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Research Article

Effects of Piroxicam-Ketamine Combination on Hematologic and Serum Biochemistry Parameters of West African Dwarf Goats (*Capra Hircus*)

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Abstract

Drug combinations are utilized in various medical contexts, particularly for balanced anaesthesia during surgeries; however, their impacts on physiological and haematological parameters are usually overlooked. The combination of ketamine and piroxicam has been proposed for certain surgical procedures, yet its effects on haematological and biochemical parameters remain unexamined. Therefore, this study investigated the influence of the ketamine-piroxicam combination on haematological and serum biochemical parameters in goats. A total of thirty West African Dwarf goats, averaging twelve months of age, were utilized in this research. The subjects were divided into five groups, each consisting of six goats. All groups received intravenous ketamine (10 mg/kg), while groups II, III, IV, and V received intramuscular piroxicam (5 mg/kg) at intervals of 15, 30, 60, and 120 minutes prior to ketamine administration. Blood samples were obtained in both EDTA and non-EDTA containers for comprehensive haematological and biochemical analysis (liver and kidney function) before drug administration, 90 minutes post-administration, and 48 hours later. Results indicated that piroxicam mitigated the harmful osmotic fragility effects of ketamine on erythrocytes. A significant increase in packed cell volume (PCV) was noted in groups III, IV, and V after 48 hours, whereas red blood cell count decreased in those groups. Groups IV and V exhibited increased total protein levels, while alanine aminotransferase (ALT) levels decreased across groups II to V. Additionally, bilirubin and creatinine levels decreased in groups II to V. The findings suggest that the combination affects haematological, erythrocyte osmotic fragility, and serum biochemical parameters, warranting careful consideration in the concurrent use of these pharmaceuticals.

Keywords: Piroxicam; Ketamine; Goat; Haematology; Serum Biochemistry

Introduction

Goats are of great economic value to smallholder farmers who convert its low cost inputs to high valued products like meat, milk and skin [1]. Several clinical conditions like mastitis, post-operative pain, gastrointestinal, reproductive and urinary tract inflammations are treated in goats using piroxicam [2]. Ketamine, a dissociative anaesthetic, is used to manage several surgical conditions in goats. Some clinical conditions require the combination of drugs like analgesics and anaesthetics and this extensive use of drugs are known to produce adverse drugs effects.

Piroxicam and ketamine have been concurrently used [3] but the effect of this combination on haematology and serum biochemistry has not been investigated. Thus there is the need to evaluate the combination on haematology and biochemical parameters in West African dwarf goats.

Methodology

Drugs

Ketamine hydrochloride (50 mg/ml) (SWISS Parenterals Pvt. Ltd. Gujarati, India) was administered at 10 mg/kg body weight. Piroxicam (10 mg/ml) (Hubei Tianyao Pharmaceutical Co. Ltd. No: 7 Dufu Block, Jianshe Road, Xiangyang, Gubei, China, marketed by Chupet Pharma. Co. Lagos, Nigeria) was administered at 5 mg/kg body weight.

Experimental animals

Thirty (30) apparently healthy West African Dwarf (WAD) goats comprising male (15) and female (15) of about 1 year old were used for the study. The goats were purchased from the local breeders in Makurdi Metropolis of Benue State, Nigeria. All the animals were screened for the presence of endo-parasites and ecto-parasites, vaccinated against Peste des Petits Ruminants (PPR) virus, and acclamatized for two weeks prior to the experimentation. Pasture, concentrates (yam peels, grains, maize bran and molasses) and water were provided *ad libitum.* All the animals were handled according to the international guiding principle for biomedical research involving animals [4] and as approved by the Ethical Committee of the College of Veterinary Medicine, Federal University of Agriculture, Makurdi, Nigeria. Blood samples were collected from the jugular vein of all the goats, into two sample bottles; one with EDTA

and the other without EDTA, before the administration of the drugs, at 90 min and 2 days post piroxicam/ketamine administration. The animals in group one were administered ketamine alone via jugular vein, while the animals in groups two, three, four and five were treated with ketamine at 15 min, 30 min, 60 min and 120 min post piroxicam administration via the jugular vein. The blood samples were used for estimation of erythrocyte osmotic fragility and haematological parameters, while serum samples obtained from the blood were used for estimation of the biochemical parameters.

