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Amoxicillin: A better antibiotic in enhancing feed efficiency and body weight gain in broilers

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Abstract
The current study aimed to investigate the effects of dietary supplementation of broiler chicken with an antibiotic growth promoter on their growth, performance, carcass traits and intestinal morphology. Seventy-two (72) one-day-old, straight Ven Cobb chicks were randomly assigned to either of four equal groups (T0-T4), each having three replicates, and reared for 42 days in deep-litter system at Institutional Poultry Farm, Gannavaram (16.54 °N, 80.80 °E) without environmental control (mean ambient temperature 26 °C, relative humidity 73%). T0, receiving a standard basal diet without any growth promoting, antimicrobial or anti-coccidial agents, served as the negative control. T1 received Brand A (Amoxicillin 50%) at 250 ppm, T2 received Brand B (ciprofloxacin 25%) at 500 ppm, T3 received Brand D (oxytetracycline 50%) at 500 ppm. Different parameters about growth, performance, carcass traits, and intestinal morphology, serum biochemical parameters were recorded in the birds and, unless stated otherwise, the statistical significance of the differences between group mean values were ascertained by one-way analysis of variance (ANOVA) at $P< 0.05$. Besides significantly better FCR than groups T0, T2, T3, T1 showed significantly better weight gain than group T0 and comparable growth to all other groups. Group T1 showed significantly higher values of serum albumin, serum total protein, the height of ileal villi, and depth of ileal crypts as compared to the unsupplemented control and the antibiotic-supplemented groups. Group T1 also showed significant improvements in body weight gain, muscle protein content, ileal villous width, jejunal villous height and width, jejunal crypt depth, and blood glucose over the unsupplemented control T0 and most of the antibiotic-supplemented groups. It could be concluded that Amoxicillin is an efficacious growth promoter for broiler chicken and that it could be used successfully in broiler feeds for improving growth, performance, carcass traits, and intestinal morphology.

Keywords: Amoxicillin, growth promoter, Intestinal morphometry, serum biochemistry, feed efficiency

Introduction
Antibiotics at sub-therapeutic doses act as growth promoters. Broilers due to shortage of conventional feeds and antibiotics as probiotics can aid in producing helping microflora and propels feed absorption and also increase growth and feed conversion efficiency. Pigs supplemented with antibiotics in their feed require 10–15% less feed to achieve the desired level of growth (Chattopadhyay, 2014) [2]. The cost of feed constitutes a major portion of the expenses involved in rearing animals. The meat obtained from antibiotic-fed animals is also of better quality with a higher amount of protein and less amount of fat compared to that obtained from animals not supplemented with antibiotics (Hughes & Heritage, 2002.) [8]. The use of tetracycline and penicillin in chicken feed led to a significant improvement in the production of eggs and hatchability besides feed efficiency (Gustafson & Bowen, 1997) [6]. Cytokines produced in the process lead to the release of some catabolic hormones which cause wastage of muscles. Antibiotics relieve the animals of the need to produce cytokines by suppressing the causative agents of infections. The adverse effects of inflammation and pro-inflammatory mediators in animals (e.g., reduction in growth, feed intake, reproduction, milk production, and metabolic health) are well-known. The anti-inflammatory potential of antibiotics (particularly macrolides) provides a rational basis of their beneficial effects which is independent of their antimicrobial effect (Buret G, 2010) [1]. The inclusion of antibiotics in swine feeds has been found to reduce mortality and morbidity, particularly in young pigs (Cromwell, 2002) [4]. Following a review of the above studies, and because no research has been done to understand the biochemistry, morphometry, and Feed conversion efficiency of various antibiotics, the current study was conducted to investigate the impacts of various antibiotics fed at subtherapeutic doses.

Materials and Methods

A total of 72 one-day-old hatched cob chicks (weighing 38.04 ± 0.92 g) were purchased from Venkateswara hatcheries (Vijayawada, India). The trial was conducted at the Institutional Livestock Farm complex, NTR College of Veterinary Science, Gannavaram (16.54° N, 80.80° E). All the broilers were randomly divided into 3 treatments, 3 replicates per treatment, and 6 chickens per replicate. The test period was 42 days. T0, receiving a standard basal diet without any growth promoting, antimicrobial or anti-coccidial agents, served as the negative control. T1 received Brand A (Amoxicillin 50%) at 250 ppm, T2 received Brand B (ciprofloxacin 25%) at 500 ppm, T3 received Brand D (oxytetracycline 50%) at 500 ppm. The feed formulation was based on Bureau of Indian standards (BIS, 1992) and the formulation is shown in (Table 1). After 7 weeks birds were sacrificed by a halal method. Later small intestines were stored 0.9% NaCl. Blood samples were collected from wing veins in clot activators for 30 min. later serum was collected and serum biochemical parameters were analyzed by using a spectrophotometer (multiskan Go, Thermo scientific) as per the protocols of ERBA kits. Birds were slaughtered and carcass traits were recorded.

