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Comparative efficacy of anticoccidial drugs in coccidiosis of broiler chicks

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Abstract

Coccidiosis of domestic fowl is a parasitic disease that infects poultry drastically and can cost the pastured poultry producer much in the course of a year. Two hundred forty, day-old-broiler chicks were purchased and were randomly divided in eight groups, containing thirty birds in each group. Decoquinate 6%, maduramicin ammonium 2%, monensin sodium 13.2%, salinomycin sodium 12%, a live attenuated vaccine, and trivalent live attenuated vaccine, was provided to the day chicks of six groups, respectively. The chicks of last two groups served as infected non-medicated and uninfected non-medicated, respectively. Feed consumption, weight gain, feed conversion ratio, mortality and oocyst count per gram feces were recorded during the conduction of the experiment. Among treated groups, performance of salinomycin group was significantly better ($p < 0.05$) in all aspects. Salinomycin acts against the sporozoites, trophozoites and first generation schizonts and is highly effective against the economically important species of *Eimeria*. The present study confirms that use of salinomycin, as an anticoccidial, is a drug of choice.

Key words : Broiler chick, Coccidiosis, Anticoccidiosis, Salinomycin

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Introduction

Coccidiosis of domestic fowl is a worldwide disease caused by obligatory intracellular protozoa of the genus *Eimeria*. The disease is characterized by enteric lesions of variable extent and severity, reducing the absorptive function of the intestinal mucosa, thus leading to weight loss, diarrhea, poor feed conversion and a higher mortality in the affected flocks. About 1,800 *Eimeria* species affect the intestinal mucosa of different animals and birds[1]. Seven distinct *Eimeria* species are actually considered pathogenic to chickens: *E tenella, E acervulina, E maxima, E necatrix, E brunetti, E praecox* and *E mitis*[2-5]. Avian *Eimeria* spp have homogenous life cycles, which have been well described[6]. Coccidiosis is responsible for important economic losses in poultry production[7,8]. The annual worldwide economic losses due to coccidiosis are estimated at about $800 million[9]. These estimates include the costs of prophylactic in-feed medication for broilers and broiler-breeders, alternative treatments (e.g., with amprolium) if the medications fail, and losses due to mortality, morbidity, and poor feed conversions of birds that survive from outbreaks.

Control measures, especially for broiler chickens, are still predominantly based on the prophylactic use of anticoccidial drugs in the feed, but live vaccines are being increasingly used in the field, as scientists are also converging their attention towards the immunization of chickens against coccidiosis through vaccination[10]. The present study was therefore undertaken to investigate the effects of different commercially available feed additive anticoccidials and vaccines, in commercial broiler chicks.

Materials and Methods

Experimental protocol

Two hundred forty, day-old-broiler chicks were purchased from a local hatchery. All chicks, after intensive inspection and weighing, were randomly divided in eight groups A, B, C, D, E, F, G and H, containing thirty birds in each group. All chicks were provided with the same conditions of temperature, humidity, and ventilation for forty-two days. Twenty-four hour light was provided to all experimental birds. The birds were allowed to drink and feed *ad libitum*.

Drugs

Deccox that contained "Decoquinate 6%", was provided to the birds of group "A" at the rate of 27.2 g/ton feed. Coccinil-M that contained "Maduramicin ammonium 2%", was provided to the birds of group B at the rate of 250 g/ton feed. Elancoban that contained "Monensin sodium 13.2%", was provided to the birds of group "C" at the rate of 110 g/ton feed. Salinopharm that contained "Salinomycin sodium 12%" was provided to the birds of group "D" at the rate of 500 g/ton feed. A live attenuated vaccine (Paracox) was diluted in water at the rate of approximately 5,000 doses in up to 3 liters of water and sprayed evenly over the surface of the feed using a coarse spray. This feed was then provided to the chicks

of group "E". A trivalent live attenuated vaccine (Livacox-T) was sprayed on day old chick of group "F" at the rate of 1ml vaccine in 19 ㎖ of water for 100 birds (as per recommended). The chicks of group "G" served as infected but non-medicated. The chicks of group "H" served as uninfected and non-medicated. Details of all drugs used in this experiment are shown in Table 1.

