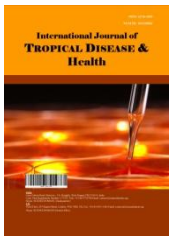

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Comparative Efficacy of Two Antibiotics for the Management of Secondary Bacterial Infection in Goats Clinically Affected by *Peste des Petits Ruminants*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: *Peste des petits Ruminants* (PPR) is a major viral disease that poses a challenge to small ruminant farming. Its natural occurrence has been complicated by secondary bacterial infection which has led to an increase in morbidity and mortality rates. This study reports the management outcome of natural PPR-infected goats using two types of antibiotics in Nsukka metropolis of Enugu State Nigeria.
Methodology: Goats (N=24) were confirmed to be suffering from PPR based on clinical signs and using polymerase chain reaction (PCR). The animals were divided into two groups. Group A was treated with 20% oxytetracycline (N= 10) and group B with procaine penicillin and streptomycin combination (penstrept) (N= 14) injection. Clinical signs, recovery and survivability, temperature, haematology [Packed cell volume (PCV); haemoglobin concentration (Hbconc); red blood cell

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(RBC) and white blood cell (WBC) counts] and some serum biochemical profiles [alanine aminotransferase (ALT); aspartate transaminase (AST); total protein (TP); Albumin; urea; creatinine; potassium and sodium] were used to assess the efficacy of the antibiotics using standard techniques.

Results: The mean temperature, RBC, WBC and urea values of the PPR-infected goats were above their reference ranges, mean albumin values were below the reference range while mean Hbconc, PCV, AST, ALT, TP and creatinine values were within their reference range before the commencement of treatment. Following treatment, clinical signs cleared in 20% and 35.7% of the goats treated with oxytetracycline and penstrep respectively. Death was recorded in 20% and 15% of goats treated with oxytetracycline and penstrep respectively before the end of treatment. Penstrep-treated group showed improvement in their haematological profile.

Conclusion: Based on our findings, the use of penstrep in the management of PPR-infected goats gave a better result.

Keywords: Goats; haemo-biochemical profile; oxytetracycline; peste des petits ruminants; procaine penicillin and streptomycin combination.

1. INTRODUCTION

Peste des petits ruminants (PPR) has been identified as one of the major diseases that pose a serious challenge to small ruminant farming [1]. This infection is an acute, highly contagious, transboundary viral disease of sheep and goats, causing devastating disease that poses a threat to livestock production in many developing countries. The disease is enzootic in several countries of West Africa and produces variable rates of morbidity and mortality that can reach 100% and 90%, respectively [2]. For example, due to PPR outbreaks, the economic loss in Nigeria has been estimated to be 6.8 billion Naira (NGN) [3]. The aetiologic agent of PPR- *Small Ruminant Morbillivirus* (SRM), is a single-stranded ribosomal nucleic acid (RNA) virus that is a member of the *Morbillivirus* genus of the Paramyxoviridae family [4]. Infected animals present clinical signs such as fever, conjunctivitis, ocular discharges, encrustation in the media canthus, mucopurulent nasal discharges, ulcerative stomatitis, salivation, pneumonia, coughing, sneezing, profuse diarrhoea, dehydration with sunken eyes, emaciation and inflammation of the mucous membrane of the respiratory and digestive tracts. This infection of small ruminants can only be managed symptomatically as it has no specific treatment. Management using broad-spectrum antibiotics, antihistaminic, fluid therapy, intestinal sedative and multivitamin has been reported [5]. The disease in its natural occurrence has been complicated by secondary bacterial infection. Some bacteria that have been isolated from the pneumonic lungs of sheep and goats are *Escherichia coli*, *Klebsiella pneumonia*, *Mannheimia haemolytica*, *Streptococcus pyogenes*, *Staphylococcus aureus* and *Pasteurella multocida* [6]. Secondary bacterial infection has been reported to lead to increased morbidity and mortality rates [2,7] with the main pathologic lesions observed in the digestive and respiratory systems. This paper, therefore, compares the efficacy of two antibiotics in the management of secondary bacterial infection in goats clinically affected by PPR in Nsukka metropolis, Enugu state Nigeria.

