The Pharma Innovation Journal 2021; 10(11): 1595-1597

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 1595-1597

www.thepharmajournal.com
Received: 09-08-2021
Accepted: 30-09-2021

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Effect of ionophore toxicity on body weight gain, feed consumption and feed conversion ratio in broilers and its amelioration by Vitamin C

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Abstract
The present study was conducted to observe the effect of ionophore toxicity on average body weight, body weight gain, feed consumption and feed conversion ratio (FCR) in broiler birds. For this study, 96 day old broiler chicks were randomly divided into 6 groups with 16 birds in each groups. Group 1 served as control, Group II was given Vitamin. Group III was provided maduramicin@8ppm in feed and Group IV was given maduramicin along with vitamin C. Group V was addedsalinomycin@120ppm in feed and group VI was given salinomycin alongside vitamin C. Average body weight, weight gain, feed consumption and FCR were recorded for all groups. There was significant decrease in average body weight, body weight gain, feed consumption but FCR was significantly higher in group III and V. Vitamin C supplementation significantly increased the average body weight, body weight gain, feed consumption while it decreased the FCR in group IV and VI as compared to group III and V respectively. Our results show that maduramicin and salinomycin toxicity negatively impact growth rate of birds and thus cause significant losses to poultry birds. Since ionophores are not judiciously used under Indian field conditions, their overuse can cause significant economic losses to poultry farmers. Also, vitamin C can confer significant protection against salinomycin and maduramicin toxicity.

Keywords: Ionophore, maduramicin, salinomycin, broiler birds, Vitamin C

Introduction
Over a four-decade period, the poultry sector in India has gone through a paradigm shift in structure and operation, from a simple backyard activity to a major commercial agri-based industry (Chatterjee and Rajkumar, 2015) [4]. There has been a fast development in the poultry sector and the poultry population has increased from 307.07 million in 1992 to 729.2 million in 2012 (19th Livestock Census, 2012). Further according to latest 20th livestock census, done in 2019.The total poultry population in India stood at 851.81 million which is increased by 16.8% from the 2012 census. In India, chickens are typically reared under intensive conditions, particularly in rural areas, which makes them susceptible to infections by opportunistic pathogens. Avian coccidiosis is a parasitic disease that is causing significant health and economic losses in the poultry industry. *Eimeria* spp. causes coccidiosis in birds aged 3 to 6 weeks. Disease leads to high mortality, morbidity, haemorrhagic enteritis, decreased body weight gain, and massive production losses. (Shirley *et al.*, 2004) [12]. Coccidiosis is primarily controlled through the use of anticoccidial drugs in feed, such as polyether ionospheres, maduramicin, and salinomycin (McDougald and Reid, 1991) [10], which are also the most commonly used anticoccidial drugs in the broiler industry. A strain of *Actinomadura yumaensis* produces maduramicin, whereas a strain of *Streptomyces albus* produces salinomycin (Folz *et al*., 1988 and Kinashi *et al*., 1973) [5, 8]. These ionophores form complexes with polar cations such as K+ and Na+, altering the normal concentration gradient across parasite surface membranes. Maduramicin (5 ppm) and salinomycin (60 ppm) are the recommended doses for broilers, respectively. However, these ionophores are now used recklessly in field conditions, resulting in toxicity. Because ionophore compounds have a narrow safety margin, their indiscriminate administration causes toxicity and may impair growth and weight gain (Ashrafihelan, 2014) [2]. So keeping this in mind the whole experiment was conducted to determine the effect of toxic doses of ionophores on body weight gain, feed intake and FCR parameters of broilers and whether the toxic effects can be ameliorated with usage of Vitamin C.

Material and Methods

The study was conducted in the Division of Veterinary Pathology, F.V.Sc & AH, SKUAST- J, R.S. Pura for a period of 35 days. A total of ninety six day old broiler chicks were procured from a healthy commercial hatchery in Jammu. All the birds were from same batch and from same breeding stocks. Chicks were acclimatized for a period of one week. After proper rearing in brooder for 1 week, the chicks were randomly divided into six groups with 16 chicks in each group. Chicks in group I served as control. Group II birds were provided Vitamin C @ 200mg/ litres of drinking water, Group III were given maduramicin @ 8ppm in feed. Group IV were administered with maduramicin @ 8ppm in feed and Vitamin C @ 200mg/litre of drinking water. Group V were fed salinomycin @120 ppm in feed. Group VI was provided with salinomycin @120 ppm in feed and Vitamin C @ 200mg/litre of drinking water. On first day of experiment initial body weights were recorded. Subsequently, body weights were recorded weekly upto the end of experiment (35 days). After this weekly body weight gain were also calculated. Average weekly feed consumption in all groups was recorded upto the end of the trial. The feed consumed and leftover by the broiler birds were calculated to obtain Feed conversion ratio (FCR).

