Comparative therapeutic effect of three types of antibiotics on pneumonia associated with klebsiella pneumoniae in boer goats.

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A B S T R A C T

Pneumonia in Boer goats is a multifactorial disease required a special care for economic, effictive and rapid treatment. Therefore, this study aimed to compare the therapeutic efficacy of three antibiotics (Tulathromycin, Florfenicol and Amoxicillin) in treatment of *klebsiella pneumoniae* in Boer goat. Forty five pneumonic Boer goats suffered from respiratory distress that were divided into three groups (each of 15) according to the type of the antibiotic used (Tulathromycin, Florfenicol and Amoxicillin). All Boer goats were examined before treatment (0 day) and on the 1st, 3rd, 5th and 7th days post treatment. The results revealed a clinical recovery of 80%, 73.3% and 60% of cases after first dose of tulathromycin, florfenicol and amoxicillin, respectively. The results of hematological, serum biochemicals and pulmonary function tests revealed improvement of most of parameters from the 3rd day of treatment by tulathromycin and florfenicol. However, treatment by amoxicillin restored the parameters from the 5th day and might be extended to the 7th day of treatment. Isolates were subcultured and confirmed as *K. pneumoniae* using standard microbiology techniques. The results were confirmed by the result of antibiotic sensitivity test against *klebsiella* which was highly sensitive to tulathromycin, sensitive to florfenicol and moderately sensitive to amoxicillin. We concluded that tulathromycin has a better efficacy than florfenicol and amoxicillin in treatment of Boer goats affected with *k. pneumoniae*.

KEY WORDS: Klebsiella pneumoniae, Tulathromycin (T), Florfenicol (F), Amoxicillin (A).
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1. INTRODUCTION

Klebsiella pneumoniae is a common opportunistic pathogen of upper respiratory tract in goats (Fang et al., 2004). *Klebsiella pneumoniae* is a facultative anaerobic, rod-shaped, gram-negative bacterium with a prominent polysaccharide capsule. This capsule encases the entire cell surface, accounts for the large appearance of the organism on gram stain and provides resistance against many host defense mechanisms (Loschko et al., 2011). Control of infectious respiratory diseases can be conducted by isolation of affected animals and provide a warm, drought-free environment. The use of antibiotics to control bacterial pneumonias or prevent secondary bacterial infection is usually recommended. Moreover, the use of non-steroidal anti-inflammatory drugs is necessary to reduce pulmonary congestion and pyrexia (Matthews, 2009). Antibiotics commonly used for parenteral treatment of caprine pneumonia include penicillin, amoxicillin, ceftiofur and florfenicol (Berge et al., 2006). Tulathromycin is a novel, safe and effective against bacterial respiratory pathogens in the caprine species. Its unique structural properties permit rapid dissemination out of plasma and extended residence time in tissues, primarily the lung since goats are susceptible to many of the same bacterial pathogens. Although this drug is classified as bacteriostatic, it can also exhibit bactericidal activity at higher concentrations (Evans, 2005). Florfenicol is a broad-spectrum antibiotic with a label

claim of activity against common bacterial pathogens in bovine respiratory disease. It inhibits protein synthesis by binding to ribosomal subunits of susceptible bacteria (Donkersgoed et al., 2009). Amoxicillin is semi synthetic amino penicillin which has activity against penicillin-sensitive gram positive as well as some gram negative bacteria continues to be a useful antimicrobial drug for its low index of toxicity and reliable absorption which continues to make it an attractive agent in the treatment of variety of infections (Henry, 2001). Comparative therapeutic effects of different antibiotics used for treatment of pneumonia was not conducted in Boer goats. Therefore, the aim of this study was to evaluate the therapeutic efficacy of three kinds of commonly used antibiotics including tulathromycin, florfenicol and amoxicillin in treatment of Boer goat pneumonia caused by *klebsiella pneumoniae.*

2. MATERIAL AND METHODS

2.1. Animals

The total number of animals used in this study was 45 Boer goats that were suffered from clinical signs of pneumonia (fever, nasal discharge, lacrimation, coughing and abnormal lung sounds) that were subdivided into three groups according to the antibiotic used for treatment as the followings: Group 1: Contained 15 diseased animals with pneumonia and treated by Tulathromycin (Draxxin®) with two doses of 2.5mg/kg (1ml/40kg B.Wt) injected SC with 48 hours interval, according to the manufacturer instructions. Group 2: Contained 15 diseased animals with pneumonia and treated by Florfenicol (Nuflor®) with two doses of 20mg florfenicol/kg B.Wt (1ml/15kg B.Wt) injected IM with 48 hours interval, according to the manufacturer instructions. Group 3: Contained 15 diseased animals with pneumonia and treated by Amoxicillin (Trioxyl LA®) with two doses of 15mg per kg body weight (1ml/10kg B.Wt) injected IM with 48 hours interval, according to the manufacturer instructions. All diseased animals received additional therapy including Diclofenac sodium (Declo-5®) as a non-steroidal anti-inflammatory and antipyretic drug was injected IM with a dose of 1ml/10Kg B.Wt once daily for 3 days. AD3E (ADEMIN inj®) was also injected IM as an immune stimulant and a vitamin supply with a dose of 1ml/10Kg B.Wt once daily for 5 days (Zaghawa et al., 2010). Samples were collected from all diseased animals immediately before treatment (0 day) and on the 1^{st}, 3^{rd}, 5^{th}, and 7^{th} day after onset of treatment.

