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Comparative Efficacy of Enrofloxacin and Oxytetracycline by Different Administration Methods in Broilers after Experimental Infection with Avian Pathogenic Escherichia coli

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Original Article

Comparative Efficacy of Enrofloxacin and Oxytetracycline by Different Administration Methods in Broilers after Experimental Infection with Avian Pathogenic *Escherichia coli*

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Abstract

The aims of this study were to compare the efficacy of 2 kinds of antibiotics that are commonly used in the Thai broiler industry and to determine the optimal times of drug administration. One hundred and sixty, 21-day-old broilers were divided into eight groups. Chickens in groups 1, 2 and 3 were challenged with avian pathogenic *E. coli* (APEC) and received oxytetracycline for the first 3 days after infection via oral, drinking water within 2 h and drinking water throughout the day, respectively. The chickens in groups 4, 5 and 6 were challenged with APEC and received enrofloxacin for the first 3 days after infection via oral, drinking water within 2 h and drinking water throughout the day, respectively. The chickens in group 7 and 8 served as positive and negative control groups. Enrofloxacin treated chickens showed better results in feed conversion ratio, mortality, gross pathology and bacterial isolation than those treated with oxytetracycline ($p<0.05$). Infections of chickens with APEC can be treated with the enrofloxacin. Oral administration provided a better protection than drinking water within 2 h and drinking water throughout the day, respectively.

Keywords : avian pathogenic *E. coli,* broilers, drug administration, enrofloxacin, oxytetracycline.

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บทคัดย่อ

การเปรียบเทียบประสิทธิภาพของเอนโรฟลอกซาซินและออกซีเตตราซัยคลินในการบริหารยาที่แตกต่างกันในไก่เนื้อภายหลังการติดเชื้อ *เอสเชอริเชีย โคไล* ก่อโรคในสัตว์ปีก

นิวัตร จันทร์ศิริพรชัย

การทดลองนี้มีวัตถุประสงค์ในการเปรียบเทียบประสิทธิภาพของยาปฏิชีวนะ 2 ชนิด ซึ่งพบการใช้บ่อยในอุตสาหกรรมไก่เนื้อในประเทศไทย และเพื่อหาช่วงเวลาที่เหมาะสมในการบริหารยา โดยนำไก่เนื้ออายุ 21 วัน จำนวน 160 ตัว แบ่งออกเป็น 8 กลุ่ม กลุ่ม 1 2 และ 3 ได้รับเชื้อ *อี. โคไล* ก่อโรคในสัตว์ปีก และได้รับออกซีเตตราซัยคลินติดต่อกัน 3 วัน โดยการป้อนปาก การละลายน้ำดื่มภายใน 2 ชั่วโมงและการละลายน้ำดื่มตลอดวัน ตามลำดับ ไก่กลุ่ม 4 5 และ 6 ได้รับเชื้อ *อี. โคไล* ก่อโรคในสัตว์ปีก และได้รับเอนโรฟลอกซาซินติดต่อกัน 3 วัน โดยการป้อนปาก การละลายน้ำดื่มภายใน 2 ชั่วโมงและการละลายน้ำดื่มตลอดวัน ตามลำดับ ไก่กลุ่ม 7 และ 8 เป็นไก่กลุ่มควบคุมบวกและลบ ตามลำดับ ไก่ที่ได้รับเอนโรฟลอกซาซิน พบอัตราแลกเนื้อ อัตราตาย มหพยาธิวิทยาและการแยกเชื้อแบคทีเรียดีกว่าไก่ที่ได้รับออกซีเตตราซัยคลิน ($p<0.05$) การติดเชื้อ *อี. โคไล* ก่อโรคในสัตว์ปีกสามารถรักษาด้วยเอนโรฟลอกซาซิน การบริหารยาโดยการป้อนปากให้การปกป้องที่ดีกว่าการละลายน้ำดื่มภายใน 2 ชั่วโมง และการละลายน้ำดื่มตลอดวัน ตามลำดับ