FCR was calculated by the formulae

$$FCR = \frac{\text{Feed consumed by bird (g)}}{\text{Body weight gain (g)}}$$

Statistical analysis for the experimental work was performed by two-way ANOVA using SPSS 16.0 values were expressed as mean ± S.E. P value less than 0.05 was considered statistically significant. This whole experiment was approved by Institutional Animal Ethics Committee vide order no. I/IAEC/2020 Dated 22-10-2020.

Results and Discussion

Weekly body weight

The data on average weekly body weight of birds in different groups at different intervals is summarized in table 1.

At 1st week no significant difference was seen in body weight among various groups. In 2nd week and 3rd week, values of body weights differed significantly among different groups. Birds in group II weighed significantly heavier as compared to the control birds. Values of average weight in group III, IV, V and VI were however significantly lower as compared to group I. But weights in group IV and VI respectively were significantly higher as compared to the weights in group III and V. At 4th week and 5th week also significant decline was seen in group III and V in average weight in comparison to group I and II whereas group IV and VI weights were significantly higher as compared to the weights of birds in group III and V respectively.

Table 1: Weekly body weight (Gms) (Mean± S.E) of birds in different groups in different intervals.

Weeks	Group I	Group II	Group III	Group IV	Group V	Group VI
Ist week	210.25^{a}±4.15	212.87^{a}±2.81	211.62^{a}±5.81	213.25^{a}±6.21	215.00^{a}±5.01	214.87^{a}±4.01
2nd week	560.82^{a}±11.38	603.37^{b}±14.82	381.25^{c}±30.45	458.37^{d}±42.62	390.12^{c}±26.63	430.00^{d}±60.35
3rd week	845.25^{a}±18.45	938.75^{b}±5.94	534.50^{c}±42.65	630.00^{d}±17.25	560.00^{c}±13.82	647.89^{d}±21.86
4th week	1072.12^{a}±60.23	1251.15^{b}±93.24	640.50^{c}±24.70	750.00^{d}±34.76	645.08^{c}±23.25	805.98^{e}±17.50
5th week	1336.36^{a}± 46.63	1657.65^{b}± 65.94	797.54^{c}±87.39	959.00^{d}±15.95	831.00^{c}±87.91	1079.89^{e}±85.33

Values are given as mean ± SE of 8 animals unless otherwise stated. Values having different superscripts (a, b, c.…) in a row are statistically different from one another at 5% level of significance.

Weekly body weight gain

The data on average weekly body weight gain of birds in different groups at different intervals is summarized in table 2. At 1st week and 2ndweek, group III and V average weekly body weight gain was significantly lower in comparison to group I whereas in group IV and VI the gains were significantly higher than that in group III and V respectively. In 3rd week, group III and V were also significantly lower than group I but group IV didn't show any significant difference from group III whereas gain in group VI was significantly higher from that in group V. At 4th week significant decline was seen in group III and V when average body weight gain was compared with the corresponding values in group I. Weight gain in Group IV and VI was significantly higher than group III and group V respectively.

Table 2: Weekly body weight gain (GMS) (Mean± S.E) of birds in different groups in different intervals.

Weeks	Group I	Group II	Group III	Group IV	Group V	Group VI
Ist week	350.25^{a}±2.53	391.87^{b}±14.12	170.62^{c}±18.79	245.25^{d}±17.57	175^{c}.00±21.72	216.87^{e}±6.72
2nd week	285.12^{a}±3.03	335.37^{b}±13.80	153.25^{c}±22.88	211.37^{d}±11.71	170.11^{c}±31.01	217^{d}.00±10.35
3rd week	227.25^{a}±23.57	313.75^{b}±12.99	106.50^{c}±31.65	120^{c}.00±20.62	85^{c}.00±16.42	158^{d}.87±19.72
4th week	294.12^{a}±14.88	406.37^{b}±15.58	157.00^{c}±18.11	209^{d}.12±45.09	176.62^{c}±21.87	254^{d}.00±12.44

Values are given as mean ± SE of 8 animals unless otherwise stated. Values having different superscripts (a, b, c.…) in a rows are statistically different from one another at 5% level of significance.

