

Comparative studies on the effects of lincomycin and bacitracin on hematobiochemical and immunological parameters in broiler chickens

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Abstract

A total of 100 one-day-old healthy broiler chicks were used to study the effects of lincomycin and bacitracin on some hematobiochemical and immunological parameters. Chicks were divided into four equal groups, 25 each. The first group was kept as control; the 2nd group was received 0.5 g of lincomycin per liter; the 3rd group was received 100 mg bacitracin per liter and the 4th group was administered both lincomycin and bacitracin, each at the above-mentioned dose. Drugs were given in drinking water for 5 successive days from 20th to 25th day of age. Bodyweight was recorded at the beginning of the experiment and at 1st-day post administration where body performance was recorded. One day post administration, blood samples were collected for estimation of hematobiochemical and immunological alterations. The obtained results revealed that broiler chicks administered lincomycin or bacitracin or both revealed a marked increase in bodyweight, weight gain, phagocytic activity, phagocytic index, erythrocytic count, hemoglobin level, packed cell volume, total leukocytic count, serum total protein, albumin, total globulin, α , β and γ globulin. Furthermore, a significant elevation in malondialdehyde associated with a marked reduction in albumin-globulin ratio, serum total lipid, cholesterol and triglyceride and a significant decrease in catalase and superoxide dismutase, were recorded, compared with the control group. In conclusion, lincomycin and bacitracin either alone or in combination have positive impacts on growth performance, immunological and hematobiochemical parameters of broiler chickens. So, it is recommended to use both drugs as growth promoters in broiler chickens.

Keywords: Bacitracin; Biochemical; Chickens; Hematological; Immunological; Lincomycin.

1. Introduction

Poultry is considered as a good source of animal protein with a high biological value for human consumption all over the world (Gilmour et al. 2004). Intensive broilers production now exceeds 2×10^{10} bird worldwide, but it attracts accusations of poor welfare (Dawkins et al. 2004). Prevention of diseases is the main issue in the poultry industry, due to resulting reduced growth rate and enhanced mortality (Porter 1998, Elbadawy & Aboubakr 2017). Antibiotic growth promoters have been used for decades in poultry farms as a tool to maintain bird health and improve growth performance (Huyghebaert et al. 2011). Among the well-developed antibiotics that seem promising in veterinary use are lincomycin and bacitracin (Chan et al. 2015). Lincomycin is a naturally occurring lincosamide antibiotic obtained as a fermentation product of *Streptomyces lincolnensis*. It has a spectrum of activity against Gram-positive bacteria and most anaerobes (Greenwood 2010). Lincomycin acts by inhibition of protein synthesis of bacterial cells (Ali et al. 2014). Several studies have shown lincomycin at low concentrations of 2.2 to 4.4 mg/kg to be effective in improving weight gain and efficiency of food utilization (Stutz & Lawton 1984, Dafwang et al. 1987). Bacitracin is a mixture of high molecular weight polypeptides that possess antimicrobial activity against gram-positive microorganisms interfering with the formation of the bacterial cell wall (Butaye et al., 2003). Bacitracin is one of the most extensively used growth promoters to enhance productivity in poultry (Huyghebaert et al., 2011). Studies have reported changes in the gut bacterial flora of broiler chickens associated with dietary supplementation with bacitracin (Lu et al. 2008, Torok et al. 2011). Additionally, bacitracin is used for the treatment and control of many infections in broiler chickens as *Clostridium perfringens* infection (Rukmini et al. 2015) which is one of the most economically important gut diseases in broiler chickens with a high mortality rate (Aboubakr & Elbadawy 2017). Few data are available about the effects of both drugs on the healthy broiler chickens. Therefore, the present study was conducted using a large number of chickens to determine the effects of lincomycin and bacitracin on some hematobiochemical and immunological parameters in healthy broiler chickens.