คำสำคัญ : *อี. โคไล* ก่อโรคในสัตว์ปีก ไก่เนื้อ การบริหารยา เอนโรฟลอกซาซิน ออกซีเตตราซัยคลิน

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Introduction

Colibacillosis is an important infectious disease in chickens especially broilers that can cause major economic loss in the Thai poultry industry (Chansiripornchai and Sasipreeyajan, 2002[a]). Colibacillosis is caused by *Escherichia coli (E. coli)* which is a gram negative bacterium. The bacteria, generally, can be found in the intestines of many kinds of animal species, but pathogenic serotypes of *E. coli* could be found around 10-15% of the total bacteria of healthy chickens' intestines. Also, the specific serotype found in intestines, may differ from the serotype found in the pericardial sac in one chicken. All ages of poultry are susceptible to infection with avian pathogenic *E. coli* (APEC) but the most seriously affected are birds of 4 to 5 weeks old (Chansiripornchai et al., 1995). Generally, APEC is a complicated infection of the respiratory system following a former infection by *Mycoplasma gallisepticum*. Colibacillosis can be prevented and treated by broad spectrum antibiotics or gram negative bacteria antibiotics. However, poultry veterinarians have a limited choice of efficacious antimicrobials to relieve pain and suffering. Moreover, the repeated applications of antibiotics can increase the rate of bacterial resistance to the antibiotics. The antibiotic resistance of APEC isolated in Thailand during 1990-1995 revealed that more than 80% of the isolates were resistant to nalidixic acid, oxolinic acid, sulfamethoxasole+ trimethoprim, sulfadiazine, oxytetracycline, tetracycline, kanamycin, novobiocin and erythromycin and anti-bacterial resistance was low for the third generation of quinolone groups such as norfloxacin, danofloxacin and enrofloxacin (Chansiripornchai et al., 1995). This report agrees with other researchers using the third generation quinolones for the treatment of *E. coli* infections (Bauditz, 1987; Scheer, 1987; Chansiripornchai and Sasipreeyajan, 2002[b]). In any case, the administration techniques of the drug delivery are also important in achieving the most effective treatment by antibiotics of bacterial infection.

Most farmers apply the drug once, twice a day or available throughout the day for at least 3 consecutive days. The aims of this study were to compare the efficacy of 2 kinds of antibiotics that are commonly used in the Thai broiler industry and to determine the optimal time of drug administration.

Materials and Methods

Chickens: Unvaccinated Arbor Acres broiler-type chicks of mixed sex were obtained on the day of hatching from a commercial hatchery (Krungthai farm, Thailand). The chickens were fed *ad libitum* before and during the experiments. At the onset of the experiments (21-days old), there was no statistically significant difference in the average weight of the experimental groups ($p>0.05$). The guidelines and legislative regulations on the use of animals for scientific purposes of Chulalongkorn University, Bangkok, Thailand were followed as is certified in permission no. 0831068.

Bacterial strain: The chickens were challenged with an APEC strain of serotype O78 that was originally isolated from the air sacs of diseased chickens with a field case of colisepticemia (Chansiripornchai and Sasipreeyajan, 2002[a]). The challenge strain was tested by disc diffusion test (Bauer et al., 1966; Chansiripornchai et al., 1995) before an animal experiment had been performed. The result revealed that the challenge strain of APEC is resistant to oxytetracycline (Oxoid, Hampshire, UK) and sensitive to enrofloxacin (Oxoid, Hampshire, UK). The challenge material was a logarithmic-phase culture produced by 10-h of static incubation of APEC in nutrient broth. Sekizaki et al. (1989) showed that this *E. coli* serotype produced high mortality in a very short time. Each bird in every group except for the negative control group were injected with 0.3 ml of the *E. coli* suspension, containing 10^8 cfu/ml. The APEC suspension was injected into the right caudal thoracic air sac of the infected chickens.