2. MATERIALS AND METHODS

2.1 Experimental Animals

A total of 74 goats showing clinical signs suggestive of PPR (e.g. ocular and nasal discharges, encrustation in the media canthus, ulcerative stomatitis, coughing, difficulty/laboured breathing, diarrhoea) were identified (by clinical examination as described by [7,8]) in households in Nsukka metropolis of Enugu State, Nigeria from November 2019 - March 2020. A total of 58 goats (comprising 22 males and 36 females) were purchased from the owners (convenience sampling based on willingness to sell their sick goat) and used for this study. The infected goats were not vaccinated from the information obtained from the owners.

The goats were kept in a fly-proof well-ventilated house, fed cut and carry grasses [elephant grass (Pennisetumpurpureum), guinea grass (Panicum maximum), and palm frond] as is the usual practice in this eco-zone and clean water provided ad libitum. Each goat was identified using a neck tag (numbered 1-58). They were handled in compliance with the guidelines for the humane treatments of animals during

experimentation at the University of Nigeria. The faecal dropping was removed daily and the floor was disinfected with common disinfectants (phenol and detergents) and exposed to 2% sodium hydroxide to kill the viruses present in the faeces [9]. The goats were grouped as follows: those with odd numbers on the neck tags as group A (treated with long-acting oxytetracycline injection) and those with even numbers as group B (treated with Procaine Penicillin and Dihydrostreptomycin combination).

Blood (5 ml) through venipuncture and nasal swab samples were collected from each goat before the commencement of treatment and were properly labelled. Treatment was done using 20% oxytetracycline injection (Kepro, Netherland) (20mg/kg body weight intramuscularly, 2nd dose given after 48 hours) and Procaine Penicillin and Dihydrostreptomycin combination injection (Penstrep) (Kepro, Netherland) (1ml/25kg body weight intramuscularly for 3 days). On days 3 and 7 post-commencement of treatment, blood samples (5ml) were again collected from the jugular vein; temperature and clinical observation were taken and documented.

Blood samples (4ml) for biochemistry were allowed to clot and then centrifuged at 1500 x g for 10 minutes. Sera harvested were stored at –20°C, while blood samples (1ml) for haematology were put into sample tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. All the samples were taken to the Department of Veterinary Medicine Laboratory, University of Nigeria Nsukka in plastic coolers for processing and analysis. The nasal swabs and sera samples were packed in dry ice and transported to Biotechnology Centre and the Biochemical Division, National Veterinary Research (NVRI) Institute, Vom, Jos Plateau State, Nigeria respectively for PPRV detection and biochemical analysis.

2.2 *PPR* Virus Detection

The nasal swabs were evaluated for PPRV by RT-PCR assay. RNA extraction using QIAamp Viral RNA Mini kit (Qiagen, Hilden, Germany), RT-PCR using QIAGEN® OneStep Ahead RT-PCR Kit (Qiagen, Hilden, Germany) and Nucleoprotein gene primers as described by Couacy-Hymann et al. (2002), and analysis of amplicon were done using standard procedures as described by Chukwudi et al. [10].

2.3 Parameters for Assessing the Efficacy of the Drugs

Rectal temperature, clinical signs and survivability were documented. Packed cell volume (PCV), Haemoglobin concentration, Red blood cell (RBC) count, and White blood cell (WBC) count as described by Coles [11] and Schalm et al. [12] were determined using standard laboratory techniques. Total protein, albumin, urea, creatinine, alanine aminotransferase (ALT), aspartate transaminase (AST) and serum electrolytes such as Potassium (K) and sodium (Na) were determined using standard Randox® test kit according to the manufacturer's recommendation.

2.4 Statistical Analysis

Data generated from temperature, haematology and serum biochemistry were analysed using one-way analysis of variance (ANOVA) (monitoring the progress of treatment) using SPSS version 16 software package. The means were separated using Duncan's multiple range test [13] at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 PCR

Out of the 58 treated goats that were showing clinical signs suggestive of PPR, only the nasal swabs of 24 goats were positive for PPRV by RT-PCR assay (Fig. 1).