Serum Biochemistry

Glucose, Total protein, Albumin, SGPT, Serum cholesterol, creatinine, Calcium and Phosphorus were estimated. Meanwhile feed conversion ratio and carcass traits were also estimated. All the parameters were subjected to 1 way ANOVA, Duncan Tukey, test by using SPSS.

Intestinal morphometry

The segments of the small intestine (duodenum, jejunum and Ileum) were separated by dissection and were externally and internally washed with 0.9% NaCl to remove the intestinal contents individually then they were transferred to jars containing 10% buffered formalin for fixation. After a 12-24 h fixation period, samples were embedded in paraffin, sectioned to a 2-5 µm thickness, mounted on glass slides, and stained with hematoxylin - eosin. Villi height, width and crypt depth were then measured using stereoscopic microscope. The villus height (measured from the tip to the base, excluding the intestinal crypt), the villus width (measured halfway between the base and the tip), the crypt depth (measured from the base upward to the region of transition between the crypt and villi). The surface area of the villus was calculated as the product of the height multiplied by the width. The villus height: crypt depth ratio was then calculated.

Results and Discussion

During the medication period, all of the birds in the three AGP therapy groups improved their Feed conversion efficiency compared to the blank control group. The positive effects of AGPs on Feed conversion efficiency shown in this investigation are in line with previous findings (Corrêa *et al*., 2003; Miles *et al*., 2006; Yang *et al*., 2019) [3, 9, 13]. AGPs in broiler chicken diets enhanced body weight gain, feed intake, and feed conversion ratio.

Biochemical analysis

Glucose, albumin, globulin, SGPT, Serum Cholesterol, in T2 group treated with Amoxicillin have shown a significant difference compared to other treatment groups. Glucose levels were elevated in (T2 group) Amoxicillin group which is in contrast with studies made by (Slyamova *et al*., 2016) [11]. Total cholesterol level is significantly high ($p< 0.05$) in T1 group compared to rest. Earlier studies by (Rotimi *et al*., 2015) [10] revealed an increase in serum total cholesterol is due to increased rate of HMG CO-A synthesis led to dyslipidemia. There was no significant difference observed in calcium and phosphorus between groups.

Intestinal Morphometry

Groups fed with antibiotics have thinner tunica muscularis compared to control group. These findings are in accordance with (Miles *et al*., 2006.) [9] (Table 3). Morphometry studies have shown a significant difference ($p< 0.05$) in villar length, villar width, crypt length, crypt width and Tunica muscularis in groups treated by Amoxicillin. There is no significant difference between treatments in crypt length however there is significant difference in treatments compared to control. Studies conducted by (Franti *et al*., 1971) [5] revealed that growth promoting antibiotics sterilize GI tract, they control certain population of microorganisms to the betterment of host. (Xia *et al*., 2004) [12] also concluded that intestinal mucosal membrane was improved with the addition of antibiotics as growth promoters. Significant increase in villar length, width, crypt length, crypt width in Amoxicillin treated groups are in line with (He *et al*., 2019) [7] findings.

As Studies on the effect of Amoxicillin on intestinal morphometry is limited, there were no supporting evidences on the effect of Amoxicillin.

Feed Efficiency

Treatment group 4 (T3), has lower feed intake in starter phase followed by T2 and T1. But the total weight gain is lower in T3 group than T1 at the end of the period. Despite this, no substantial differences between the groups have been discovered. Finally, T2 (Amoxicillin) group demonstrated a significant difference in body weight growth during the finisher period. Furthermore, the Amoxicillin group (T2) had a lower feed conversion ratio implying better feed conversion efficiency than the other groups. These results are in accordance with studies conducted by (Gustafson & Bowen, 1997) [6] (Table 5). The reason that the T4 group has a lower feed intake, there could be the chance of parasitic infestation that impaired the feed efficiency.

Table 1: Experimental diets and their chemical composition (%) as per BIS, (1992).

Feed Ingredients and additives	Starter	Finisher	*Starter	*Finisher	*Starter	*Finisher
			CP%	CP%	ME Kcal/Kg	ME Kcal/Kg
Maize	57	60.6	4.96	5.36	1881	2032.8
Vegetable oil	2	2.4	0	0	180	216
DORB	0	0	0	0	0	0
Soybean meal	39	35	17.16	15.4	1050.66	942.9
DCP	1	1	0	0	0	0
Shell grit	0	0	0	0	0	0
Trace Min. Mix	0.2	0.2	0	0	0	0

Salt	0.3	0.3	0	0	0	0
Lysine	0.13	0.13	0	0	0	0
DL-Methionine	0.1	0.1	0	0	0	0
Vit AB2D3	0.02	0.02	0	0	0	0
Choline Chloride	0.2	0.2	0	0	0	0
Coccidiostat	0.04	0.04	0	0	0	0
Antibiotic	0.01	0.01	0	0	0	0
Sub Total	100	100	22.12	20.76	3111.66	3191.7

Table 2: Different antibiotics as growth promoters and their dose rate.