Erythrocyte osmotic fragility determination

Sodium chloride solution was prepared according to Faulkner and King [5] in concentration ranging from 0.1 to 0.85 at pH 7.4. A set of 10 test tubes (containing 5 ml of sodium chloride solution) where arranged serially in a test tube rack to analyze each sample. The test tubes were labelled with corresponding sodium chloride concentrations. One ml pipette was used to transfer 0.02 ml of blood into each of the ten test tubes. The content was then mixed by gently inverting the test tubes for about 3 times. The test tubes were allowed to stand at room temperature (26-270 C) for 30 minutes. The contents of the test tubes were maintained at pH 7.5 thereafter the contents of the test tube were centrifuged at 1,500 g for 20 minutes. The supernatant of each test tube was transferred into a cuvette. The concentration of haemoglobin in the supernatant solution was measured at 540 nm using a spectrophotometer (Spectronic-20, Philip Harris Limited, Shenstone, England) by reading the absorbance. The same procedure was repeated for every blood sample used for the study. The percent haemolysis was then calculated using the formula [5].

Haematology

The packed cell volume (PCV) and haemoglobin (Hb) were determined using micro haematocrit method and cyanmethaemoglobin method as described by Mitruka and Rawnsley [6]. Red Blood Count (RBC) and White Blood Count (WBC) were determined using Neubauer haemocytometer after appropriate dilution [7]. and Kelly [8].

Biochemical assay

Serum level of ALT and AST were determined using the method of Reitman and Frankel [9], and serum ALP level was assayed by Babson and others [10] procedure. Serum total protein level was determined by the method of Tietz [11], while creatinine level was assayed by Jaffe's reaction as described by Bishop [12] and BUN by Fawcett and Scott [13] method. Randox® commercial kits (Randox Lab. LTD. UK) were used for the various assays.

Statistical analysis

Erythrocyte osmotic fragility, haematological and biochemical parameters were presented as mean ± standard error of mean (SEM) and were analyzed using Two-way analysis of variance (ANOVA). Least significant difference (LSD) was detected at 5% level of significance [14].

Result

Effects of piroxicam co-administered with ketamine on erythrocyte osmotic fragility (eof) parameters of west african dwarf (WAD) goats

Table 1 shows the results of erythrocytes osmotic fragility induced by piroxicam-ketamine combination administered at varying time intervals in West African dwarf goats. In group 1, the level of level of erythrocytes fragility from 0.10 to 0.40 M were above 100 followed by a continuous significant ($p < 0.05$) decrease from 0.5M till 0.9 M. Group 2 showed a fluctuating decrease from 0.1 - 0.5 M (89.61 ± 2.47 - 95.53 ± 4.6) and then a significantly ($p < 0.05$) continuous decrease from 0.6-0.9 M. Similar trend was observed in groups 3,4 and 5. At 0.7 M osmotic strength, groups 2,3 and 4 showed a significantly increased post treatment values compared to group 1 (65.46 ± 22.40). At 0.9 M there was a significant increase in fragility in the samples collected after two days in a the groups except in group 5 which showed a significant decrease two days after treatment.