2. Material and methods

2.1. Drugs



Lincomycin hydrochloride and bacitracin methylene disalicylate were obtained from ATCO pharma for pharmaceutical industries, Cairo, Egypt under the commercial name of ATO LINC 400[®] and BACITOP[®], respectively. Each gram powder of ATO LINC 400[®] contains 453.6 mg lincomycin Hcl (eq. to 400 mg lincomycin base). In chickens and turkeys, it is administered orally at a dose of 0.5 gm/liter drinking water to combat necrotic enteritis (*Clostridia* spp.), mycoplasmosis and air sacculitis (*Mycoplasma gallisepticum*), infectious synovitis (*Mycoplasma synoviae*) and infectious sinusitis (*Mycoplasma meleagridis*). Each gram powder of BACITOP[®] contains 62 mg bacitracin methylene disalicylate (eq. to 44.06 mg bacitracin base). It is administered orally at a dose of 100 mg/liter drinking water for 5-7 days for treatment of *Clostridium perfringens* infection in broiler chickens.

2.2. Experimental chickens

A total of 100, one-day-old Hubbard mixed breed broiler chicks were obtained from a local poultry farm and used in this trial. Birds were kept in wire floor batteries under hygienic measures. All chicks were vaccinated with Newcastle vaccines (HitchnerB1 at 7 days and Lasota at 18 days) and Gumboro vaccine at 14 days. The chickens were maintained at a suitable temperature and humidity according to their ages. The chickens had free access to water and feed. The feed was free from antibacterial drugs. The experiments were performed in accordance with the guidelines set by the Ethical Committee of Faculty of Veterinary Medicine, Benha University, Egypt.

2.3. Experimental design

At the 15th day of age, all chickens were randomly divided into 4 equal groups, each of 25 chicks and were allowed to acclimatize for 5 days before administration of drugs. The first group was kept as control; the second one has received lincomycin at 0.5 g/L. The third group was administered bacitracin at a dose level of 100 mg/L while the fourth group was given lincomycin and bacitracin together. Administration of drugs was in drinking water for 5 successive days from 20th day of age to 25th day of age.

2.4. Blood sampling

Twenty four h after last administration, two blood samples from each bird were collected, one sample with EDTA as anticoagulant for estimation of hematological parameters (erythrocytic count, packed cell volume, hemoglobin content), total leucocytic count (Weiss & Wardrop 2010), phagocytic activity (Thompson 1977, Lee & Bacon 1983) and phagocytic index. The another sample was used for the measuring of serum total protein (Doumas et al. 1981), protein fractions using cellulose acetate electrophoresis test (Henry et al. 1974), total lipid (Frings & Dunn, 1970), cholesterol (White et al. 1970), triglyceride (Bergmeyer, 1974), superoxide dismutase (Nishikimi et al. 1972), catalase (Sinha 1972) and malondialdehyde (Nielsen et al. 1997).

2.5. Statistical analysis

The obtained data were statistically analyzed according to (Petrie & Watson 2013).

3. Results

Healthy broiler chickens received bacitracin and lincomycin either alone or together showed non-significant elevation on body weight and weight gain but improved feed conversion rate throughout the experimental period when compared with the control group (Table 1). It was noticed that use of bacitracin or lincomycin in healthy broiler chickens for 5 successive days results in a marked but non-significant increase in erythrocytic count, hemoglobin and packed cell volume, leukocytic count phagocytic activity, and phagocytic index (Table 2). Furthermore, chickens administered bacitracin and lincomycin either alone or together displayed a nonsignificant increase in serum total protein, albumin, total, γ , β and α globulin coupled with a nonsignificant decrease in albumin globulin ratio at 24 h after last administration (Table 3). Moreover, oral giving of bacitracin or lincomycin in the tested doses displayed nonsignificant reductions in serum total lipid, cholesterol and triglyceride in healthy broiler chickens when compared with control broilers (Table 4). Furthermore, the obtained results revealed that broilers received lincomycin and/or bacitracin at the tested doses either alone or together showed a significant reduction in catalase and superoxide dismutase (SOD) associated with an elevation in malondialdehyde (MDA) when compared with control broiler chickens (Table 4).

