Comparative Efficacy of Coccidiostats on Growth and Feed Conversion Efficiency in Broiler Birds Experimentally Infected with *E. tenella*

N.D. Hirani¹, J.J. Hasnani¹, B.R. Maharana²*, B. Kumar², P.V. Patel¹ and S.S. Pandya¹

¹Department of Veterinary Parasitology, College of Veterinary Science & A.H. Anand Agricultural University, Anand, Gujarat, INDIA
²Dept. of Veterinary Parasitology, College of Veterinary Science & A.H. Junagadh Agricultural University, Junagadh, Gujarat, INDIA

*Corresponding author: BR Maharana; Email: drbiswaranjanmaharana@gmail.com

Received: 24 November, 2015
Accepted: 14 March, 2016

ABSTRACT

The current study was undertaken at University Poultry Farm, Anand to know the comparative efficacy of commonly used coccidiostats on oocyst index, growth and feed parameters in Cobb-400 strain of broilers. Fifty chicks T1, T2, T3 and T4 groups were given Diclazuril (0.1%), Salinomycin (12%), Diclazuril (0.1%) + Salinomycin (12%) in shuttle programme and Maduramicin (1 %) at a dose rate of 100 g, 50 g, 100 + 50 g and 50 g per 100 Kg broiler feed as coccidiostat, respectively. One group of 50 chicks will be kept as infected control (T5) and another group of 50 chicks will be kept as uninfected control (T6) without coccidiostat in feed. Oocyst Index value indicates better efficacy of T4 and T2 as compared to T1 and T3 group and T4 group showed highest body weight gain followed by T2, T1 and T3 group after experimental infection of *E. tenella* on 22nd of age. At the end of six weeks, significantly highest feed consumption was observed in T2 group followed by T4, T3 and T1 group. Overall FCR value were found lowest in T4 group followed by T1, T2, and T3 group after experimental infection of *E. tenella* on 22nd of age. At the end of six weeks, significantly highest feed consumption was observed in T2 group followed by T4, T3 and T1 group. Over all FCR value were found lowest in T4 group followed by T2, T1 and T3 group after experimental infection of *E. tenella* on 22nd of age. At the end of six weeks, significantly highest feed consumption was observed in T2 group followed by T4, T3 and T1 group. Significantly highest FCR (2.42 ± 0.01) was observed in T5 group and lowest (1.97 ± 0.51) in T6 group among all groups signifying better efficacy of Maduramicin followed by Diclazuril. This is the first time study undertaken in middle Gujarat to access the efficacy of commonly used coccidiostats in *E. tenella* infection in broiler chickens.

Keywords: Coccidiostats, diclazuril, FCR, growth, Gujarat, maduramicin, salinomycin

*Eimeria tenella*, is the most pathogenic and ubiquitous parasite responsible for caecal coccidiosis with high rate of mortality in poultry. The lesions caused by the parasite disturbs nutrient absorption, triggering several changes in carbohydrates, lipid, protein and mineral metabolism (Patra et al. 2010) resulting in reduced growth rate and poor feed conversion efficiency. This disease is one of the significant problems in poultry throughout the tropical countries (Chakrabarti, 1989). The global loss due to coccidiosis was estimated about $ 800 million (Williams, 1998) whereas Bera et al. (2010) appraised the total loss of ₹ 1.14 billion in Indian poultry industries during the year 2003-04. In spite of developments in immunological, biotechnological and genetical methods, still the control of coccidiosis chiefly relishes upon prophylactic chemotherapy with anticoccidial drugs. However, the emergence of drug resistance in coccidia is an emerging problem (Abbas et al. 2012). Middle Gujarat being the major belt of avian production and considering the problems of drug resistant, study on comparative efficacy of coccidiostats on oocyst index, growth performance and feed efficiency in broilers was being carried out by giving experimental infection of *E. tenella*.