3.2 Clinical Signs, Recovery and Survivability

The varying clinical signs displayed by the 24 goats before and after treatment were any or a combination of the following: coughing, mucopurulent nasal discharges, ocular discharges, rough hair coat, stomatitis, weak, dull, emaciation and others (Table 1).

Following treatment, only 7 goats [20% (n =2) for Oxytet treated group; 35.7% (n = 5) for Penstrep treated group] had their clinical signs completely cleared. Death was recorded in 4 goats [20% (n =2) for Oxytet treated group; 15% (n =2) for Penstrep treated group] before the end of the treatment.

3.3 Temperature

There was an increase in the mean temperature of both groups (oxytetracycline-treated and

penstrep-treated groups) before the commencement of treatment (above the reference value) (Table 2). By day 3 post-commencement, a significant decrease (*P*< .05) was observed in both groups. On day 7 post-commencement of treatment, a significant increase (*P*< .05) was recorded in the oxytetracycline-treated group compared to that of day 3 post commencement of treatment.

3.4 Haematological Analysis

3.4.1 Packed cell volume (PCV)

There were no significant differences (*P*> .05) in the mean PCV of oxytet-treated group all through the duration of treatment, while there were significant decreases (*P*< .05) on days 3 and 7 post-commencement of treatment in the penstrep-treated group when compared to their initial value on day 0 before the commencement of treatment (Table 3). The mean PCV values of both groups all through the experiment/treatment and monitoring were within the reference range.

3.4.2 Haemoglobin concentration (Hbconc)

There were no significant differences (*P*> .05) in the mean Hbconc of the oxytet-treated group all through the duration of treatment, while there was a significant decrease (*P*< .05) on day 3 post-commencement of treatment in the penstrep-treated group when compared to their initial values before the commencement of treatment (Table 3). The mean Hbconc values of both groups all through the experiment/treatment and monitoring were within the reference range.

3.4.3 Red blood cell count (RBC)

There were higher mean RBC values (compared to the reference value) of both groups (oxytetracycline-treated and penstrep-treated groups) before the commencement of treatment (Table 3). By day 3 post-commencement of treatment, a significant decrease (*P*< .05) in RBC values was observed in both groups.