S No	Brand	Trade name	Drug	Dose
1	A	Amox	Amoxicillin	50%@ 250ppm
2	B	Cipro	Ciprofloxacin	25%@ 500ppm
3	C	TM-200	Oxy tetracycline	50%@ 500ppm

Table 3: Effect of different antibiotic growth promoters on serum biochemical parameters

	Glucose	Albumin	Globulin	Total Protein	SGPT (IU)	Serum Cholesterol	Calcium	Phosphorous
T0- CONTROL	274.87±9.21^{bc}	0.57±0.03^{a}	0.46±0.02^{a}	1.04±0.01^{a}	72.67±0.99^{a}	109.92±6.76^{ab}	12.36±0.83	13.55±1.12
T1-AMOX	296.96±12.82^{c}	1.03±0.02^{d}	0.98±0.05^{d}	1.79±0.02^{c}	77.00±0.58^{c}	146.70±10.30^{c}	13.83±1.39	13.15±1.08
T2- CIPRO	251.20±3.22^{ab}	1.18±0.01^{e}	1.15±0.01^{e}	2.38±0.02^{d}	72.34±0.50^{a}	116.49±3.39^{ab}	14.90±1.07	13.74±0.52
T3 TM-200	259.91±8.43^{ab}	1.38±0.03^{f}	1.33±0.02^{f}	2.56±0.12^{e}	72.34±0.50^{a}	118.33±4.09^{ab}	13.68±0.56	13.95±0.71

Table 4: Effect of different antibiotic growth promoters on intestinal morphometry

	Villar length	Villar width	Crypt length	Crypt width	Tun muscular is
T0- CONTROL	70.50±5.71^{ab}	5.34±0.56^{a}	20.17±1.76^{b}	3.84±0.17^{a}	23.34±1.06^{a}
T1-AMOX	64.67±3.76^{ab}	8.00±0.00^{b}	14.00±0.64^{ab}	5.67±0.43^{b}	8.00±0.52^{b}
T2- CIPRO	63.67±1.67^{ab}	5.34±0.22^{a}	13.67±0.96^{ab}	5.00±0.97^{b}	10.67±1.59^{c}
T3 TM-200	60.50±4.96^{c}	4.84±0.84^{c}	13.50±1.71^{ab}	4.84±0.41^{bc}	9.00±1.30^{c}

Table 5: Effect of Different Antibiotic Growth Promoters on Feed efficiency

	Feed intake (Starter Phase)	Feed Intake (Finisher Phase)	Feed intake (Total period)	Body Wt. gain (Starter Phase)	Body Wt. gain (Finisher Phase)	Body Wt. (Total Period)
T0- CONTROL	1639.67±41.79^{c}	2109.67±24.59^{c}	3749.34±65.75^{b}	739.00±8.60^{a}	1053.97±72.19	1792.97±65.02^{a}
T1-AMOX	1458.34±26.02^{b}	2020.67±14.75^{a}	3479.00±34.71^{a}	867.90±49.78^{bc}	1169.04±93.01	2036.94±43.33^{b}
T2- CIPRO	1420.67±25.52^{b}	2078.67±10.22^{bc}	3499.34±16.59^{a}	790.57±30.71^{ab}	1118.94±55.06	1909.50±25.24^{ab}
T3 TM-200	1355.67±23.52^{a}	2075.34±7.76^{bc}	3431.00±15.77^{a}	822.04±5.20^{abc}	1046.57±35.49	1868.60±30.38^{ab}

Table 6: Effect of different antibiotic growth promoters on feed efficiency

	FCR (Starter Phase)	FCR (Finisher Phase)	FCR (Total)
T0- CONTROL	2.23±0.07^{c}	2.01±0.09	2.10±0.03^{d}
T1-AMOX	1.69±0.10^{a}	1.77±0.19	1.72±0.07^{ab}
T2- CIPRO	1.82±0.14^{ab}	1.89±0.16	1.84±0.03^{c}
T3 TM-200	1.66±0.09^{a}	2.00±0.13	1.84±0.04^{c}

Conclusion

This study has fulfilled the gaps existing in knowledge Amoxicillin and other antibiotics as growth promoters in broilers. Amoxicillin could be a choice to be used as growth promoter a head of other antibiotics. Though there is an increased dyslipidemia due to amoxicillin, the feed efficiency and body weight gain were quite significant. Though antibiotics have increased growth, the increase in SGPT levels in serum is the limitation that need to be addressed in future.

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