MATERIALS AND METHODS

Feed- water management and experimental design

The present study was undertaken at University Poultry Farm to know the comparative efficacy of commonly used coccidiostats on growth and feed parameters in Cobb-400 strain of broilers reared on battery cage system with
routine standard protocols under coccidia-free conditions (Barley et al. 2015). Ground maize was given for first day in plastic feed dishes to broiler chicks. From second day, the experimental feed was offered. After first week of age, the feed was offered in the linear cage feeders adjusted outside of the cages up to 6 weeks of experimental period. Weighed quantity of feed was offered thrice a day i.e. at 9:00 a.m., 2:30 p.m. and 10:00 p.m. during entire experimental period. Stirring and mixing of feeds in the feeder was done 4-5 times per day. Clean, fresh, wholesome drinking water was made available to all experimental birds throughout the experimental period. Experimental infection of 50,000 oocysts of *E. tenella* was given on 22nd day of age. Experimental work was approved by the Institutional Animal Ethics Committee (IAEC), Veterinary College, Anand having CPCSEA Registration number 486/01/A/ CPCSEA during the second meeting of the year 2011 with approval letter No. AAU/GVC/CPCSEA-IAEC/72/2011 dated 08/12/2011.

Fifty chicks of T1, T2, T3 and T4 group were given Diclazuril (0.1%), Salinomycin (12%), Diclazuril (0.1%) + Salinomycin (12%) in shuttle programme (Diclazuril was given for initial three week followed by Salinomycin in last three week) and Maduramicin (1 %) at a dose rate of 100 gm, 50 gm, 100 + 50 gm and 50 gm. per 100 Kg. broiler feed as coccidiostat, respectively. One group of 50 chicks will be kept as infected control (T5) and another group of 50 chicks will be kept as uninfected control (T6) without coccidiostat in feed. All birds were given starter feed up to 4 weeks of age and finisher feed for 5 to 6 weeks of age. Wing banding was done to keep the accurate record of each chick/ bird.

**Oocyst index**

Oocyst index was determined by microscopic examination of mucosal scrapings from the caeca on day 7 post infection as per the method of Hilbrich (1978) with some modification. Briefly, the caecal mucosa was scraped onto the cover slip and the cover slip was then pressed on a microscopic slide in such a way that the mucosal material got spread underneath the whole surface area of the cover slip. Five fields of cover slip were viewed for each scraping i.e. four corners and central field and the oocysts were counted in each field. The oocyst index was graded as 0, 1, 2, 3, 4, 5 for oocysts per field as <1 oocysts, 1-10 oocysts, 11-20 oocysts, 21-50 oocysts, 51-100 oocysts and >100 oocysts, respectively.

**Growth and feed parameters**

Body Weight (g) at day old (BW₀) and thereafter at weekly interval i.e. at 1st (BW₁), 2nd (BW₂), 3rd (BW₃), 4th (BW₄), 5th (BW₅) and 6th (BW₆) weeks of age were recorded in the cool morning hours before feeding. Body weight gain (g) was calculated at weekly interval. Broiler birds were weighed individually at weekly interval up to six weeks of age and weekly body weight gain was calculated by subtracting the average body weight (g) of previous week from that of average weekly body weight (g) of current week and were designated as BWG₀₋₁, BWG₁₋₂, BWG₂₋₃, BWG₃₋₄, BWG₄₋₅ and BWG₅₋₆. BWG₀₋₁, BWG₄₋₅ and BWG₀₋₆ were also calculated. Weight gains of each group were compared in between different treatment group and with non-medicated non-infected control group.

The weighed quantity of feed was offered daily to birds of each replication in each group. At the end of every week, the left over feed was weighed and recorded in each replicate. Feed consumption was calculated by subtracting the left over feed from total feed offered in each week. Feed consumption during 1st, 2nd, 3rd, 4th, 5th and 6th weeks were calculated and designated as FC₁, FC₂, FC₃, FC₄, FC₅ and FC₆ respectively. Feed consumption up to 4th week, 5 to 6 week and up to 6th week of age were calculated and designated as FC₀₋₄, FC₅₋₆ and FC₀₋₆, respectively. FCR was calculated during each week (FCR₁, FCR₂, FCR₃, FCR₄, FCR₅ and FCR₆), 0-4 weeks (FCR₀₋₄), 5-6 weeks (FCR₅₋₆) and 0-6 weeks (FCR₀₋₆) and it is derived by the following formula.

\[
FCR = \frac{\text{Average Feed Consumption (g)}}{\text{Average Body weight Gain (g)}}
\]

**Statistical analysis**

Data so generated during the present study were statistically analyzed as per the method of Snedecor and Cochran (1980) by using completely randomized design. Statistical Analysis System (SAS, 2000) was also used for the description statistics of the data.
RESULTS AND DISCUSSION