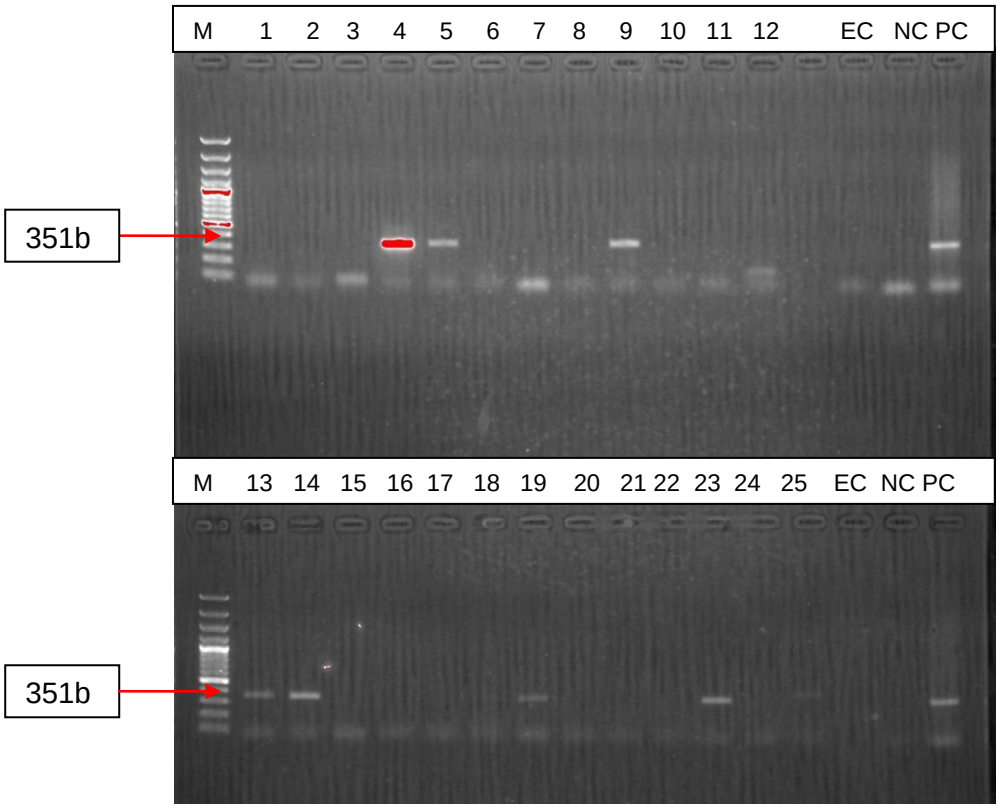

Fig. 1. Representative gel picture of samples analysed by RT-PCR.
Lane M= 100bp DNA molecular weight marker, Lane EC, NC and PC are extraction, negative and positive control respectively, Lane 1-25 are PCR product for representative samples.

Table 1. Details of clinical signs displayed by the treated 24 goats before and after commencement of treatment

Oxytet Group (A)	Goat S/NO	Clinical signs before treatment	Clinical signs after treatment	Response
	5	Dia, Cou, Od, MpNd,	Nd,	
	9	Cou, Nd,	No obvious signs	Cleared
	13	Nd, Cou. Dia, Du, RHC, Wk, Us	Nd	
	19	Nd, Od, Cou. Du, Ema, RHC, Wk	Nd, Ema,	
	17	Mpnd, Od, Cou	No obvious sign	Cleared
	27	Nd, Od, Dia, Us	Nd, Dia,	
	29	Nd, Od, Cou. Dia, Du, RHC	Nd, Dia,	
	33	Nd, Cou, Du, Dia	Death	
	35	MpNd, Dia, Cou	Nd, Dia, wk	
	51	Nd, Od, Cou. Du, Wk	Death	
Pentrep group (B)				
	4	Severe MpNd, Du	Nd,	
	14	Nd, Dia, Us, Cou. Du, RHC	Nd, Dia (reduced)	
	28	MpNd, Cou. Dia, Du, RHC, Ema, Wk, Se	Nd, Dia (reduced), Ema	
	30	Nd, Cou. Du, RHC, Ema	RHC, Ema	
	32	Nd, Od, Cou. Du, RHC,	No obvious sign	Cleared
	36	MpNd, Cou. Dia, Us, Du, RHC, Ema	Nd, Dia (reduced)	
	38	Nd, Od, Cou. Du,	Nd	
	42	MpNd, Us, Cou, Du	Death	
	44	Severe MpNd, Dia, Du	Death	
	46	Nd, Cou, Du	No obvious sign	Cleared
	48	Nd, Du, Cou	No obvious sign	Cleared
	50	MpNd, Cou, Dia	Nd	
	52	MpNd, Cou	No obvious sign	Cleared
	56	Cou, Nd, Du	No obvious sign	Cleared

Clinical signs: Nd- nasal discharge; Od- ocular discharge; Cou- coughing; Ema- emaciated; RHC- rough hair coat; Wk- weak: Du- dull; Dia- diarrhea; MpNd- mucopurulent nasal discharge; Us- Ulcerative stomatitis

Table 2. Temperature (°C) of goats naturally infected with PPR and treated with oxytetracycline and penstrep

Groups	Day 0	Day 3 post-treatment	Day 7 post-treatment
A- Oxytet treated	40.95 ± 0.55^{b}	38.60 ± 0.10^{a}	39.70 ± 0.40^{b}
B- Penstrep treated	40.70 ± 0.20^{b}	38.20 ± 0.25^{a}	38.8 ± 1.70^{a}
Reference value	38.5-39.7°C [14]		

Superscript a,b,c indicates significance row-wise

3.4.4 White blood cell count (WBC)

There was a slight increase in the mean WBC values (above the reference value) of both groups (oxytetracycline-treated and penstrep-treated groups) before the commencement of treatment (Table 3). There were no significant differences ($P > .05$) in the mean WBC values of both groups all through the duration of treatment.

3.5 Biochemical Profile

3.5.1 Aspartate transaminase (AST)

There were no significant differences ($P > .05$) in the mean AST values of both groups all through the duration of treatment (Table 4). The AST values all through the experimental/ treatment and monitoring period were within the reference range.