GROUPS		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
Kt only	0 mins	116.54 ± 6.64	116.10 ± 2.44	120.65 ± 3.9	116.85 ± 6.98	111.04 ± 6.98	89.27 ± 26.58^{b}	57.22 ± 32.09^{b}	19.15 ± 1.64^{b}	13.81 ± 1.93^{b}
	90 mins	159.08 ± 45.43^{c}	100.45 ± 21.14^{bd}	105.87 ± 12.95^{d}	99.11 ± 11.64^{bd}	97.01 ± 11.86^{bd}	102.91 ± 16.76^{b}	65.46 ± 22.40^{b}	14.98 ± 3.66^{bd}	10.48 ± 1.89^{bd}
	2 days	102.29 ± 5.18d	104.39 ± 4.46^{d}	110.10 ± 4.06d	102.51 ± 11.48^{d}	100.14 ± 12.40	97.63 ± 11.64^{b}	43.92 ± 19.79^{bd}	17.14 ± 1.86^{b}	15.55 ± 1.66^{b}
Px 15 min Kt	0 mins	106.34 ± 6.91	88.87 ± 0.87^{bd}	99.69 ± 14.16^{bd}	98.3 ± 14.33^{bd}	95.67 ± 15.12^{b}	86.36 ± 19.22^{b}	54.52 ± 28.15^{b}	11.62 ± 1.56^{bd}	10.06 ± 1.60^{bd}
	90 mins	95.00 ± 5.01^{d}	118.65 ± 12.74^{a}	94.64 ± 8.38^{d}	101.71 ± 7.80^{ad}	95.02 ± 7.97^{d}	85.28 ± 11.53^{b}	34.38 ± 7.21^{b}	14.32 ± 4.54^{bd}	11.61 ± 3.63^{bd}
	2 days	89.61 ± 2.47^{d}	95.62 ± 3.21^{ad}	92.02 ± 5.84^{d}	92.67 ± 1.70^{d}	95.53 ± 4.6^{d}	74.2 ± 13.76^{b}	24.47 ± 4.92^{bd}	19.58 ± 1.88^{b}	17.42 ± 2.28^{bc}
Px 30 min Kt	0 mins	112.03 ± 3.89	103.74 ± 3.44^{bd}	109.74 ± 10.63	106.69 ± 7.09^{d}	103.50 ± 5.39^{bd}	77.08 ± 8.85^{b}	29.22 ± 16.59^{bd}	11.82 ± 1.61^{bd}	10.89 ± 1.62^{bd}
	90 mins	100.96 ± 4.96^{d}	104.26 ± 1.60	111.73 ± 63.4^{d}	112.16 ± 6.68^{a}	113.89 ± 8.88^{a}	71.03 ± 16.29^{b}	25.71 ± 11.93^{bd}	11.57 ± 1.34^{bd}	11.04 ± 1.48^{bd}
	2 days	115.80 ± 2.45	110.32 ± 4.25^{b}	119.75 ± 7.28^{a}	119.75 ± 4.68^{a}	114.26 ± 1.49	84.58 ± 13.90^{b}	28.51 ± 9.07^{bd}	11.03 ± 1.00^{bd}	15.91 ± 0.81^{bc}
Px 60 min Kt	0 mins	103.51 ± 13.59	112.15 ± 16.41^{a}	101.63 ± 9.14^{d}	101.64 ± 9.46^{d}	101.38 ± 5.30^{d}	86.28 ± 3.29^{b}	15.3 ± 0.56^{bd}	11.21 ± 0.70^{bd}	9.06 ± 1.94^{bd}
	90 mins	76.98 ± 4.96^{d}	100.31 ± 12.29^{ad}	84.94 ± 7.57^{ad}	91.44 ± 8.98^{ad}	81.68 ± 10.77^{ad}	82.43 ± 7.23^{a}	15.27 ± 0.71^{bd}	11.61 ± 0.74^{bd}	10.46 ± 0.23^{bd}
	2 days	111.68 ± 4.26	112.30 ± 6.89	109.94 ± 4.64^{d}	110.07 ± 1.10^{d}	112.96 ± 8.75	89.70 ± 5.97^{b}	22.72 ± 1.73^{bd}	17.47 ± 1.18^{d}	17.84 ± 2.05^{bc}
Px 120 min Kt	0 mins	93.57 ± 4.24^{d}	94.62 ± 6.77^{d}	94.20 ± 3.13^{d}	94.1 ± 5.84^{d}	94.1 ± 5.84^{d}	87.81 ± 5.37	32.01 ± 3.53^{b}	18.26 ± 2.14^{b}	15.53 ± 1.20^{b}
	90 mins	93.9 ± 3.59^{d}	94.36 ± 3.53^{d}	93.28 ± 4.48^{d}	94.32 ± 5.20^{d}	95.26 ± 7.00^{d}	93.58 ± 5.50	41.89 ± 10.82^{b}	18.07 ± 2.31^{b}	15.52 ± 1.19^{b}
	2 days	114.76 ± 6.18	113.84 ± 3.58	111.98 ± 7.08^{d}	115.89 ± 6.50	115.93 ± 6.11	77.64 ± 16.93^{b}	17.35 ± 7.28^{bd}	13.20 ± 1.25^{bd}	12.55 ± 2.06^{bd}