2.2. Clinical examination

The detected Boer goats were subjected to clinical examination and all clinical signs were recorded (Pugh, 2002).

2.3. Hematological examination

RBCs count (10^6 /µl), Hemoglobin (Hb) (gm/dl), PCV%, total leukocytic and differential leukocytic counts were determined by hematology analyzer (Feldman et al., 2000).

2.4. Pulmonary function tests

Anaerobically the jugular venous blood samples were drawn from each animal into 3ml plastic syringes (containing freeze-dried lithium heparin). Immediately after vein-puncture, the tip of the needle was sealed with a rubber stopper in order to prevent gas from moving in or out of it. The samples were placed in a bed of crushed ice, taken immediately to the laboratory for analysis. The blood samples were analyzed for pH, PCO_2, PO_2, base excess (BE), bicarbonate (HCO_3) levels, and total carbon dioxide contents (tCO_2) using blood gas analyzer (Hussein and Aamer 2013).

2.5. Biochemical examination

Special kits (Stain Bio Company) were used for spectrophotometric determination of total protein, albumin, ALT, AST, creatinine, urea, Ca, P, Na, K, Cl, iron, Mg. Serum immunoglobulins IgG and IgA were determined by direct ELISA as previously

recorded (Henrik, 1994). Albumin and globulins were separated by cellulose acetate electrophoresis using Helena system (Helena France) (Batavani et al., 2006).

2.6. Isolation and identification of causative bacteria

The collected samples were submitted for microbiological examination with nasal swabs samples and trans-tracheal aspiration were inoculated in nutrient broth for activation of the microorganism at 37 °C for 24 hours. A sterile loopfull from the broth with activated micro-organism was directly sub-cultured on MacConkey's and blood agar. Plate readings occurred at 24 hrs and 48 hrs. The isolates recovered were sub-cultured and further identified using colony morphology, Gram stain and biochemical tests (Carter, 1990).

2.7. Antibiotics sensitivity test:

This test performed by the disc diffusion method (Amany, 1998). The antibiotic discs were obtained from Oxoid including Amoxycillin 25µg, Erythomycin 15µg, Gentamycin 30µg, Penicillin G 10 units, Enrofloxacin 10µg and Florofenicol 10µg, Norofloxacin 10µg, Oxacillin 10µg, Nalidixic acid 10µg, Lomefloxacin 10µg, Ceftriaxone 30µg, Ampicillin 10µg, Trimethoprime/Sulphathazine 25µg, Topramycin 10µg and Tulathromycin 10µg.

2.8. Statistical analysis:

The data were statistically analyzed using two way ANOVA as previously described (Bailey, 2008) using sigma stat software to test the effects of treatment on the times, all pairwise multiple comparison procedures (Holm-Sidak method) was used as a post-hoc test**.** The results were demonstrated as means ± SE. The results were considered statistical significant when $p<0.05$.

3. RESULTS

3.1. Clinical examination:

Tulathromycin antibiotic treatment revealed clinical recovery of 80% of cases after the first dose. While treatment with florfenicol antibiotic revealed clinical recovery of 73.3% of cases after the first dose of treatment. But treatment with amoxicillin antibiotic revealed clinical recovery of 60% of cases after the first dose of treatment.

3.2. Hematological examination:

Treatment with T and F revealed a significant ($P<0.05$) increase in RBCs count from the 5th day of treatment and at the 7th day of treatment with A compared to values on zero day before treatment. The PCV% was significantly ($P<0.05$) increased from the 1st day after treatment with T and from the 3rd day after treatment with F and A compared to zero day before treatment. The Hb concentration started to elevate after the 1st day of treatment with T, F and A with a significant ($P<0.05$) increase from the 5th day of treatment with T and F but A treatment on the 7th day compared to values before treatment (0 day). The total leukocytic count of T, F and A were significantly ($P<0.05$) decreased from the 3rd day compared to values before treatment (zero day). Neutrophils count had a significant ($P<0.05$) decrease from the 1st day of treatment with T and from the 3rd day of treatment with F and A compared to values before treatment. Lymphocyte count were significantly ($P<0.05$) increased from the 3rd day of treatment with T, F and A compared to values of zero day (Tables 1).

3.3. Pulmonary functions:

Treatment with T and F produced elevation of PO_2 which was significant ($P<0.05$) from the 3rd day compared to the values before treatment (zero day) and significantly ($P<0.05$) increased from the 5th day of A. Both PCO_2 and HCO_3 values were reduced by treatment with T, F and A compared to values before treatment. However, this reduction was significantly ($P<0.05$) starting from the 3rd day after onset of treatment with T, F and A. The reduction of tCO_2 values were significantly ($P<0.05$) from the 3rd day of treatment with T and F while from the 5th day after treatment with

A. The pH values were significantly (P<0.05) increased from the 1st day of treatment with T and F, but significantly (P<0.05) increased from the 3rd day after treatment with A compared to values before treatmen (0 day). The values of BE were significantly (P<0.05) decreased starting from the 3rd day after treatment with T, F and A (Tables 1).