Comparative efficacy of coccidiostats on oocyst index

The Oocyst index was studied on seventh day post infection and the values were given in Table-1. Maduramicin and Salinomycin groups have lower oocyst index as compared to Diclazuril and Diclazuril + Salinomycin Shuttle group. Result indicates better efficacy of Maduramicin and Salinomycin which is completely incorporated with the findings of Muzurkiewez et al. (1987), Abbas et al. (2008) and Georgieva et al. (2010). These results might attributed to effects of maduramicin on lipid peroxidation reducing oxidative stress as reported by Georgieva et al. (2010). Raju et al. (2012) found higher oocyst index in Maduramicin and Salinomycin treatment group which might be due to location and oocysts dose difference.

Table 1: Oocyst index number in different treatment group at 7 day post infection

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Treatment group</th>
<th>Index Value</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T1</td>
<td>2,0,3,4,4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>2</td>
<td>T2</td>
<td>0,3,3,2,1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td>3</td>
<td>T3</td>
<td>2,2,3,3,4</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>4</td>
<td>T4</td>
<td>0,1,2,2,3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td>T5</td>
<td>3,4,4,4,5</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Comparative efficacy of coccidiostats on body weight and body weight gain

Before experimental infection of *E. tenella* in broiler birds, body weight was significantly highest in T5 group followed by T4, T2, T6, T1 and T3, respectively indicating better efficacy of Maduramicin followed by Salinomycin, Diclazuril and Diclazuril + Salinomycin coccidiostat among coccidiostat given treatment group at three weeks of age (Table 2). After experimental infection of *E. tenella* on 22nd day of age, highest body weight was observed in T4 Maduramicin group followed by T2 Salinomycin group, T1 Diclazuril group and T3 Diclazulin + Salinomycin group at 4th week of age. T6 Negative control group birds having highest body weight among all six groups, while T5 Positive controls birds showing lowest body weight at this age. Similar trend of body weight was observed up to six week of age among four treatment groups. Highest body weight was observed in Maduramicin given group followed by Salinomycin, Diclazuril and Diclazuril + Salinomycin group at 6 week of age in coccidiostat treatment groups. Among all groups, negative control group birds shown highest body weight and positive

Table 2: Weekly and overall body weight in gram (Mean ± S.E.) in different treatment group at starter stage and finisher stage

<table>
<thead>
<tr>
<th>Week</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>Treatment Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW1</td>
<td>46.46 ± 0.52</td>
<td>47.06 ± 0.16</td>
<td>46.80 ± 0.14</td>
<td>47.08 ± 0.42</td>
<td>47.32 ± 0.11</td>
<td>46.84 ± 0.26</td>
<td></td>
</tr>
<tr>
<td>BW2</td>
<td>120.20 ± 1.43</td>
<td>117.96 ± 1.48</td>
<td>116.86 ± 1.47</td>
<td>105.08 ± 0.29</td>
<td>122.46 ± 0.84</td>
<td>116.66 ± 0.82</td>
<td></td>
</tr>
<tr>
<td>BW3</td>
<td>289.10 ± 4.70</td>
<td>251.00 ± 3.00</td>
<td>265.32 ± 4.51</td>
<td>266.66 ± 3.29</td>
<td>307.34 ± 0.33</td>
<td>310.00 ± 3.30</td>
<td></td>
</tr>
<tr>
<td>BW4</td>
<td>541.94 ± 5.24</td>
<td>581.94 ± 4.12</td>
<td>525.10 ± 5.21</td>
<td>600.10 ± 5.05</td>
<td>617.80 ± 7.49</td>
<td>575.68 ± 2.01</td>
<td></td>
</tr>
<tr>
<td>BW5</td>
<td>989.04 ± 5.57</td>
<td>1013.98 ± 5.15</td>
<td>979.30 ± 11.04</td>
<td>1023.86 ± 6.92</td>
<td>974.84 ± 2.85</td>
<td>1031.60 ± 11.14</td>
<td></td>
</tr>
</tbody>
</table>

The means bearing different superscript within same row differ significantly from each other (P<0.05).