Table 1: Effects of Piroxicam Co-Administered with Ketamine on erythrocyte osmotic fragility (EOF) Parameters of West African Dwarf (WAD) Goats expressed as Mean ± Standard Error of Mean

Keys: a = Significantly higher ($P < 0.05$) along the row; b = Significantly lower ($P < 0.05$) along the row' c = Significantly higher ($P < 0.05$) along the column d = Significantly lower ($P < 0.05$) along the column

Effects of piroxicam co-administered with ketamine on haematological parameters of west african dwarf (WAD) goats

Table 2 shows the haematological effect of piroxicam-ketamine combinations in West African dwarf goats. The PCV showed a significant increase ($p < 0.05$) in the blood sample collected on day 2 in the groups 3 and 4. The RBC values showed significant increase ($p < 0.05$) in group 3 and a significant decrease ($p < 0.05$) 90 mins post treatment in group 5. The WBC showed a significant ($p < 0.05$) decrease in day 2 blood samples in groups 2,4 and 5 and a significant decrease in the 90 mins samples from groups 3 and 5. The MCV values showed a significant increase in the day 2 samples in all the groups but the 90 mins sample from group 3 showed a significant decrease. A similar pattern was observed in MCH values.

GROUPS		PCV %	RBC × 10^{12}/L	WBC× 10^{12}/L	Hb g/dl	MCV	MCH	MCHC
Kt only	0 mins	26 ± 3.1	11.8 ± 1.2	8.3 ± 3.5	8.7 ± 1.0	22.1 ± 1.4	7.3 ± 0.4	33.3 ± 0.1
	90 mins	28.5 ± 1.5	11.6 ± 1.0	6.3 ± 2.5	9.5 ± 0.5	20.9 ± 0.6	8.3 ± 1.2	33.3 ± 0.0
	2 days	28.7 ± 0.7	10.5 ± 0.5	8.3 ± 2.1	9.5 ± 0.2	27.3 ± 0.6[a]	9.1 ± 0.2[a]	33.2 ± 0.0
Px 15 min Kt	0 mins	26.3 ± 38	12.7 ± 0.5	5.5 ± 0.5[b]	8.8 ± 0.6	20.8 ± 1.5	6.8 ± 0.7	33.1 ± 0.1
	90 mins	26.7 ± 1.8	12.4 ± 0.7	7.6 ± 0.9	8.9 ± 0.6	21.5 ± 0.7	7.2 ± 0.2	33.2 ± 0.2
	2 days	29.7 ± 0.9	11.1 ± 0.8	3.5 ± 0.7[b]	9.9 ± 0.3	26.8 ± 1.5[a]	9.0 ± 0.4[a]	33.2 ± 0.2
Px 30 min Kt	0 mins	29.7 ± 2.8	14.9 ± 1.3[a]	6.0 ± 0.6	9.9 ± 1.0	18.3 ± 0.3[b]	6.6 ± 0.6[b]	33.3 ± 0.0
	90 mins	28.3 ± 0.9	16.8 ± 0.9[a]	4.4 ± 0.1[b]	9.4 ± 0.3	17.1 ± 0.5[b]	5.6 ± 0.2[b]	33.3 ± 0.0
	2 days	30.0 ± 1.6[a]	13.2 ± 0.6[a]	10.5 ± 1.0	10.0 ± 0.4	29.1 ± 3.1[a]	9.2 ± 1.5[a]	33.3 ± 0.1
Px 60 min Kt	0 mins	27.7 ± 38	13.0 ± 2.8	6.3 ± 1.9	9.2 ± 0.7	25.5 ± 3.0[a]	7.5 ± 1.0	33.2 ± 0.0
	90 mins	29.0 ± 1.5	12.2 ± 0.2	8.4 ± 1.3	9.7 ± 0.5	23.8 ± 0.9	8.0 ± 0.3[a]	33.3 ± 0.0
	2 days	30.7 ± 1.8[a]	10.8 ± 1.9	5.5 ± 0.2[b]	10.2 ± 0.6	29.6 ± 3.8[a]	9.9 ± 1.3[a]	33.2 ± 0.0
Px 120 min Kt	0 mins	28.3 ± 1.7	12.6 ± 0.9	12.8 ± 2.4	9.4 ± 0.6	22.6 ± 2.1	7.3 ± 0.5	32.9 ± 0.4
	90 mins	24.3 ± 1.5	9.8 ± 1.9[b]	5.4 ± 1.5[b]	8.1 ± 0.5	21.3 ± 1.5	8.9 ± 1.6	34.4 ± 0.9
	2 days	29.3 ± 1.2	12.7 ± 1.9	5.8 ± 0.5[b]	9.8 ± 0.4	35.9 ± 10.6[a]	8.0 ± 1.1	33.3 ± 0.0