3.4. Serum biochemical analysis:

Treatment with T, F and A produced significant (P<0.05) increase in total protein on the 7th day of treatment compared to values before treatment and other days of treatment. However, treatment with T was significantly (P<0.05) increased albumin from the 1st day of treatment compared to 3rd day after treatment with F and A. The globulin level was significantly reduced on the 3rd day of treatment with all types of antibiotics (T, F and A). The A/G ratio showed a pattern similar to albumin where the significant (P<0.05) elevation started on the 1st day of treatment with T and on the 3rd day of treatment with both F and A compared to values of zero day (Tables 2). Treatment with T, F and A showed a significant (P<0.05) decrease in gamma (γ) globulin from the 3rd day compared to values before treatment (0 day) and from the 5th day of treatment with F and A (Tables 2). The result of serum immunoglobulin showed a significant (P<0.05) decrease in immunoglobulin (IgG and IgA) levels starting from the 1st day of treatment with T, F and A compared to values before treatment (Table 2). The serum level of ALT in pneumonic Boer goats after treatment with T was significantly (P<0.05) decreased from the 1st day and from the 3rd day of treatment with F and A compared to values before treatment. The serum AST level showed a significant (P<0.05) reduction from the 1st day of treatment with all types of antibiotics (T, F and A) (Table 1). The kidney function tests after treatment with any of the three antibiotics showed a significant (P<0.05) reduction in urea started from the 1st day of treatment compared to values before treatment (0 day), but creatinine from the 3rd day of treatment (Table 1). The serum electrolyte levels of pneumonic Boer goats after treatment with T had a significant (P<0.05) increase in Ca level from the 3rd day of treatment, but on the 5th day after treatment with F and A compared to values before treatment (0 day). The P level was significantly (P<0.05) reduced from the 3rd day of treatment with any of the three antibiotics compared to values of zero day before treatment. Both Fe and Mg levels were significantly (P<0.05) increased from the 5th day of treatment with any of antibiotics used compared to values before treatment (0 day). Treatment with T showed significant (P<0.05) decrease in K level from the 3rd day of treatment while from the 5th day of treatment with F and A, while the Cl levels was significantly (P<0.05) decreased from the 3rd day of treatment with T, F and A compared to values before treatment. The Na level was non-significantly changed all over the period of treatment (Table 2).

3.5. Antibiotic sensitivity test to isolated klebsiella:

The sensitivity test proved that the isolated bacteria (*Klebsiella* spp) highly sensitive (++++) to tulathromycin with inhibition zone 25 mm, sensitive (+++) to florfenicol with inhibition zone 23 mm and moderately sensitive (++) to amoxicillin with inhibition zone 15mm (Table 3).

4. DISCUSSION

Treatment with tulathromycin revealed disappearance of the nasal and ocular discharge and decreased coughing of 80% of cases after the first dose of treatment. This result comparable to the result of pneumonic calves treated with tulathromycin, none of the clinical signs were observed in calves with pneumonia 7

Table (1): The results of hematology, pulmonary function, serum enzymes and kidney function changes of the three treatment groups (T, F and A).