3.5.2 Alanine aminotransferase (ALT)

There were no significant differences ($P > .05$) in the mean ALT values of both groups all through the duration of treatment (Table 4). The ALT values all through the experimental/ treatment and monitoring period were within the reference range.

3.5.3 Total protein (TP)

There were no significant differences (*P*> .05) in the mean TP values of both groups all through the duration of treatment (Table 4). The TP values all through the experimental/ treatment and monitoring period were within the reference range.

3.5.4 Albumin

There was a significant decrease (*P*< .05) in the mean albumin values of both groups from day 3 post-commencement of treatment when compared to their initial values before the commencement of treatment (Table 4). The albumin values from day 3 post-commencement of treatment were below the reference range.

3.5.5 Urea

There were higher mean urea values (compared to the reference value) of both groups (oxytetracycline-treated and penstrep-treated groups) before the commencement of treatment. By day 3 post-commencement of treatment, there was a significant decrease (*P*< .05) in the mean urea values of the penstrep-treated group when compared to their initial values on day 0 (Table 4).

3.5.6 Creatinine

There were no significant differences (*P*> .05) in the mean creatinine values of both groups all through the duration of treatment (Table 4). The creatinine values all through the experimental/ treatment and monitoring period were within the reference range.

3.5.7 Potassium (K)

There were higher mean potassium values (compared to the reference value) of the penstrep-treated group before the commencement of treatment. Following treatment by day 3, it decreased to a nearly normal value, and by day 7 post-commencement of treatment the potassium value increased above the reference value although not significant (*P*> .05). There were no significant differences (*P*> .05) in the mean potassium levels of the oxytet-treated group all through the duration of treatment (Table 4).

3.5.8 Sodium (Na)

There was a higher mean sodium level (compared to the reference range) of the oxytet-treated group before the commencement of treatment. Following treatment by day 3, it continued to increase, and by day 7 post-commencement of treatment, the sodium level decreased and was within the reference value although not significant. There were no significant differences (*P*> .05) in the mean sodium levels of the penstrep-treated group all through the duration of treatment (Table 4).

Table 3. Haematology of goats naturally infected with PPR and treated with oxytetracycline and penstrep

Group/parameter	Day 0	Day 3 post-treatment	Day 7 post-treatment
PCV (%)			
A- Oxytet treated	29.00 ± 3.06^{a}	28.33 ± 4.91^{a}	23.5 ± 0.50^{a}
B- Penstrep treated	29.50 ± 2.50^{a}	23.00 ± 2.00^{c}	26.00 ± 0.15^{b}
Reference value	22-35% [15]		
HB conc (g/dl)			
A- Oxytet treated	11.30 ± 0.60^{a}	9.30 ± 1.48^{a}	11.60 ± 0.90^{a}
B-Penstrep treated	10.85 ± 0.95^{a}	7.90 ± 0.7^{b}	13.05 ± 2.05^{a}
Reference value	7-15 g/dl [15]		
RBC (x 10^6/mm^3)			
A- Oxytet treated	16.23 ± 0.54^{a}	8.23 ± 1.25^{b}	12.54 ± 2.33^{c}
B-Penstrep treated	14.96 ± 0.59^{a}	6.55 ± 0.55^{b}	15.38 ± 3.18^{a}
Reference value	9.2-13.5 x 10^6/mm^3[15]		
WBC (x 10^3/mm^3)			
A- Oxytet treated	15.87 ± 7.57^{a}	14.10 ± 2.00^{a}	17.68 ± 0.48^{a}
B-Penstrep treated	14.45 ± 3.10^{a}	13.34 ± 3.99^{a}	15.15 ± 1.8^{a}
Reference value	6-13 x10^3/mm^3 [16]		

Superscript a,b,c indicates significance row-wise

Table 4. Biochemistry of goats naturally infected with PPR and treated with oxytetracycline and penstrep