Feed consumption

The data on average weekly feed consumption of birds in different groups in different intervals is summarized in table 3. In all 4 weeks, there was significant decrease in feed consumption in group III and V when compared with control birds whereas group IV and VI birds consumed significantly higher amount of feed in comparison to group III and V respectively.

Table 3: Weekly feed consumption (Gms) (Mean± S.E) of birds in different groups in different intervals.

Weeks	Group I	Group II	Group III	Group IV	Group V	Group VI
Ist week	533.53^{a}±12.54	635.08^{b} ±21.34	304.30^{c} ±14.41	448.35^{d}±13.67	330.75^{c} ±21.79	401.76^{e} ±12.63
2nd week	555.75^{a} ±18.34	589.06^{b} ±10.05	412.12^{c} ±22.30	537.03^{e}± 12.95	510.60^{d} ±13.33	573.87^{f} ±14.48
3rd week	435.84^{a} ±34.55	547.75^{b} ±12.00	276.44^{c} ±21.43	425.06^{d}±29.58	278.08^{c} ±11.30	398.25^{d}±18.99
4th week	585.36^{a} ±10.06	698.32^{b} ±25.33	492.98^{c} ±11.19	509.96^{d}±12.21	495.32^{c} ±10.94	513.50^{d} ±12.17

Values are given as mean ± SE of 8 animals unless otherwise stated. Values having different superscripts (a, b, c….) in rows are statistically different from one another at 5% level of significance.

Feed conversion ratio (FCR)

The data on average feed conversion ratio of birds in different groups at different intervals is summarized in table 4.

At 1st week no significant difference was seen between various groups. At 2nd, 3rd and 4th week FCR was significantly increased in group III and V when compared with group I whereas for groups IV and VI, FCR were significantly lower in comparison to the corresponding ratio in group III and V respectively. FCR was highest in ionophore toxic groups.

Table 4: Feed conversion ratio (%) (Mean± S.E) of birds in different groups in different intervals

Weeks	Group I	Group II	Group III	Group IV	Group V	Group VI
Ist week	1.78^{a} ±0.13	1.76^{a} ±0.12	1.79^{a} ±0.41	1.83^{a} ±0.07	1.89^{a} ±0.23	1.86^{a} ±0.18
2nd week	1.82^{a} ±0.02	1.76^{a} ±0.11	3.51^{b} ±0.25	2.50^{c} ±0.17	3.00^{d} ±0.08	2.65^{c} ±0.24
3rd week	1.92^{a} ±0.21	1.75^{a} ±0.18	4.01^{b} ±0.17	2.30^{c} ±0.14	3.28^{d} ±0.22	2.52^{e} ±0.23
4th week	1.99^{a} ±0.24	1.72^{a} ±0.11	3.14^{b} ±0.13	2.44^{c} ±0.12	2.82^{b} ±0.11	2.02^{a} ±0.17

Values are given as mean ± SE of 8 animals unless otherwise stated. Values having different superscripts (a, b, c…) in rows are statistically different from one another at 5% level of significance.

Other workers have also shown negative effects of ionophore excess for broiler productivity. Potter *et al.* (1986) [11] found that toxic doses of salinomycin caused a decrease in growth in young birds. Harms *et al.* (1987) [6] also reported that at toxic salinomycin doses, feed consumption and average body weight decreased. Hoshino *et al.* (1992) [7] discovered that at 100ppm, salinomycin lead to a decrease in weight gain and feed intake in cockerels. Similarly, Arun *et al.* (2003) [3] discovered that when salinomycin was added @120 ppm in feed, a decrease in feed intake and weight loss was recorded. Also, Koutoulis *et al.* (2013) [9] reported growth retardation in birds fed high doses of salinomycin. Likewise, Bedrnik *et al.* (1980) [3] found that @ 120 ppm, salinomycin induced a decrease in feed conversion efficiency, whereas there was no change in feed conversion efficiency in broilers when salinomycin was used @60 ppm.

Conclusion

The average body weight, body weight gain, feed consumption were significantly lower and FCR was significantly higher in birds fed maduramicin and salinomycin but Vitamin C supplementation reversed the impact of these ionophores on the above variables and significantly improved weight gain, feed consumption and weight gain whereas reduced the FCR. Since addition of ionophores under field conditions in India is often carelessly done, it is important to create awareness regarding its proper usage so as to reduce production losses for farmers. Moreover, dietary supplementation with vitamin C can prevent these adverse effects.

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