Parameters	*Groups*	*0-day before treatment*	*1st day post treatment*	*3rd day post treatment*	*5th day post treatment*	*7th day post treatment*
RBCs *(10^6/ul)*	T	4.94±0.168^{1,a}	5.04±0.18^{1,a}	5.2±0.16^{1,a}	5.66±0.13^{2,a}	6.08±0.18^{2,a}
	F	4.96 ±0.088 ^{1,a}	5.04±0.17^{1,a}	5.2±0.16 ^{1,2,a}	5.6±0.2^{2,a}	6.06±0.18^{3,a}
	A	4.96±0.064 ^{1,a}	5.03±0.16 ^{1,a}	5.11±0.21^{1,a}	5.36±0.17^{1,b}	6.02±0.104^{2,a}
Hb *(gm/dl)*	T	10.98±0.73^{1,a}	11.6±0.96^{1,2,a}	12±0.73^{1,2,a}	12.19±0.68 ^{2,a}	12.35±0.56 ^{2,a}
	F	11.06±0.47^{1,a}	11.76±0.52 ^{1,a}	12.07±0.93^{1,a}	12.11±0.81^{1,a}	12.3±0.42^{1,a}
	A	11.02±1.15^{1,a}	11.3±1.42^{1,2,a}	11.63±1.07^{1,2,a}	11.93±0.75^{1,2,a}	12.29±0.66^{2,a}
PCV *(%)*	T	27.89±1.79^{1,a}	29.8±0.65^{2,a}	31.13±0.88^{2,3,a}	32±0.75^{3,4,a}	33±0.75^{4,a}
	F	27.92±1.76^{1,a}	28.96±1.53^{1,a,b}	30.83±1.46^{2,a,b}	31.96±0.86^{2,3,a}	33±0.78^{3,a}
	A	28.06±1.84^{1,a}	28.64±2.65^{1,2,a}	29.94±1.84^{2,3,b}	31.33±1.48^{3,4,a}	32.94±0.95^{4,a}
WBCs *(10^3/µl)*	T	15.43±0.71^{1,a}	14.98±0.62^{1,2,a}	14.18±0.5^{2,a}	12.43±0.3^{3,a}	12.17±0.34^{3,a}
	F	15.66±0.77^{1,a}	15.07±0.64^{1,2,a,b}	14.22±0.42^{2,a,b}	12.69±0.29^{3,a}	12.28±0.22^{3,a}
	A	15.59±0.49^{1,a}	15.26±0.53^{1,b}	14.56±0.45^{2,b}	13.61±0.31^{2,3,b}	12.34±0.33^{3,a}
Lymphocyte *(10^3/µl)*	T	7.6±0.73^{1,a}	7.65±0.68^{1,a}	7.94±0.53^{2,a}	8.23±0.44^{2,3,a}	8.36±0.34^{3,a}
	F	7.63±0.81^{1,a}	7.65±0.73^{1,a}	7.92±0.67^{2,a}	8.18±0.72^{2,3,a}	8.37±0.67^{3,a}
	A	7.64±0.62^{1,a}	7.66±0.63^{1,a}	7.89±0.63^{2,a}	8.13±0.62^{2,3,a}	8.36±0.61^{3,a}
Neutrophil *(10^3/µl)*	T	6.43±0.25^{1,a}	5.95±0.21^{2,a}	4.87±0.23^{3,a}	2.92±0.17^{4,a}	2.56±0.2^{5,a}
	F	6.61±0.31^{1,a}	6.02±0.37^{1,a,b}	4.95±0.24^{2,a,b}	3.22±0.22^{3,a}	2.65±0.16^{4,a}
	A	6.54±0.26^{1,a}	6.2±0.3^{1,b}	5.3±0.37^{2,b}	4.18±0.42^{3,b}	2.72±0.17^{4,a}
PCO_2 *(mmHg)*	T	47±3^{1,a}	44±1^{2,a}	41.05±0.55^{3,a}	40.5±1.65^{3,a}	38.75±0.75^{3,a}
	F	47.25±3.25^{1,a}	45±0.5^{1,a,b}	41.5±1^{2,a,b}	40.5±1.5^{2,3,a,b}	38.75±0.75^{3,a}
	A	47.5±2.5^{1,a}	46.75±1.38^{1,b}	42.88±0.63^{2,b}	41.25±0.88^{2,3,b}	39±0.5^{3,a}
PO_2 *(mmHg)*	T	37.08±1.04^{1,a}	37.25±1.25^{1,a}	38±0.75^{1,2,a}	38.75±0.75^{2,3,a}	39.5±0.5^{3,a}
	F	37.13±1.13^{1,a}	37.25±0.75^{1,a}	38±1^{1,2,a}	38.5±0.5^{1,2,a}	39.25±0.75^{2,a}
	A	37.2±1.1^{1,a}	37.25±0.75^{1,a}	37.75±0.88^{1,a}	38.25±0.88^{1,2,a}	39.25±0.38^{2,a}
tCO_2 (mmol/L)	T	24.9±1.8^{1,a}	24.6±2.1^{1,a}	21.75±0.88^{2,a}	20.85±0.76^{2,a}	19.53±0.38^{2,a}
	F	24.9±0.9^{1,a}	24.73±0.98^{1,a}	22.23±0.61^{2,a}	20.6±1.35^{2,3,a}	19.5±1^{3,a}
	A	24.98±1.79^{1,a}	24.75±1.88^{1,a}	24.5±0.5^{1,b}	21.03±0.83^{2,a}	19.43±1.08^{2,a}
HCO_3 (mmol/L)	T	23.25±1.38^{1,a}	21.25±1.38^{2,a}	19.65±0.4^{2,3,a}	18.93±0.21^{3,a}	18.33±0.18^{3,a}
	F	23.88±0.63^{1,a}	22.98±0.98^{1,a,b}	20.45±0.68^{2,a,b}	19.05±0.23^{2,3,a}	18.38±0.38^{3,a}
	A	23.85±1.35^{1,a}	23±1.5^{1,2,b}	21.35±0.68^{2,b}	19.3±0.3^{3,a}	18.45±0.48^{3,a}
pH	T	7.31±0.043^{1,a}	7.33±0.04^{2,a}	7.348±0.074^{2,a}	7.368±0.033^{2,a}	7.395±0.023^{2,a}
	F	7.31±0.035^{1,a}	7.323±0.036^{2,a}	7.345±0.053^{2,a}	7.365±0.043^{2,a}	7.393±0.016^{2,a}
	A	7.3±0.05^{1,a}	7.315±0.04^{1,a}	7.333±0.043^{1,a}	7.363±0.038^{2,a}	7.383±0.018^{2,a}
BE (mmol/L)	T	0.3±1.1^{1,a}	0.19±1.21^{1,a}	-1.4±0.65^{1,2,a}	-3.25±0.9^{2,a}	-3.65±0.43^{2,a}
	F	0.35±1.575^{1,a}	0.25±1.65^{1,a}	-1.33±0.53^{1,2,a}	-3.23±0.39^{2,3,a}	-3.65±0.6^{3,a}
	A	0.45±0.73^{1,a}	0.29±0.64^{1,b}	-0.75±1.5^{1,2,a}	-3.03 ±0.73^{2,3,a}	-3.63±0.68^{3,a}
ALT (IU/L)	T	34.81±2.11^{1,a}	29.7±2.48^{2,a}	26.71±1.16^{2,3,a}	24.75±1.53^{3,4,a}	22.123±1.662^{4,a}
	F	35.84±4.94^{1,a}	32.26±3.93^{1,a,b}	28.01±1.65^{2,a}	25.5±1.9^{2,3,a,b}	22.6±1.697^{3,a}
	A	36.34±3.88^{1,a}	33.05±2.71^{1,2,b}	29.9±1.28^{2,3,b}	26.96±1.94^{3,4,b}	23.627±0.841^{4,a}
AST (IU/L)	T	126.9±7.89^{1,a}	108.3±8.3^{2,a}	98.47±7.69^{3,a}	86.72±4.38^{4,a}	71.78±3.82^{5,a}
	F	128.9±9.08^{1,a}	109.6±8.7^{2,a}	100.15±4.9^{3,a}	87.37±3.94^{4,a}	72.47±3.4^{5,a}
	A	128.7±8.67^{1,a}	109.7±8.2^{2,a}	100.27±6.79^{3,a}	89.05±3.97^{4,a}	73.73±3.57^{5,a}
Urea (mg/dl)	T	36.85±2.7^{1,a}	31.7±0.95^{2,a}	30.33±1.59^{2,a}	25.11±1.49^{3,a}	24.26±0.84^{3,a}
	F	38.45±3.86^{1,a}	32.63±1.83^{2,a,b}	31.01±1.66^{2,a}	26.98±0.81^{3,a}	24.53±0.88^{3,a}
	A	38 ±3.17^{1,a}	33.21±1.95^{2,b}	31.08±1.79^{2,a}	27.24±2.52^{3,a}	24.68±1.2^{3,a}
Creatinine (mg/dl)	T	1.48±0.323^{1,a}	1.09±0.25^{2,a}	0.87±0.11^{2,3,a}	0.755±0.075^{3,a}	0.698±0.096^{3,a}
	F	1.473±0.242^{1,a}	1.09±0.23^{2,a}	0.9±0.16^{2,3,a}	0.785±0.098^{3,a}	0.7±0.05^{3,a}
	A	1.475±0.283^{1,a}	1.107±0.222^{2,a}	0.932±0.075^{2,3,a}	0.83±0.063^{3,a}	0.71±0.043^{3,a}