Group/parameter	Day 0	Day 3 post-treatment	Day 7 post-treatment
AST (IU/L)			
A- Oxytet treated	201.34 ± 21.29[a]	229.58 ± 25.84[a]	243.46 ± 10.59[a]
B- Penstrep treated	287.44 ± 15.05[a]	196.05 ± 16.12[a]	224.99 ± 12.24[a]
Reference value	0-300 IU/L [17]		
ALT (IU/L)			
A- Oxytet treated	9.13 ± 3.23[a]	13.33 ± 2.93[a]	18.90 ± 2.63[a]
B- Penstrep treated	12.70 ± 4.88[a]	9.61 ± 0.10[a]	14.77 ± 1.32[a]
Reference value	6-19 IU/L [16]		
Total protein (mg/gl)			
A- Oxytet treated	6.28 ± 1.21[a]	7.65 ± 0.69[a]	6.36 ± 0.51[a]
B- Penstrep treated	6.84 ± 1.83[a]	6.66 ± 0.74[a]	7.99 ± 0.34[a]
Reference value	6.3-8.5 g/dl [15]; 6.2-7.9 g/dl [16]		
Albumin (mg/dl)			
A- Oxytet treated	2.87 ± 0.32[a]	2.16 ± 0.33[b]	1.84 ± 0.22[b]
B- Penstrep treated	3.34 ± 0.50[a]	1.89 ± 0.35[b]	2.47 ± 0.30[b]
Reference value	2.9-4.3 g/dl [15]; 2.8-4.3 g/dl [16]		
Urea (mg/dl)			
A- Oxytet treated	36.28 ± 2.55[a]	34.78 ± 4.20[a]	34.42 ± 8.06[a]
B- Penstrep treated	37.06 ± 0.78[a]	27.29 ± 1.71[a]	23.34 ± 8.00[a]
Reference value	10-26 mg/dl [16]		
Creatinine (mg/dl)			
A- Oxytet treated	1.29 ± 0.16[a]	1.65 ± 0.28[a]	1.53 ± 0.03[a]
B- Penstrep treated	1.23 ± 0.06[a]	1.21 ± 0.14[a]	0.90 ± 0.38[a]
Reference value	0.6-1.6 mg/dl [16]		
Potassium (mmol/L)			
A- Oxytet treated	4.56 ± 1.19[a]	4.34 ± 1.34[a]	6.27 ± 1.75[a]
B- Penstrep treated	7.02 ± 2.50[a]	6.07 ± 1.47[a]	7.81 ± 2.81[a]
Reference value	3.0-6.0 mmol/L [15]; 3.4-6.1 mmol/L [16]		
Sodium (mEq/L)			
A- Oxytet treated	147.7 ± 14.74[a]	154 ± 6.34[a]	134.4 ± 15.00[a]
B- Penstrep treated	139.5 ± 10.00[a]	151 ± 5.84[a]	138.305 ± 8.03[a]
Reference value	124-146 mEq/L [15]		

Superscript a,b,c indicates significance row-wise

4. DISCUSSION

The clinical manifestations of *Peste des petits ruminants* (PPR) observed in goats used in this study agree with the findings in previous studies [7,8,18]. The goats showing clinical signs suggestive of PPR but were negative for PPRV as seen in this study were suggested to be suffering from other respiratory and digestive diseases such as contagious caprine pleuropneumonia, pneumonic pasteurellosis, salmonellosis and colibacillosis, as these diseases share the same clinical symptoms with PPR and thus were considered as a differential diagnosis of PPR [19].

Following the therapeutic intervention, only 20% of the Oxytet-treated group and 35.7% of the Penstrep-treated group had their clinical signs completely cleared indicating that the antibiotics used (oxytetracycline and penstrep) were not efficient in handling the possible secondary bacterial complications of PPR in the goats treated. This observation is in contrast with the report of Islam et al. [20] and Islam et al. [21] who reported 55% and 64% recovery rates respectively. This could be attributed to the symptomatic treatment carried along with oxytetracycline administration. Wosu, [5] had earlier reported a recovery rate of 58.8% using chloramphenicol, penicillin and streptomycin in addition to anthelmintic, fluid therapy, intestinal sedative and scrubbing of the labial scab with lemon fruit. However, Anene et al. [22] recorded a recovery rate of 14.29% in PPR infected goats using oxytetracycline, chloramphenicol 25% solution and metamerazine in different groups at recommended doses. Both antibiotics used in

this study were indicated for the treatment of respiratory infections. Thus, the low recovery rate obtained may be attributed to treatment without supportive therapy. Supportive therapy is of great importance in the successful management of PPR.