Table 1. Experimental groups and respective treatment

Groups	Trade name	Ingredient	Dose
A	Deccox	Decoquinate 6%	27.2 g/ton feed
B	Coccinil-M	Maduramicin ammonium 2%	250 g/ton of feed
C	Elancoban	Monensin sodium 13.2%	110 g/ton feed
D	Salinopharm	Salinomycin sodium 12%	500 g/ton feed
E	Paracox	Live attenuated vaccine	5,000 doses in up to 3 liters of water and spray evenly over the surface of the feed
F	Livacox-T	Trivalent live attenuated vaccine	1 ㎖ vaccine in 19 ㎖ of water for 100 birds
G	Infected Non-medicated	N/A	N/A
H	Uninfected Non-medicated	N/A	N/A

Source of infection

In order to induce coccidiosis in the experimental birds, infected guts and cecas were obtained from birds with confirmed coccidiosis. Isolation and sporulation of oocysts was carefully done. To permit this, fecal material containing coccidian were mixed with 2.5% of potassium bichromate solution and a shallow pole of this mixture was made in a Petri dish. The mixture was incubated at room temperature for one week to allow better sporulation [11]. The average number of oocysts per 0.1 ㎖ of mixture was calculated to obtain the total count in 1 ㎖ of undiluted stock mixture. The birds in all the groups, except those of group "H" (control), were infected with an oral dose of 40,000 sporulated oocysts of mixed coccidian species at the age of 22nd and 35th day.

Performance

Feed consumption, weight gain, feed conversion ratio, mortality and oocyst count per gram feces were recorded during the conduction of experiment. MacMaster method was used for counting oocyst per gram of feces [12].

Statistical analysis

The recorded data of feed consumption, weight gain, feed conversion ratio, mortality and oocyst count was subjected to statistical analysis by using two-way analysis of variance and means were compared with least significant difference (LSD) [13].

Results

Mean values of feed consumption, weight gain, feed conversion ratio, mortality percentage at 42 days of age and average oocyst count on 5th, 6th and 7th day after inoculation have been presented in Table 2.

Table 2. Broiler production performance (0-6 weeks)

Group	Medication	Feed consumption(kg)	Weight gain (kg)	Feed conversion ratio	Mortality (%)	Oocyst count / gram feces
A	Decoquinate, 6%	3.23	1.70	1.90	10.0	29,900
B	Maduramicin ammonium, 2%	3.32	1.73	1.91	13.3	28,700
C	Monensin sodium, 13.2%	3.28	1.76	1.96	16.67	34,200
D	Salinomycin sodium, 12%	3.36	1.80	1.85	0.0	21,800
E	Live attenuated vaccine	3.35	1.68	1.99	3.33	31,800
F	Trivalent live attenuated vaccine	3.31	1.66	1.99	4.0	34,500
G	Infected non-medicated	3.35	1.63	2.06	20.0	45,000
H	Control	3.54	1.82	1.93	0.0	0

The average values of feed consumption during the experiment were 3.23, 3.32, 3.28, 3.36, 3.35, 3.31, 3.35 and 3.54 kg for the groups A, B, C, D, E, F, G, and H, respectively. Similarly, mean values of final body weight gain were 1.70, 1.73, 1.76, 1.80, 1.68, 1.66, 1.63 and 1.82 kg for the groups A, B, C, D, E, F, G, and H, respectively. The average values of feed conversion ratio (FCR) of chicks in groups A, B, C, D, E, F, G, and H at the end of experiment were 1.90, 1.91, 1.96, 1.85, 1.99, 1.99, 2.06 and 1.93 respectively. The mortality percentage of chicks in groups A, B, C, D, E, F, G, and H at the end of experiment were 10, 13.3, 16.67, 0, 3.33, 4, 20 and 0, respectively. There was zero mortality in birds of group "D" (salinomycin) and "H" (uninfected and non-medicated). Oocyst counting was done, for each group, by collecting the fecal samples after 5th, 6th and 7th days of infection. There were no oocysts found in group "H", as it was not infected with coccidia. The average oocyst count per gram of feces recorded during three days, for groups A, B, C, D, E, F, G and H were 29,900, 28,700, 34,200, 21,800, 31,800, 34,500, 45,000 and 0, respectively.

Results revealed that the birds, which

were uninfected and Non-medicated, showed better performance ($p < 0.05$) than all other medicated groups. Among infected groups, weight gain, feed conversion ratio, percentage mortality and oocyst count per gram of feces of the chicks of group "D" (salinomycin) was significantly better ($p < 0.05$) than other groups.