T= tulathromycin F= florfenicol A= amoxicillin

Superscript number denotes significant difference from the value of 0 day before treatment at P<0.05.

Superscript letter denotes significant difference between groups within the same time at P<0.05.

Table (2): The results of serum biochemical of protein analysis, protein electrophoresis, immunoglobulin (IgG & IgA) and electrolyte changes of the three treatment groups (T, F and A).

Parameters	*Groups*	*0-day before treatment*	*1st day post treatment*	*3rd day post treatment*	*5th day post treatment*	*7th day post treatment*
Total protein (g/dl)	T	6.37±0.21^{1,a}	6.426±0.079^{1,a}	6.454±0.089^{1,a}	6.494±0.103^{1,a}	6.734±0.059^{2,a}
	F	6.39±0.18^{1,a}	6.395±0.125^{1,b}	6.42±0.073^{1,a,b}	6.48±0.107^{1,a}	6.72±0.08^{2,a}
	A	6.38±0.18^{1,a}	6.39±0.09^{1,b}	6.408±0.081^{1,b}	6.442±0.055^{1,a}	6.68±0.097^{2,a}
Albumin (g/dl)	T	2.45±0.19^{1,a}	2.65±0.032^{2,a}	2.84±0.066^{3,a}	3.01±0.056^{4,a}	3.24±0.028^{5,a}
	F	2.46±0.16^{1,a}	2.588±0.029^{1,b}	2.76±0.043^{2,a,b}	2.983±0.038^{3,a}	3.237±0.033^{4,a}
	A	2.46±0.17^{1,a}	2.54±0.02^{1,b}	2.695±0.032^{2,b}	2.95±0.037^{3,a}	3.212±0.048^{4,a}
Globulin (g/dl)	T	3.92±0.088^{1,a}	3.776±0.069^{1,2,a}	3.61±0.08^{2,3,a}	3.49±0.06^{3,a}	3.492±0.03^{3,a}
	F	3.93±0.08^{1,a}	3.807±0.108^{1,2,a,b}	3.66±0.06^{2,3,a,b}	3.497±0.09^{3,4,a}	3.483±0.063^{4,a}
	A	3.93±0.08^{1,a}	3.847±0.079^{1,2,b}	3.713±0.061^{2,b}	3.493±0.043^{3,a}	3.47±0.067^{3,a}
A/G Ratio	T	0.63±0.05^{1,a}	0.702±0.018^{2,a}	0.79±0.036^{3,a}	0.86±0.027^{4,a}	0.928±0.01^{4,a}
	F	0.63±0.044^{1,a}	0.68±0.02^{1,a,b}	0.75±0.016^{2,a}	0.85±0.019^{3,a,b}	0.93±0.015^{4,a}
	A	0.63±0.044^{1,a}	0.662±0.012^{1,b}	0.73±0.013^{2,b}	0.84±0.013^{3,b}	0.925±0.022^{4,a}
Alpha α-1- globulin *(g/dl)*	T	0.24±0.035^{1,a}	0.259±0.025^{1,a}	0.26±0.005^{1,a}	0.26±0.005^{1,a}	0.273±0.002^{1,a}
	F	0.244±0.03^{1,a}	0.258±0.024^{1,a}	0.26±0.003^{1,a}	0.26±0.007^{1,a}	0.272±0.005^{1,a}
	A	0.246±0.031^{1,a}	0.258±0.015^{1,a}	0.26±0.004^{1,a}	0.26±0.003^{1,a}	0.27±0.005^{1,a}
Alpha α-2- globulin *(g/dl)*	T	0.603±0.117^{1,a}	0.601±0.011^{1,a}	0.58±0.013^{1,a}	0.56±0.009^{1,a}	0.585±0.005
	F	0.619±0.113^{1,a}	0.605±0.017^{1,a}	0.58±0.01^{1,a}	0.57±0.015^{1,a}	0.582±0.01^{1,a}
	A	0.618±0.112^{1,a}	0.607±0.012^{1,a}	0.59±0.01^{1,a}	0.56±0.007^{1,a}	0.579±0.011^{1,a}
Beta- β-globulin (g/dl)	T	0.688±0.064^{1,a}	0.661±0.012^{1,a}	0.66±0.015^{1,a}	0.66±0.012^{1,a}	0.667±0.006^{1,a}
	F	0.673±0.063^{1,a}	0.662±0.019^{1,a}	0.66±0.011^{1,a}	0.65±0.02^{1,a}	0.665±0.012^{1,a}
	A	0.675±0.062^{1,a}	0.662±0.014^{1,a}	0.66±0.011^{1,a}	0.65±0.01^{1,a}	0.659±0.013^{1,a}
Gamma- γ-Globulin (g/dl)	T	2.387±0.19^{1,a}	2.258±0.021^{1,a}	2.12±0.04^{2,3,a}	2.01±0.034^{3,a}	1.967±0.017^{3,a}