Table 1: Effect of Lincomycin (0.5 g/L) and Bacitracin (100 mg/L) in Drinking Water for 5 Successive Days on Body Performance in Healthy Chickens at the 15th Day of Age and 1st- and 10th-Day Post Administration. Values are Mean \pm SE (N= 5)

Group	Weight (1 st day of age)	15 th day of age			1 st day post-treatment (26 th day of age)			10 th -day post-treatment (36 th day of age)		
		Bodyweight (g)	Weight gain	FCR	Bodyweight (g)	Weight gain	FCR	Bodyweight (g)	Weight gain	FCR
Control	38.5 \pm 1.47	499.6 \pm 9.4	461.1 \pm 13.3	1.2	1284.5 \pm 14.6	784.9 \pm 19.4	1.25	2079.2 \pm 16.3	794.7 \pm 13.9	1.65
Lincomycin	38.4 \pm 1.28	498.8 \pm 6.5	460.5 \pm 2.9	1.2	1290.2 \pm 19.5	791.3 \pm 15.5	1.24	2089.3 \pm 14.6	799.2 \pm 12.6	1.64
Bacitracin	38.3 \pm 1.31	498.9 \pm 8.8	460.5 \pm 12.9	1.2	1292.7 \pm 16.6	793.7 \pm 14.2	1.24	2092.4 \pm 15.6	799.7 \pm 9.9	1.64
Lincomycin and bacitracin	38.5 \pm 1.21	502.1 \pm 9.9	463.6 \pm 12.7	1.2	1298.6 \pm 14.5	796.4 \pm 14.8	1.23	2099.6 \pm 15.7	801.1 \pm 8.4	1.64

Table 2: Effect of Lincomycin (0.5 g/L) and Bacitracin (100 mg/L) in Drinking Water for 5 Successive Days on Erythrogram and Leukocytic Count, Phagocytosis and Phagocytic Index in Healthy Chickens, 24 h after Last Administration. Values are Mean \pm SE (N= 5)

Group	RBCs ($\times 10^6/\mu\text{L}$)	Hb (gm/dL)	PCV (%)	Total WBCs ($\times 10^3/\mu\text{L}$)	Phagocytosis	Phagocytic index
Control	3.75 \pm 0.33	10.74 \pm 0.93	31.5 \pm 0.84	10.9 \pm 0.33	62.7 \pm 0.54	4.74 \pm 0.38
Lincomycin	3.88 \pm 0.49	11.0 \pm 0.87	32.0 \pm 0.75	11.2 \pm 0.21	63.9 \pm 0.98	5.05 \pm 0.79
Bacitracin	3.80 \pm 0.28	10.9 \pm 0.72	33.0 \pm 0.68	11.1 \pm 0.23	63.0 \pm 0.84	4.90 \pm 0.81
Lincomycin and bacitracin	3.89 \pm 0.33	10.9 \pm 0.73	32.0 \pm 0.89	11.1 \pm 0.33	63.1 \pm 0.67	4.86 \pm 0.92

Table 3: Effect of Lincomycin (0.5 g/L) and Bacitracin (100 mg/L) in Drinking Water for 5 Successive Days on the Levels of Serum Total Protein (TP), Albumin (Alb.) and Globulin Fraction in Healthy Chickens, 24 h after Last Administration. Values are Mean \pm SE (N= 5)

Group	TP	Alb.	Globulin (gm/dL)			Total	A/G ratio
			α	β	γ		
Control	5.41 \pm 0.21	3.20 \pm 0.21	0.64 \pm 0.10	0.69 \pm 0.18	0.88 \pm 0.16	2.21 \pm 0.21	1.45 \pm 0.12
Lincomycin	5.47 \pm 0.17	3.21 \pm 0.42	0.65 \pm 0.16	0.72 \pm 0.17	0.90 \pm 0.20	2.28 \pm 0.16	1.40 \pm 0.13
Bacitracin	5.44 \pm 0.19	3.22 \pm 0.32	0.65 \pm 0.11	0.70 \pm 0.18	0.89 \pm 0.22	2.23 \pm 0.31	1.44 \pm 0.12
Lincomycin and bacitracin	5.49 \pm 0.21	3.20 \pm 0.32	0.69 \pm 0.11	0.71 \pm 0.17	0.90 \pm 0.23	2.30 \pm 0.17	1.39 \pm 0.15

Table 4: Effect of Lincomycin (0.5 g/L) and Bacitracin (100 mg/L) in Drinking Water for 5 Successive Days on Serum Levels of Lipid Profile, Catalase, Superoxide Dismutase (SOD) and Malondialdehyde (MDA) in Healthy Chickens, 24 h after Last Administration. Values are Mean \pm SE (N= 5).