Discussion

It is an undisputed fact that the worlds poultry industry could not exist without some means of controlling coccidiosis, a debilitating, sometimes fatal, disease complex in chickens caused by one or more of seven species of the apicomplexan parasite, *Eimeria*. Since 1940s, anticoccidial drugs of many different chemical types have been developed for commercial use. However, although successive improvements in their efficacy have been made over the years, resistance has developed to all of the anticoccidial drugs introduced so far[14]. This has come to be of great concern to commercial chicken producers. In addition to this, other problems threaten the economic status of the industry, such as the recent poor success in the discovery of new types of anticoccidial drugs, the increasing costs of their commercial development and, not least, the widespread consumer and government pressures to exclude chemotherapeutic additives from the diets of food animals[15].

Results revealed that birds of group "H" consumed higher feed ($p < 0.05$) than all other medicated groups. Williams and Gobbi [16], Chapman et al[17] and Vermeulen et al[18] reported similarly that coccidiosis resulted in decreased feed intake. In the similar way, birds of group "H" gained more weight as compared to other groups. Among the infected groups, weight gain of the chicks of group "D" (Salinomycin) was significantly increased ($p < 0.05$). Similar positive results of salinomycin on weight gain were reported by Conway et al[19], Conway et al[20], and Hooge et al[21]. FCR of the birds of group "D" was significantly better ($p < 0.05$) than the other groups, while poorest FCR was observed in group "G" (infected non-medicated). The results of the present study were in agreement with Augustine et al[22], Jaramillo et al[23] and Gray et al[24]. Among infected groups, percentage mortality of the birds of group D was significantly better ($p < 0.05$) than the other groups. Hooge et al[21] also explained the similar effect of salinomycin in lowering mortality of coccidiosis-infected birds. Similarly, among treated groups, the numbers of oocyst count from the birds of group "D" was significantly reduced ($p < 0.05$) compared to other groups. Similar positive results of salinomycin in reduction of oocyst count were observed by Allen *et al.*, [25], Conway et al[26], Daugschies et al[27] and McAllister et al[28]. From above mentioned data it is evident that use of salinomycin is a better choice for prevention as well as treatment of coccidiosis in broiler.

Salinomycin is an ionophore produced from the fermentation of *Streptomyces albus*. It was discovered and patented in Japan by Kaken in 1973[29]. Salinomycin works against coccidia by enhancing the transport of potassium ions into cells, leading to exhaustion of the cells ion

pump systems and water overload. Salinomycin acts against the sporozoites, trophozoites and first generation schizonts and is highly effective against the economically important species of *Eimeria* [30].

References

1. Shirley MW. 1995. *Eimeria* spp. and strains of chickens. In: Eckert J, Braun R, Shirley MW, et al. *Guidelines on techniques in coccidiosis research.* European Commission, Directorate General XII, Science Research and Development, Agriculture Biotechnology, L-2820 Luxemburg : 1-34.
2. Callow LL. 1984. *Eimeria* in domestic fowls. In: Callow LL. (Ed.), *Animal Health in Australia,* Vol. 5. Australian Publishing Service, Canberra : 35-47.
3. Fernandez S, Costa AC, Katsuyama AM, et al. 2003. A survey of the inter-and intra-specific RAPD markers of *Eimeria* spp. of the domestic fowl and the development of reliable diagnostic tools. *Parasitol Res* 89(6) : 437-445.
4. Jorgensen WK, Stewart NP, Jeston PJ, et al. 1997. Isolation and pathogenicity of Australian strains of *Eimeria praecox* and *Eimeria mitis. Aust Vet J* 75 : 592-595.
5. McDougald LR, Reid WM. 1997. In: Calnek BW, Barnes HJ, Beard CW, et al (Eds.), *Diseases of Poultry,* Iowa State University Press, Ames, IA, pp. 865-883.
6. Fernando AM. 1973. *Eimeria* : Infections of the intestine, In Long PL (ed.), *Coccidiosis of man and domestic animals.* CRC Press, Inc., Boca Raton, Fla: 63-75.
7. Braunius WW. 1988. Epidemiology of *Eimeria* spp. in broiler chicks as influenced by anticoccidial agents. *Tijdschrt Diergeneeskd* 113 : 123-131.
8. Magner BR. 1991. Anticoccidials. In: Brander GC, Pugh DM, Bywater RJ, et al. 1991. *Veterinary Applied Pharmacology and Therapeutics,* 5th Ed. ELBS, Bailliere Tindall, London : 549-563.
9. Williams RB. 1998. Epidemiological aspects of the use of live anticoccidial vaccines for chickens. *Int J Parasitol* 28 : 1089-1098.
10. Allen PC, Fetterer RH. 2002. Recent advances in biology and immunobiology of *Eimeria* species and diagnosis and control of infection with these coccidian parasites of poultry. *Clin Microbiol Rev* 15 : 58-65.
11. Norman DL. 1985. *Veterinary Protozoology.* Iowa State University Press, USA.
12. Urquhart GM. Armour J, Duncan JL, et al. 1996. *Veterinary parasitology.* Blackwell Science. UK.
13. Steel RGD, Torrie JH. 1980. *Principles and procedures of statistics.* McGraw Hill Book Co Inc. New York : 137-171.
14. Chapman HD. 1997. Biochemical, genetic and applied aspects of drug resistance in *Eimeria* parasites of the fowl. *Avian Pathol* 26 : 221-244.
15. Williams RB. 1992. The development, efficacy and epidemiological aspects of Paracox™, a new coccidiosis vaccine for chickens. Harefield: PitmanMoore Europe
16. Williams RB, Gobbi L. 2002.