	F	2.394±0.166^{1,a}	2.285±0.044^{1,2,b}	2.16±0.03^{2,3,a,b}	2.01±0.05^{3,4,a}	1.964±0.036^{4,a}
	A	2.386±0.159^{1,a}	2.324±0.031^{1,2,b}	2.21±0.034^{2,b}	2.03±0.04^{3,a}	1.962±0.038^{3,a}
IgG (mg/dl)	T	1071±13.2^{1,a}	1042±10.4^{2,a}	1038±10.4^{2,a}	1020±6^{3,a}	1017±4.4^{3,a}
	F	1070.8±12.96^{1,a}	1044±11.6^{2,a}	1039±9.2^{2,a}	1022.8±7.76^{3,a}	1018±4.4^{3,a}
	A	1072±13.6^{1,a}	1046± 8.8^{2,a}	1040±8^{2,a}	1026±7.2^{3,a}	1019.4±3.52^{3,a}
IgA (mg/dl)	T	213.8±4.96^{1,a}	205.4±2.32^{2,a}	202.6±2.64^{2,a}	195±3.6^{3,a}	190.2±2.24^{3,a}
	F	214.8±6.16^{1,a}	209.2±2.96^{1,2,a}	203.4±3.52^{2,a}	196.2±3.04^{3,a}	191±2^{3,a}
	A	215.2±6.24^{1,a}	211±4.4^{1,2,a}	206.2±5.04^{2,a}	195.6±2.08^{3,a}	191±2.8^{3,a}
Ca (mg/dl)	T	7.09±0.23^{1,a}	7.22±0.32^{1,2,a}	7.51±0.31^{2,3,a}	7.9±0.26^{3,a}	8.54±0.31^{4,a}
	F	7.11±0.21^{1,a}	7.21±0.24^{1,a}	7.5±0.16^{1,2,a}	7.88±0.06^{2,a}	8.54±0.13^{3,a}
	A	7.11±0.32^{1,a}	7.21±0.35^{1,a}	7.49±0.32^{1,2,a}	7.78±0.32^{2,a}	8.52±0.21^{3,a}
P (mg/dl)	T	6.59±0.23^{1,a}	6.14±0.24^{1,2,a}	5.43±0.32^{2,3,a}	4.83±0.34^{3,4,a}	4.28±0.23^{4,a}
	F	6.66±0.54^{1,a}	6.37±0.81^{1,b}	5.46±0.25^{2,a}	4.86±0.24^{2,3,a}	4.29±0.15^{3,a}
	A	6.62±0.53^{1,a}	6.38±0.58^{1,b}	5.48±0.36^{2,a}	4.94±0.17^{2,3,a}	4.33±0.35^{3,a}
Fe (mg/dl)	T	0.403±0.018^{1,a}	0.43±0.02^{1,a}	0.48±0.05^{1,a}	0.57±0.13^{2,a}	0.623±0.107^{2,a}
	F	0.414±0.034^{1,a}	0.42±0.04^{1,a}	0.47±0.03^{1,2,a}	0.55±0.02^{2,3,a,b}	0.621±0.061^{3,a}
	A	0.413±0.02^{1,a}	0.42±0.02^{1,a}	0.45±0.03^{1,2,b}	0.51±0.02^{2,b}	0.603±0.039^{3,a}
Mg (mmol/L)	T	1.054±0.18^{1,a}	1.196±0.252^{1,a}	1.37±0.198^{1,2,a}	1.5±0.12^{2,a}	1.692±0.067^{2,a}
	F	1.07±0.17^{1,a}	1.18±0.204^{1,a,b}	1.27±0.15^{1,a,b}	1.43±0.16^{2,a}	1.68±0.079^{2,a}
	A	1.07±0.21^{1,a}	1.13±0.22^{1,b}	1.27±0.198^{1,b}	1.42±0.17^{2,a}	1.659±0.076^{2,a}
Na (mmol/L)	T	142.4±0.88^{1,a}	142.4±3.12^{1,a}	143.4±2.48^{1,a}	144±1.6^{1,a}	144.6±1.52^{1,a}
	F	142.4±1.28^{1,a}	142.2±2.24^{1,a}	143±2.4^{1,a}	143.6±1.12^{1,a}	144.6±0.88^{1,a}
	A	142.2±1.04^{1,a}	142.4±1.12^{1,a}	142.8±1.04^{1,a}	144±1.2^{1,a}	144.6±1.12^{1,a}
K (mmol/L)	T	5.28±0.304^{1,a}	5.08±0.656^{1,2,a}	4.86±0.512^{2,3,a}	4.58±0.376^{3,a}	4.36±0.312^{4,a}
	F	5.36±0.456^{1,a}	5.12±0.584^{1,a}	5.02±0.584^{1,2,a}	4.7±0.44^{2,b}	4.38±0.368^{3,a}
	A	5.32±0.544^{1,a}	5.14±0.58^{1,a}	5 ±0.56^{1,2,a}	4.78±0.496^{2,b}	4.38±0.368^{3,a}
Cl (mmol/L)	T	82.66±3.408^{1,a}	84.26±3.97^{1,a}	88.9±3.66^{2,a}	93.12±2.02^{3,a}	97.58±1.144^{4,a}
	F	82.57±2.43^{1,a}	83.77±2.78^{1,a}	87.26±3.02^{2,a}	92.62±2.54^{3,a}	97.57±1.93^{4,a}
	A	82.6±1.73^{1,a}	83.58±1.45^{1,a}	87.18±1.32^{2,a}	92.58±1.66^{3,a}	97.52±1.04^{4,a}