Group	Lipid profile (mg/dL)			Antioxidants enzyme (U/mL)		MDA (mmol/mL)
	Total lipid	Cholesterol	Triglyceride	Catalase	SOD	
Control	226.3 \pm 1.87	93.6 \pm 1.94	114.1 \pm 1.82	37.1 \pm 1.40	256.3 \pm 1.49	22.2 \pm 0.39
Lincomycin	225.4 \pm 1.78	92.4 \pm 1.74	112.8 \pm 1.86	32.8 \pm 1.01*	250.1 \pm 1.53*	23.9 \pm 0.66*
Bacitracin	225.6 \pm 1.98	92.7 \pm 1.86	113.7 \pm 1.69	32.9 \pm 1.20*	251.3 \pm 1.32*	23.7 \pm 0.51*
Lincomycin and bacitracin	225.6 \pm 1.84	92.8 \pm 1.69	114.2 \pm 1.82	33.1 \pm 1.10*	251.1 \pm 1.21*	23.7 \pm 0.35*

* P < 0.05.

4. Discussion

Healthy broiler chickens received bacitracin and lincomycin either alone or together showed non-significant elevation on bodyweight and weight gain but improved feed conversion rate throughout the experimental period when compared with the control group. The growth promoting the effect of antimicrobials may be due to suppression to the microorganisms that invade the host and retard its metabolic activity (Charleston et al. 1998). Another explanation for improved body performance after using lincomycin and bacitracin is the antimicrobial effect of them which consequently improves the metabolic activity of bird by inhibiting pathogenic organisms that damage gut epithelium and impairing food absorption, inhibiting non pathogenic organisms which compete for growth factors in gut and inhibiting organisms producing toxic substances affecting growth (Abdelaziz 2002). Lincomycin and zinc bacitracin induced an increase in weight gain of broilers (Jiang et al. 2013). The growth promoting the effect of bacitracin might be attributed to a decrease in the thickness of the intestinal wall and thus increases the absorption of nutrients (Henry et al. 1974). Turkeys received zinc bacitracin showed improved body performance (Sims et al. 2004). Our results were agreed with Abaza et al. who mentioned that zinc bacitracin resulted in a progressive significant increase in average final bodyweight, average total weight gain and feed conversion ratio (Abaza et al. 2008). Several other data showed similar results (Ramadan 2017), (Pan et al. 2017, Adel 2018) in broilers received zinc bacitracin. Additionally, lincomycin supplementation to broilers diet significantly improved body weight gain (Sun et al. 2005). Similarly, lincomycin caused in improved weight gain and feed conversion rate in the broilers (Khan and Nagra 2010). Also, the same improvements in body performance were observed in healthy broiler received lincomycin (Mohamed 2016).

Administration of bacitracin or lincomycin or both in healthy broiler chickens for 5 successive days resulted in nonsignificant increases in erythrocytic count, hemoglobin and packed cell volume, leukocytic count phagocytic activity, and phagocytic index. These changes in blood picture may be due to the protection of intestinal epithelium from the toxic effect of subclinical infection of bacteria by tested drugs. It was found that zinc bacitracin in ration induced nonsignificant changes in the total erythrocytic count, hemoglobin, packed cell volume and total leukocytic counts (Ramadan 2017, Adel 2018). Our results were in harmony with those showing that healthy broilers received lincomycin showed nonsignificant increases in the total erythrocytic count, hemoglobin, packed cell volume and leukocytic count (Mohamed 2016). In the same way, healthy broiler chickens received lincomycin showed a significant increase in total erythrocytic count, hemoglobin, packed cell volume and total leukocytic counts (Kadry et al. 2009). Additionally, lincomycin induced a nonsignificant increase in phagocytic activity and index (Fateeva 1983) and (Faden et al. 1985). Furthermore, lincosamides have dramatically increased phagocytic activity (Cialdella et al. 1986) as well as achieves high intracellular levels of phagocytic cells (Alikhani & Salehifar 2012). Our data coordinated with the findings showing that bacitracin induced a non-significant elevation in phagocytic activity and phagocytic index (Adel 2018).