Table 2: Effects of Piroxicam Co-Administered with Ketamine on Haematological Parameters of West African Dwarf (WAD) Goats expressed as Mean ± Standard Error of Mean.

Keys: a = Significantly higher ($P < 0.05$) along the column; b = Significantly lower ($P < 0.05$) along the column.

Effects of piroxicam co-administered with ketamine on differential white blood cell count of west african dwarf (WAD) goats

The differential white blood cell count in West African dwarf goats treated with piroxicam-ketamine combination is shown in table 3. There was a significant ($p < 0.05$) increase in lymphocyte count in groups 1, 2 and 5. Group 3 showed a significant decrease in lymphocyte values in 2 days post treatment sample. The neutrophils values were significantly ($p < 0.05$) decreased in groups 1,2 and 3 and then a significant ($p < 0.05$) increase in group 3 in the day 2 sample. The values of basophils significantly ($p < 0.05$) increased in groups 2, 3 and 4 while monocytes decreased significantly in groups 2 and 4.

Groups		LYMP	NEUT	EOS	BASO	MONO
Kt only	0 mins	62.3 ± 3.7	31.7 ± 2.7	2.0 ± 0.0	0.0 ± 0.0	4.0 ± 1.0
	90 mins	60.0 ± 0.0	33.0 ± 0.0	2.0 ± 0.0	0.0 ± 0.0	5.0 ± 0.0
	2 days	67.0 ± 1.5[a]	25.3 ± 1.8[b]	2.7 ± 0.9	0.3 ± 0.3	4.7 ± 0.3
Px 15 min Kt	0 mins	66.7 ± 1.3[a]	28.0 ± 1.2	2.7.0 ± 0.7	0.0 ± 0.0	2.7 ± 1.8[b]
	90 mins	64.0 ± 1.2	30.0 ± 1.2	1.7 ± 0.7	0.0 ± 0.0	3.7 ± 0.7
	2 days	71.7 ± 1.7[a]	23.3 ± 1.8[b]	1.7 ± 0.9	1.0 ± 0.6[a]	2.3 ± 0.3[b]
Px 30 min Kt	0 mins	67.3 ± 0.9[a]	27.7 ± 1.2[b]	2.3 ± 0.9	0.0 ± 0.0	2.7 ± 0.7[b]
	90 mins	70.7 ± 0.7[a]	24.0 ± 0.8[b]	1.7 ± 0.3	0.7 ± 0.3[a]	3.0 ± 0.0
	2 days	57.3 ± 1.2[a]	36.0 ± 1.5[a]	2.7 ± 0.9	0.0 ± 0.0	4.0 ± 1.2
Px 60 min Kt	0 mins	54.0 ± 4.6[b]	37.3 ± 5.7	2.3 ± 1.9	3.3 ± 0.7[a]	1.3 ± 1.0[b]
	90 mins	63.0 ± 1.7	32.3 ± 2.2	1.0 ± 0.6[b]	0.5 ± 0.4[a]	3.0 ± 1.6[b]
	2 days	63.3 ± 2.0	30.0 ± 1.7	2.3 ± 0.9	0.0 ± 0.0	4.3 ± 1.2
Px 120 min Kt	0 mins	58.7 ± 1.9	35.0 ± 0.6	3.7 ± 0.9	0.7 ± 0.3[a]	4.7 ± 0.3
	90 mins	67.7 ± 3.4[a]	27.0 ± 3.5	1.7 ± 0.3	0.7 ± 0.7	3.0 ± 0.6
	2 days	65.7 ± 2.0	29.7 ± 2.0	1.7 ± 0.3	0.0 ± 0.0	3.7 ± 0.7