Medication: Oxytetracycline and enrofloxacin (F.E. Pharma Co. Ltd, Thailand) were administered orally at concentrations of 30 and 10 mg/kg live weight/day, respectively, to the chickens or in their drinking water for 3 consecutive days after infection. The water intake of the birds was measured before the experiments were commenced, so the approximate water intake of the chickens was known and the quantity of the drug to be dissolved in the water to give a known average intake of drug per kg live weight of the chickens could be calculated. Before administration of the drugs, the water was withdrawn for an hour before giving the medicated water. The withdrawal periods resulted in birds being sufficiently thirsty to consume all the medicated water within two hours. The medicated water was substituted by unmedicated water immediately after all the water had been drunk.

Experimental designs: One hundred and sixty, 21-day-old broilers were divided into eight groups of 20 birds, with each group subdivided into 2 replicates of 10 birds. The chickens in groups 1-3 were challenged with APEC and administered with oxytetracycline twice a day; via oral, drinking water within 2 h and drinking water throughout the day. The chickens in groups 4-6 were challenged with APEC and administered with enrofloxacin twice a day; via oral, drinking water within 2 h and drinking water throughout the day. The chickens in groups 7 and 8 served as positive and negative control groups, respectively. The broilers were euthanized at 28 days of age.

Observed parameters and analysis: The feed conversion ratio (FCR) and mortality were recorded for seven days following the infection of the chickens with APEC. The pathological lesions in the dead chickens were investigated at necropsy. After seven days, the surviving chickens were euthanized and APEC was isolated from their livers and identified by standard culture media and biochemical tests. The ANOVA and Duncan multiple range test were used for statistical comparison of the groups by SPSS for window.

Results

Feed conversion ratio: The broilers received enrofloxacin had significantly better FCR than broilers received either oxytetracycline or no medication ($p<0.05$). The broilers in the positive control group showed the worst FCR. On the other hand, the broilers in the negative control group revealed better FCR than all groups, which was similar to group 4. FCR of broilers received oxytetracycline orally showed better results than broilers that received oxytetracycline via drinking water within 2 h and drinking water throughout the day, respectively. The FCR of broilers that received enrofloxacin orally showed better results than the FCR of broilers received enrofloxacin via their drinking water within 2 h and drinking water throughout the day, respectively (Table 1).

Mortality: The broilers that received enrofloxacin had significantly ($p<0.05$) less colibacillosis-related mortality than the broilers that received either oxytetracycline or no medication. The broilers in the positive control group had similar mortality rates to the broilers that received oxytetracycline via drinking water throughout the day. No mortality was found in the broilers received enrofloxacin and the negative control. The mortality of broilers that received oxytetracycline orally and via drinking water within 2 h was significantly better than the broilers that received either oxytetracycline via their drinking water throughout the day or having no medication ($p<0.05$) (Table 1).

Gross pathology and bacterial cultures: The chickens that died within one day of challenge showed only mild degree of airsacculitis but the typical lesions of APEC infection such as airsacculitis, fibrinopurulent pericarditis, fibrinopurulent perihepatitis and peritonitis were clearly present in chickens that died after the first day of challenge. These typical clinical lesions were similar in the oxytetracycline treated group and the positive control group, but they were less evident in the enrofloxacin treated group. No airsacculitis, pericarditis, peritonitis and perihepatitis were found in the negative control group. The highest percentages of airsacculitis, pericarditis, peritonitis and perihepatitis were found in chickens that received oxytetracycline, which was similar to the positive control group. Chickens that received enrofloxacin did not have different percentages of airsacculitis, pericarditis, peritonitis and perihepatitis from those in the negative control group. The highest bacterial culture of the livers was found in the positive control group and this was followed by all the groups of the oxytetracycline treatment. The bacteria isolated from the livers of the enrofloxacin groups were significantly less than the bacteria isolated from the oxytetracycline and the positive control groups ($p<0.05$). No bacterial cultures were found in the negative control group (Table 1).