Our results revealed that chickens are given bacitracin or lincomycin in tested dose each alone or together in drinking water for 5 successive days displayed a nonsignificant increase in serum total protein, albumin, total, γ , β and α globulin coupled with a non-significant decline in albumin globulin ratio at 1st-day post administration. In a similar way, zinc bacitracin induced a non-significant elevation in plasma protein profile levels (Ibrahim 2005, Abaza et al. 2008). Additionally, zinc bacitracin in the diet of broilers chickens was found safe as the liver function tests and protein picture were not altered (El-Bahr et al. 2013). Moreover, bacitracin supplement in ration induced a non-significant elevation in total protein, albumin, total globulin, γ globulin, β and α globulin (Manafi et al. 2017). Recently, the above-mentioned results were supported by another study that stated that using bacitracin at therapeutic dose induced non-significant increase in serum total protein, albumin, total protein, albumin total, α , β and γ globulin in broiler chickens (Adel 2018). Our results coordinate well with the non-significant alterations in serum total protein, albumin, total, α , β and γ globulin in healthy chickens received lincomycin (Mohamed 1995, Mohamed 2016) and clindamycin (Ali 2007). Another supporting study stated that growth promoter (bacitracin and lincomycin) induced a non-significant increase in serum total protein, albumin, total, α , β and γ globulin in healthy broilers (Naveenkumar et al. 2018).

Oral dosing of bacitracin or lincomycin at the tested doses induced a nonsignificant decline in serum total lipid, cholesterol and triglyceride levels in healthy broiler chickens when compared with the control group. The same change in lipid profile after using zinc bacitracin was reported in broiler chicks (Abdulrahim et al. 1996) and in turkeys (Cheng et al. 2002). Other supporting studies (Ibrahim 2005, Li et al. 2006, Teo & Tan 2007) demonstrated that zinc bacitracin has resulted in a consistent non-significant reduction in plasma total lipid, cholesterol, and triglyceride levels. Similarly, in ducks, zinc bacitracin in diets induced lower in the level of serum total lipid and cholesterol concentration (Wu et al. 2013). Manafi et al. found that bacitracin methylene disalicylate supplement in ration induced the nonsignificant changes in cholesterol, triglyceride (Manafi et al. 2017). Similarly, zinc bacitracin and bacitracin methylene disalicylate induced significant reduction concentrations of serum lipid profiles (Ogboko 2010) and (Chowdhury et al. 2018), respectively. Furthermore, the growth promoters (bacitracin and lincomycin) induced a non-significant reduction in serum total lipid, cholesterol and triglyceride levels in healthy broiler chickens (Naveenkumar et al. 2018).

The obtained results revealed also that, healthy broilers received lincomycin and/or bacitracin either alone or together showed a significant reduction in catalase and superoxide dismutase associated with an elevation in malonaldehyde 24 h after administration when

compared with the control group. Consistently with another study, zinc bacitracin has induced a significant decrease in serum superoxide dismutase and catalase while serum malonaldehyde significantly increased (Ding et al. 2011). Also, zinc bacitracin in diets induced a non-significant decrease in activities of superoxide dismutase and catalase in ducks (Wu et al. 2013). Additionally, broilers fed zinc bacitracin in the diet showed a decrease in enzymatic antioxidants (superoxide dismutase and catalase) (El-Bahr et al. 2013). Previous results demonstrated also that, zinc bacitracin in the diet decreased levels of serum enzymatic antioxidants besides increased the lipid peroxidation level (Malondialdehyde) (Ismail et al. 2015). Moreover, zinc bacitracin and bacitracin methylene disalicylate induced a nonsignificant reduction in superoxide dismutase and catalase but malonaldehyde increased (Zhou et al. 2016) and (Chowdhury et al. 2018), respectively.

5. Conclusion

Stemmed from our findings, it could be concluded that lincomycin and bacitracin either alone or in combination have positive impacts on growth performance, immunological and hematobiochemical parameters of the broiler chickens. Therefore, lincomycin and bacitracin are a good choice for growth promotion in broiler chickens production.

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