Table 3: Effects of Piroxicam Co-Administered with Ketamine on Differential White Blood Cell Count of West African Dwarf (WAD) Goats expressed as Mean ± Standard Error of Mean.

Keys: a = Significantly higher (P < 0.05) along the column; b = Significantly lower (P < 0.05) along the column.

Effects of piroxicam co-administered with ketamine on biochemical parameters of west african dwarf (WAD) goats

Table 4 shows the effect of piroxicam-ketamine combinations on biochemical parameters of West African dwarf goats. Total protein was significantly ($p < 0.05$) increased in groups 4 and 5 while groups 1 and 2 showed a significant decrease. Globulin significantly ($p < 0.05$) decreased in groups 1, 2 and 4. While A/G ration increased significantly in all the groups except in group 3. There was a significant increase in AST level in all the groups but it lasted for only 90min in group 1. ALT level showed a significant ($p < 0.05$) decreased level in all the groups treated except in group 1 on 2 days post treatments. ALP significantly ($p < 0.05$) decreased in all the groups except in group 3 which had an initial increase then decrease. Bilirubin was significantly ($p < 0.05$) decreased in all the groups with the exception of group 1 which showed an increase. Creatinine was significantly increased in all the groups.

GROUPS		T. prot g/dL	Albumin g/dL	Globulin g/dL	Alb/Glo Rat g/dL	AST µg/L	ALT µg/L	ALP µg/L	Bili mg/dL	Urea mg/dL	Creat mg/dL
Kt only	0 mins	4.55 ± 1.65	2.05 ± 1.20	2.50 ± 0.45	0.82 ± 0.38	64.60 ± 5.20	64.55 ± 5.25	28.4 ± 3.80	0.25 ± 0.05	39.45 ± 10.08	0.36 ± 0.34
	90 mins	3.03 ± 0.55[b]	1.83 ± 0.13	1.20 ± 0.42[b]	1.54 ± 0.31[a]	93.73 ± 19.90[a]	30.83 ± 6.83[b]	32.17 ± 12.93	0.29 ± 0.16	26.7 ± 0.64[b]	1.90 ± 0.40[a]
	2 days	4.73 ± 0.41	2.30 ± 0.23	2.43 ± 0.18	0.95 ± 0.78	65.83 ± 33.95	76.77 ± 13.97	16.2 ± 1.00	0.83 ± 0.18	21.70 ± 3.82	2.00 ± 0.36