Comparison of an attenuated anticoccidial vaccine and an anticoccidial drug programme in commercial broiler chickens in Italy. *Avian Pathol* 31(3) : 253-265.

17. Chapman HD. Cherry TE, Danforth HD, et al. 2002. Sustainable coccidiosis control in poultry production: the role of live vaccines. *Int J Parasitol* 32(5) : 617-29.
18. Vermeulen AN, Schaap DC, Schetters TP. 2001. Control of coccidiosis in chickens by vaccination. *Vet Parasitol* 100(1-2) : 13-20.
19. Conway DP, Mathis GF, Lang M. 2002. The use of diclazuril in extended withdrawal anticoccidial programs: 2. Immunity to *Eimeria tenella* challenge after drug withdrawal. *Poult Sci* 81(3) : 353-355.
20. Conway DP, Mathis GF, Johnson J, et al. 2001. Efficacy of diclazuril in comparison with chemical and ionophorous anticoccidials against Eimeria spp. in broiler chickens in floor pens. *Poult Sci* 80(4) : 426-430.
21. Hooge DM, Cummings KR, McNaughton JL. 1999. Evaluation of sodium bicarbonate, chloride, or sulfate with a coccidiostat in corn-soy or corn-soy-meat diets for broiler chickens. *Poult Sci* 78(9): 1300-1306.
22. Augustine PC, Danforth HD. 1999. Influence of betaine and salinomycin on intestinal absorption of methionine and glucose and on the ultrastructure of intestinal cells and parasite developmental stages in chicks infected with *Eimeria acervulina*. *Avian Dis* 43(1) : 89-97.
23. Jaramillo M, Ruiz H, Silva L. 1998. Comparative evaluation of triamcinolone in coccidiosis control in fattening chickens. *Acta Cient Venez* 49(1) : 62-67.
24. Gray SJ, Ward TL, Southern LL, et al. 1998. Interactive effects of sodium bentonite and coccidiosis with monensin or salinomycin in chicks. *Poult Sci* 77(4) : 600-604.
25. Allen PC. Danforth HD, Augustine PC. 1998. Dietary modulation of avian coccidiosis. *Int J Parasitol* 28(7) : 131-140.
26. Conway DP, Dayton AD, McKenzie ME. 1999. Comparative testing of anticoccidials in broiler chickens: the role of coccidial lesion scores. *Poult Sci* 78(4) : 529-535.
27. Daugschies A, Gasslein U, Rommel M. 1998. Comparative efficacy of anticoccidials under the conditions of commercial broiler production and in battery trials. *Vet Parasitol* 76(3) : 163-171.
28. McAllister TA, Annett CB, Olson ME, et al. 1996. Effect of salinomycin on giardiasis and coccidiosis in growing lambs. *J Anim Sci* 74(12) : 2896-2903.
29. Leblanc D, Morin A, Daigneault J. 1993. Comparative effect of salinomycin and monensin on *Streptococcus bovis* strain ATCC 9809. *Microbios* 76(306) : 41-45.
30. Daugschies A, Gasslein U, Rommel M. 1998. Comparative efficacy of anticoccidials under the conditions of commercial broiler production and in battery trials. *Vet Parasitol* 76(3) : 163-171.