Journal of Animal Research: v.6 n.3 June 2016
control group birds showed lowest body weight at 6 week of age (Table 2). Results indicate increased body weight with non-infected non medicated group as compare to four coccidiostat treatment groups. Similar results were observed by Majumdar et al. (1993) and Thyagarajan et al. (1989) for non infected non medicated group and also by Anosa et al. (2011) for infected but non medicated group. Maduramicin shown highest body weight followed by Salinomycin, Diclazuril and Diclazuril + Salinomycin Shuttle group among coccidiostat treatment groups. Similar results were observed by Azizi et al. (2010). Felfeldi (1991) stated that sensitivity of *E tenella* did not change after 24 successive trials to maduramicin with higher BW as compare to other coccidiostat. Miyazaki et al. (1975) found that the salinomycin drug was effectively in reducing the mortality and increasing the average weight of chickens experimentally infected with *E. tenella*.

Body weight gain was highest in Maduramicin given group (333.44 ± 5.12) followed by Salinomycin given group (330.94 ± 4.95), Diclazuril + Salinomycin group (259.78 ± 2.47) and Diclazuril group (252.84 ± 6.62) at 3 week of age before experimental infection of *E. tenella*. Positive control birds showing decreasing trend of body weight gain after experimental infection to six week of age, while negative control bird showing increasing trend of body weight gain up to 5 week of age. Over all highest body weight gain was observed in T4 group followed by T2 group, T1 group and T3 group at the end of six week period in coccidiostats given group. All four values are differing significantly among coccidiostat group as well as from control group. Negative control T6 birds shown significant highest BWG (1918.26 ± 9.86) and positive control T5 birds showing significant lowest BWG (1472.80 ± 4.96) at the end of six week period (Table 3).

Overall result of body weight and body weight gain indicating better efficacy of Maduramycin among treatment group. Salisch and Shakshouk (1990) reported that broiler chickens infected with *Eimeria tenella* (2.5 × 104 oocysts per bird) given Maduramycin at 5 ppm showed increased weight gain and feed conversion, when compared with narasin and monensin. The efficacy of Maduramicin against *E. tenella, E. maxima*, *E. necatrix*, *E. brunetti* and *E. acervulina* in Hubbard - cross were studied by Folz et al. (1988) who reported that birds treated with Maduramicin had significantly higher weight gain. These results are in agreement with our findings. Raju et al. (2012) observed that *Eimeria tenella* infected and Salinomycin treated group had better weight gain when compared to Maduramicin and Lasalocid groups. These observations are also in accordance with Chappel and Babcock (1979) who found higher relative weight gain and lower lesion score in the Salinomycin than the lasalocid treated group.

### Table 3: Weekly and overall body weight gain in gram (Mean ± S.E.) at starter and finisher stage in different treatment group.

<table>
<thead>
<tr>
<th>Treatment Mean</th>
<th>BWG (0-6)</th>
<th>BWG (1-2)</th>
<th>BWG (3-4)</th>
<th>BWG (4-6)</th>
<th>BWG (0-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Em(T)</td>
<td>73.74 ± 1.50</td>
<td>168.60 ± 5.30</td>
<td>252.84 ± 6.62</td>
<td>447.10 ± 6.27</td>
<td>512.58 ± 5.50</td>
</tr>
<tr>
<td>C.D(T)</td>
<td>70.90 ± 1.47</td>
<td>133.04 ± 4.04</td>
<td>330.94 ± 4.95</td>
<td>432.04 ± 6.19</td>
<td>466.75 ± 5.00</td>
</tr>
<tr>
<td>S Em(P)</td>
<td>70.06 ± 0.46</td>
<td>148.46 ± 3.77</td>
<td>259.78 ± 2.47</td>
<td>454.20 ± 15.73</td>
<td>932.50 ± 10.96</td>
</tr>
<tr>
<td>C.D(P)</td>
<td>58.00 ± 1.47</td>
<td>161.58 ± 3.12</td>
<td>333.44 ± 5.12</td>
<td>423.76 ± 7.16</td>
<td>796.78 ± 17.10</td>
</tr>
<tr>
<td>S Em(T*P)</td>
<td>75.14 ± 0.90</td>
<td>184.88 ± 1.01</td>
<td>310.46 ± 7.19</td>
<td>357.04 ± 10.06</td>
<td>927.52 ± 12.94</td>
</tr>
<tr>
<td>C.D(T*P)</td>
<td>69.82 ± 0.66</td>
<td>193.34 ± 3.77</td>
<td>265.68 ± 1.45</td>
<td>455.92 ± 12.43</td>
<td>984.76 ± 11.07</td>
</tr>
</tbody>
</table>

The means bearing different superscript within same row differ significantly from each other (P<0.05).
These results indicate better efficacy of Salinomycin as compared to Maduramicin which might be due to some resistant against Maduramicin compared to Salinomycin in that area.

