day of age's ± SE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment  | Protein g/dl | Glucose mg/dl | Cholesterol mg/dl | Urea g/dl |
| T1 | 3.61 ± 0.12 b | 216 ± 2.8 a | 144 ± 3.3  | 2.06 ± 0.29 |
| T2 | 4.42 ± 0.09 a | 205 ± 2.14 b | 150 ± 6.6  | 2.13 ± 0.11 |
| T3 | 4.22 ± 0.11 a  | 2.01 ± 3.44 b  | 141 ± 2.9  | 2.18 ± 0.13  |
| T4 | 3.85 ± 0.06 b  | 212 ± 2.51 a | 140 ± 3.12  | 2.09 ± 0.19  |
| T5 | 3.87 ± 0.8 b | 214 ± 2.66 a | 149 ± 5.7 | 2.15 ± 0.11  |
| T6 | 4.29 ± 0.08 a | 203 ± 2.8 b  | 146 ± 4.3  | 2.11 ± 0.15 |
|  | \* | \* | N.S | N.S |

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

**Conclusion**

It was concluded that Iraqi sodium bentonite at the level of 1, 2 % alone, and 1 % S.B + 1 % aluminum silicate can be used in pelleted making diets for improving growth performance, decrease feed intake enhance feed efficiency ratio. Increasing protein digestibility, P.E.R and viscosity, production index, and serum protein were observed in their broiler chickens.

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