Discussion

The present study showed that enrofloxacin had better efficacy than oxytetracycline to control the FCR, pathological lesions and mortality caused by APEC in broiler chickens. The results were supported by the work of Glisson et al. (2004), which showed that enrofloxacin provided the lowest mortality, gross pathology and FCR among chickens that were given enrofloxacin, oxytetracycline and sulfadimethoxine. As for administration techniques, orally administered chickens tended to show better results of FCR, mortality, gross pathology and APEC isolation than drinking water administration within 2 h or throughout the day. Also, the chickens administered via drinking water within 2 h tended to show better results of FCR, mortality, gross pathology and APEC isolation than those of the chickens administered via drinking water throughout the day. Thus, an un-limited time for consuming the drug could reduce its efficacy. According to Chansiripornchai and Sasipreeyajan (2002[a]), the administration of sarafloxacin within 2 provided the better treatment of APEC infection in broilers. Smith et al. (1986) gave sarafloxacin 4 times the minimum inhibitory concentration in experimental mice and found that the highest efficacy against *E. coli* (99.9%) occurred within 2 h after giving the drug. The efficacy of the drug was reduced when the administration time was prolonged.

Table 1 Feed conversion ratios, Pathological findings and *E. coli* isolation of experimental broilers

Groups	Drugs	Administration (twice a day)	FCR±SD	percent mortality (%±SD)	Major lesions				
					Airsacculitis (%±SD)	Pericarditis (%±SD)	Peritonitis (%±SD)	Perihepatitis (%±SD)	Culture from the livers (%±SD)
1	Oxytetracycline	oral	2.45±0.07[a]	35±7.07[a]	14/20 (7.0±1.41[a])	17/20 (8.5±0.71[a])	15/20 (7.5±0.71[a])	10/20 (5.0±1.41[a])	18/20 (9.0±1.41[a])
2		drinking water within 2 h	5.21±2.06[a]	45±7.07[a]	15/20 (7.5±0.71[a])	16/20 (8.0±1.41[a])	12/20 (6.0±1.41[a])	11/20 (5.5±0.71[a])	18/20 (9.0±0[a])
3		drinking water throughout the day	4.94±1.58[a]	70±0[b]	15/20 (7.0±2.83[a])	17/20 (8.5±0.71[a])	15/20 (7.5±2.12[a])	14/20 (7.0±0[a])	18/20 (9.0±1.41[a])
4	Enrofloxacin	oral	1.65±0.08[b]	0[C]	2/20 (1.0±0[b])	0/20 (0±0[b])	0/20 (0±0[b])	0/20 (0±0[b])	5/20 (2.5±2.12[b])
5		drinking water within 2 h	1.73±0[b]	0[C]	4/20 (2.0±1.41[b])	0/20 (0±0[b])	0/20 (0±0[b])	0/20 (0±0[b])	4/20 (2.0±1.41[b])
6		drinking water throughout the day	1.97±0.11[b]	0[C]	8/20 (4.0±0[b])	0/20 (0±0[b])	0/20 (0±0[b])	0/20 (0±0[b])	4/20 (2.0±0[b])
7	Positive control		5.53±7.81[a]	70±0[b]	16/20 (8.0±1.41[a])	16/20 (8.0±1.41[a])	18/20 (9.0±1.41[a])	16/20 (8.0±1.41[a])	20/20 (10.0+0[a])
8	Negative control		1.67±0.13[b]	0[C]	0/20 (0±0[b])	0/20 (0±0 [b])	0/20 (0±0[b])	0/20 (0±0[b])	0/20 (0±10[b])

Note- Different superscripts indicate statistically significant differences ($p< 0.05$) in each experiment.

The chickens in groups 3 and 6 which received the drug solution for more than 2 h in each day for 3 consecutive days, showed a significant decrease in the efficacy of oxytetracycline and enrofloxacin. Thus, drug administration also had an effect on the efficacious treatments of APEC infections. For the antibiotic sensitivity test, although oxytetracycline showed the *in vitro* resistant to the challenge strain of APEC, but *in vivo* revealed that the administration techniques, twice a day via oral or drinking water within 2 hrs (groups 1 or 2), showed the ability to protect chickens comparing to the drug administration twice a day via drinking water throughout the day or the positive control group (groups 3 or 7). The results will help poultry veterinarians choose and prescribe the most efficacious antimicrobial and the optimal time of drug application that promises to alleviate pain, suffering and thus promote health and well-being among chickens that are raised for human consumption.

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