Comparative efficacy of coccidiostats on feed consumption and feed conversion ratio

Before experimental infection of E. tenella, there was no consistent trend regarding feed consumption in all six groups up to 3 week of age. After experimental infection, feed consumption was highest in T2 group followed by T4 group, T3 group and T1 group at 4, 5 and 6 week of age, respectively. There was significant decrease in feed consumption observed in positive control T5 group, while significant increase in feed consumption was observed in negative control T6 group as compared at coccidiostat treatment group at starter stage (Table 4).

Among four coccidiostat group, Salinomycin given group have highest feed consumption followed by Maduramicin group in starter and finisher phase, respectively among coccidiostats groups. Significant increase feed consumption in negative control, while significant decrease feed consumption in positive control among all treatment groups were observed during starter and finisher phase respectively. At the end of six week significantly highest feed consumption was observed in T2 group (3666.10g) followed by T4 group (3640.22g), T3 group (3614.55g) and T1 group (3579.98g) among four coccidiostat group. All values are differing significantly among coccidiostat treatment group. In positive control group significant lowest feed consumption (3560.54g), while in negative control group significant highest feed consumption 3774.77g was observed at above age among all groups (Table 4).

Before experimental infection of E. tenella lowest feed conversion ratio was observed in T4 group followed by shuttle program of Diclazuril + Salinomycin, while Salinomycin given and Diclazuril given groups have 2.85 ± 0.09 and 2.84 ± 0.07 FCR value, respectively. Over all FCR value were found lowest in T4 group followed by T1, T2, and T3 among treatment group. Significant highest FCR (2.42 ± 0.01) was observed in T5 group and lowest FCR (1.97 ± 0.51) was observed in T6 group among all groups (Table 5).
An overall result of feed efficiency and feed conversion ratio indicates better result by Maduramicin and Dicalzuril among treatment groups at the age of six week which is completely in line with Azizi et al. (2010), Georgiva et al. (2010) reported better results with Maduramicin in *E. tenella* infected broilers by improving WG and FCR. Safety of Maduramicin (Cygro) was studied in 600 Tetra-82 broilers by Laczay et al. (1989). They fed Maduramicin at the dose rate of 2.5, 5.0, 7.5 and 10.0 ppm in feed during the starter and grower phases between the 1st and 42nd days and reported that Maduramicin at 5 ppm did not influence body weight gain, feed consumption, feed conversion, or death rate which not supports the present study. This difference might be due to higher dose of mixed inoculums of *Eimeria* spp. given at later age.

In the present study, Salinomycin at 60 ppm showed less feed efficiency, while Ashraf et al. (2002) used Sacox (12 per cent Salinomycin sodium) as anticoccidial in the feed and reported that it was significantly better (P>0.05) in terms of live weight gain and feed efficacy. Ebrahimnezad and Pourreza (2005) studied the effect of ionophorous anticoccidial drugs, Salinomycin and lasalocid on performance of broiler chicks and results showed that Salinomycin was better than lasalocid sodium. Badstue and Johansen (1986) evaluated the efficacy of Maduramicin ammonium at 5 ppm (Cygro) and Salinomycin 66 ppm (Sacox, coccisact) in broiler chickens. The Salinomycin group had a lower feed consumption/kg live weight than the Maduramicin group in their study. This difference might be due to variation in the dose of infection and age of birds.

Based on the finding of this study, it is concluded that coccidiostats are proved to have growth promoting action in broiler chickens during the experimental infection of 50,000 dose of *E. tenella*. Birds fed with Maduramicin medicated (5 ppm) performed well in terms of live weight gain and feed conversion ratio and it was followed by salinomycin (60 ppm) for weight gain and Diclazuril for feed efficiency in broiler birds. Based on the findings of the present study, it was concluded that Maduramicin at 5 ppm and Salinomycin at 60 ppm can also be used for prevention and control of coccidiosis with less alteration in body weight and feed efficiency in broiler birds.

**ACKNOWLEDGEMENTS**

The authors are highly thankful to Principal and Dean, College of Veterinary Science & A.H., Anand and Principal Scientist & Head, Poultry Complex, AAU, Anand for providing the necessary facilities.
REFERENCES