T= tulathromycin F= florfenicol A= amoxicillin

Superscript number denotes significant difference from the value of 0-day before treatment at P<0.05.

Superscript letter denotes significant difference between groups within the same time at P<0.05.

Table (3): Results of sensitivity test of the antibiotics toward Klebsiella isolated from the pneumonic Boer goats.

Antibiotic	*Sensitivity*	*Inhibitory Zone (mm)*
Tulathromycin	++++	25
Florfenicol	+++	23
Norfloxacin	+++	22
Lomefloxacin	+++	22
Ceftriaxone	+++	20
Gentamycin	++	17
Trimethoprime/ sulphathazine	++	15
Amoxicillin	++	15
Erythromycin	+	10
Tobramycin	+	8
Nalidixic acid	+	7
Ampicillin	-	5
Penicillin	-	5
Oxacillin	-	0

days post injection (İçen et al., 2009, Ragbetli et al., 2009 and Naccari et al., 2015).

On the other hand, treatment with florfenicol revealed disappearance of the nasal and ocular discharge after the first dose of 73% of cases. These results comparable to that recorded by (Aslan et al., 2002) who recorded complete recovery of 23 animals out of the 27 weaned and unweaned calves treated with florfenicol. The treatment with amoxicillin revealed decreased nasal and ocular discharge and decrease of coughing after the first dose of treatment of 60% of cases. These results comparable to that recorded by (Zaghawa et al., 2010) in the treatment of sheep pneumonia with amoxicillin treatment trial. After treatment with any of the three antibiotics used (T, F and A) overcome anemia by elevation of the RBC count, Hb concentration and PCV%. The reduction in total leukocytic count and neutrophils with elevated lymphocytes were restored toward the control level in the three treatment group. These results indicate the efficacy of the three antibiotics used in overcome the causative microorganism and also activate the cellular immunity to restore lymphocytes. The results of hematological changes after treatment with tulathromycin agreed with (Altunok et al., 2002, and Yazar et al., 2004) who reported that there was a changes in hematological parameters toward the normal limits in treatment with tulathromycin. The results of hematological changes after treatment with florfenicol agreed with (Ramadan and Abd El-Aty, 2011) who recorded that the hematological parameters returned toward normal levels after second day of intramuscular treatment of florfenicol. The results of hematology after treatment with amoxicillin agreed to (Elmajdoub et al., 2014) who concluded that amoxicillin given in the therapeutic dose twice daily to healthy Libyan sheep caused only minor inconclusive changes in the hematological parameters. Also the changes in hematology and leukocyte count and differential leukocytes that most of them began after the 3rd day of treatment with tulathromycin providing the earlier recovery of the hematological parameters suggesting the greater efficacy in treatment of pneumonia in Boer goats. This agreed with (Washburn et al., 2007 and Young et al., 2011).