The mortality rate of 16.67% recorded in this study could also be attributed to treatment without supportive therapy and the presence of underlining disease conditions such as helminthosis complicating the situation. Although, the work of Sharma and Tarunpreet-Joshi [23] recorded a slightly higher mortality rate of 18.38% despite using antibiotic (ceftriazone), anti-inflammatory, antihistamine, levamisole, vitamin C, B-complex and vitamin A, D and E injections in the therapeutic management of PPR-infected goats.

Pyrexia observed before the commencement of treatment is a feature of PPR, and it subsided following treatment. This finding is consistent with that of Islam et al. [20] who found that increased temperature of goats/sheep infected with PPR virus was reduced after antibiotic therapy.

The increased red blood cell (RBC) count observed before the commencement of treatment is attributed to the diarrhoeic nature of the disease and this agrees with the findings of Islam et al. [24] and Kataria et al. [25]. Diarrhoea is a symptom of PPR which leads to dehydration in the host resulting in haemoconcentration in the blood profile of PPR infected animals [25]. The non-significant difference observed in the total WBC despite treatment administered could be attributed to the activity of the virus. PPR virus is known to have lymphotropic activity as it has an affinity for lymphoid organs. Antibiotic treatment does not affect the virus.

The Aspartate transaminase (AST) and Alanine aminotransferase (ALT) activities and total protein, albumin, creatinine, potassium and sodium levels which were within reference ranges during the viral infection may suggest that less or no damage has been done to the liver and kidney, or it could be that the reference values might not be true for our indigenous breed of goats. It has been reported that breed, physiological status, nutrition, season [26,27] and geographical location [28] affect the biochemical profile. PPR infection has been reported to be associated with liver and kidney damage and was further confirmed by a marked increase in the level of ALT and AST, and a marked decrease in total protein and albumin when compared with normal healthy small ruminants [15]. The penstrep-treated group had a significant increase in their albumin level by day 7 post commencement of treatment thus showing better recovery traits.

The increased urea level of both groups agrees with the findings of Balogun et al. [29] and Sharma and Tarunpreet-Joshi [23]. Balogun et al. [29] observed a high level of urea in the serum of WAD goats post PPR infection which continued to increase as the infection progressed from the acute stage to death. Following treatment, the penstrep-treated group had their urea level returned to within the reference value thus showing a better recovery trait.

The penstrep-treated goat had a higher recovery rate and better recovery traits compared to the oxytetracycline-treated goat. This could be attributed to the additive and in some cases synergistic effect of Penstrep as it is a cocktail of both procaine penicillin G and dihydrostreptomycin. Procaine penicillin G is small-spectrum penicillin with a bactericidal action against mainly Gram-positive bacteria like Clostridium spp, Corynebacterium spp, Erysipelothrix spp, Listeria spp, penicillinase-negative Staphylococcus and Streptococcus spp, while Dihydrostreptomycin is an aminoglycoside with a bactericidal action against mainly Gram-negative bacteria like *Escherichia coli*, Campylobacter spp, Klebsiella spp, Haemophilus spp, Pasteurella spp and Salmonella spp. These organisms are responsible for secondary bacterial complications in PPR, as a good number of them have been isolated from natural PPR infected animals [6,7,2].

Also, the goats used in this study had no history of vaccination. It is worthy to note that the practices of taking sick animals to the markets for sale and also lack of awareness of PPR vaccination among small ruminant farmers have been reported to be potential risk factors of PPR prevalence in the study area [1].

5. CONCLUSION

Based on our findings, the use of penstrep in the management of PPR cases gave a better result. Supportive therapy is of great importance in the improvement of survivability in PPR cases and thus should be included. An antibiotic sensitivity test is also advised for the most appropriate

antibiotic of choice to be used in the management of secondary bacterial infection associated with PPR.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approval was granted by the University of Nigeria Nsukka Animal Care and Use Ethical Committee (UNN/ eTC/MLA/17/03).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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