Treatment with the different types of antibiotics improved the pulmonary functions by elevation of PO_2 and reduction of PCO_2, tCO_2, HCO_3 and BE. These results in comparable with the results recorded by (Tanritanir et al., 2010) in pneumonic calves treated with tulathromycin. These results may suggest that tulathromycin administration help in improving the hypoxia, hypercapnia and acidosis in Boer goats affected with pneumonia starting from the first dose of treatment and a complete recovery could be obtained after the second dose of treatment. Tulathromycin produced earlier recovery of the blood gas parameters suggesting a greater efficacy in treatment of pulmonary diseases. This may agree with (Rooney et al., 2005) who had similar results in calves. After treatment with T, F and A the levels of total protein was started to resort from the

1st day untill significantly increased on the 7th day of treatment compared to values before treatment. However, T treatment significantly restored the albumin level on the 1st day of treatment compared to F and A treatment which restored the albumin level from the 3rd day. These results suggest that tulathromycin is more efficient than florfenicol and amoxicillin in restoring the protein profile of pneumonic Boer goats. The improvement in protein profile might be attributed to the increased synthesis of protein in the liver as indicated by the reduction of serum enzymes (ALT and AST) started from the 1st day of treatment (Altunok et al., 2002, Yazar et al., 2004 and Ragbetli et al., 2009). These also providing that treatment with tulathromycin, florfenicol and amoxicillin has no adverse effect on the liver or hepatotoxic effect (Elmajdoub et al., 2014). Then the success of the three antibiotics treatment in reducing IgG and IgA started from the 5th day of treatment indicate their effectiveness in overcome the inflammatory reaction of infection which is the main cause of hyper-gammaglobunemia (Apaydin and Dede, 2010).

After treatment with T, F and A the urea and creatinine levels started to reduce on the 1st day of treatment, these results agreed with (Ragbetli et al., 2009) who demonstrated a reduction of urea level on the 7th day after treatment of pneumonia in calves using tulathromycin. The efficacy of the three treatment on improving kidney function could be attributed to their bactericidal effect that overcome infection and its related toxins that affect on the internal organs such as kidney, for tulathromycin (Evans, 2005 and Wang et al., 2011), for florfenicol (Aslan et al., 2002, Donkersgoed et al., 2009, and Atef et al., 2010), for amoxicillin (Henry, 2001 and Plumb, 2008).

Treatment with T, F and A were success in restoring the electrolytes balance through the elevation of Ca, Fe, Mg and Cl and reduction of P and K, that occurred most of them after the 3rd day of treatment with T and after the 5th day of treatment with F and A. These results in comparable with (Ragbetli et al., 2009) who recorded that one week after (7 days) treatment of pneumonic calves with tulathromycin (Draxxin®) revealed Ca, K, Na and urea were significantly altered toward the level of healthy animals. Also agreed with (Elmajdoub et al., 2014) who reported that amoxicillin given in the therapeutic dose twice daily to healthy Libyan sheep caused only minor inconclusive changes of biochemical profile of these animals. The results providing the efficacy of the three antibiotic treatment have no adverse effect of the kidney function and restoring the serum electrolytes changes occurred in pneumonic Boer goats secondary to bacterial infections and their toxins. Also providing the better efficacy of tulathromycin than florfenicol and amoxicillin in treatment of pneumonia, agreed with (Rooney et al., 2005) who reported that tulathromycin was more efficacious in the treatment of undifferentiated bovine respiratory disease compared with florfenicol. This may be attributed to the antimicrobial activity of tulathromycin is generally bacteriostatic and act by inhibiting protein biosynthesis through selective binding to bacterial ribosome and stimulating dissociation of peptidyl-tRNA from ribosome during the translocation process (Wang et al., 2011). In line with that, the result of antibiotic sensitivity test also confirmed the higher sensitivity of tulathromycin than florfenicol and amoxicillin. However, florfenicol treatment group showed better efficacy than amoxicillin treatment group. This result in agreement with Lockwood et al. (1994) who reported that florfenicol is more effective than amoxicillin in the treatment of acute bovine respiratory system diseases. Also due to the action of florfenicol by inhibition of protein synthesis by binding to ribosomal subunits of susceptible bacteria (Donkersgoed et al., 2009 and Atef et al., 2010). On the other hand, amoxicillin is semi synthetic amino penicillin which has

activity against penicillin-sensitive gram positive as well as some gram negative bacteria continues to be a useful antimicrobial drug for its low index of toxicity and reliable absorption which continues to make it an attractive agent in the treatment of variety of infections (Henry 2001).

5. CONCLUSION

Based upon the results of this work, we can conclude that: Tulathromycin is more effective than florfenicol or amoxicillin in treatment of Boer goat pneumonia mainly caused by *k. pneumoniae* as shown by the earlier restoring of most of the examined parameters and confirmed by the antibiotic sensitivity test.

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