Px 15 min Kt	0 mins	5.60 ± 1.32	3.10 ± 0.85	2.50 ± 0.47	1.24 ± 0.55[a]	103.53 ± 16.90[a]	52.53 ± 21.00[b]	17.37 ± 0.97[b]	0.15 ± 0.13	49.9 ± 21.69[a]	0.33 ± 0.23
	90 mins	3.43 ± 0.43[b]	2.00 ± 0.15	1.43 ± 0.28[b]	1.40 ± 0.54	94.60 ± 20.10[a]	54.07 ± 17.84[b]	20.37 ± 1.69[b]	0.05 ± 0.02[b]	32.27 ± 7.59	0.43 ± 0.28
	2 days	4.33 ± 0.03	2.33 ± 0.15	2.00 ± 0.12	1.17 ± 0.80	129.67 ± 27.07[a]	62.23 ± 11.81	15.27 ± 0.38[b]	0.53 ± 0.19	35.90 ± 5.87	2.03 ± 0.18[a]
Px 30 min Kt	0 mins	6.43 ± 0.63	2.43 ± 0.18	4.00 ± 0.45[a]	0.61 ± 0.40[b]	51.17 ± 4.07[b]	31.40 ± 9.61[b]	41.43 ± 3.15[a]	0.2 ± 0.06[b]	39.70 ± 1.37	2.27 ± 0.39[a]
	90 mins	6.27 ± 0.18	3.03 ± 0.13	3.24 ± 0.05[a]	0.94 ± 0.38	91.30 ± 2.50[a]	30.83 ± 5.19[b]	43.30 ± 1.04[a]	0.13 ± 0.09	30.97 ± 12.56	1.80 ± 0.98
	2 days	5.03 ± 0.15	2.63 ± 0.12	2.40 ± 0.03	1.10 ± 0.25	94.77 ± 18.37[a]	46.77 ± 13.35[b]	16.87 ± 1.49[a]	0.57 ± 0.15[b]	44.43 ± 15.99	3.83 ± 0.26[a]
Px 60 min Kt	0 mins	5.53 ± 0.22[a]	3.17 ± 0.03	2.36 ± 0.19	1.34 ± 0.16[a]	56.77 ± 21.49[b]	59.90 ± 4.97	27.90 ± 4.50	0.47 ± 0.24	36.37 ± 1.33	2.27 ± 1.16[a]
	90 mins	5.47 ± 0.52[a]	3.90 ± 0.76[a]	1.57 ± 0.24[b]	2.48 ± 0.32[a]	78.43 ± 12.78[a]	59.90 ± 10.16	27.40 ± 4.88	0.44 ± 0.21	34.23 ± 0.73	1.93 ± 0.81[a]
	2 days	6.40 ± 0.55[a]	2.50 ± 0.12	3.90 ± 0.43[a]	0.64 ± 0.28	97.70 ± 6.28[a]	42.33 ± 20.38[b]	14.97 ± 0.67[b]	0.40 ± 0.51	23.20 ± 4.42[b]	2.27 ± 1.10[a]
Px 120 min Kt	0 mins	5.13 ± 0.22[a]	2.53 ± 0.18	2.60 ± 0.04	0.97 ± 0.22	82.03 ± 14.09[a]	62.8 ± 7.87	17.8 ± 1.25[b]	0.47 ± 0.24	36.10 ± 6.52	2.87 ± 0.79[a]
	90 mins	5.13 ± 0.41[a]	2.60 ± 0.03	2.53 ± 0.38	1.03 ± 0.08	104.73 ± 12.50[a]	73.3 ± 7.62	15.23 ± 0.44[b]	0.44 ± 0.21	31.57 ± 2.98	2.03 ± 0.54[a]
	2 days	4.93 ± 0.13	2.57 ± 0.15	2.36 ± 0.02	1.09 ± 0.13	86.47 ± 15.57[a]	47.67 ± 5.82[b]	15.20 ± 0.57[b]	0.40 ± 0.51	39.3 ± 4.17	1.53 ± 0.55[a]

Table 4: Effects of Piroxicam Co-Administered with Ketamine on Biochemical Parameters of West African Dwarf (WAD) Goats expressed as Mean ± Standard Error of Mean.

Keys: a = Significantly higher ($P < 0.05$) along the column; b = Significantly lower ($P < 0.05$) along the column.

Discussion

The erythrocyte osmotic fragility values obtained in this study agrees with the result of Oyewale [15] who studied the effect of pH and temperature on fragility of goat's erythrocyte indicating that factors that affect the normal physiology of the body like pH, temperature and drugs can alter the stability of erythrocytes. Thus the fragility value of the goats erythrocytes at 0.7 M were higher when only ketamine was administered but this was ameliorate with piroxicam pre-treatment especially in the group with treatment interval of 30 and 60 mins. The increase fragility at 0.9 M in group 5 can be attributed to the substantial metabolism of piroxicam before administration of ketamine; resulting in reduced ameliorative effect of piroxicam. This result also suggests that goat's erythrocyte membrane were adversely affected by ketamine but the ketamine effect was ameliorated with pre-treatment with piroxicam. This high fragility value of goat erythrocytes could be attributed to the lower value of goat MCV which enables it to accumulate large hypotonic solution leading to critical haemolytic volume and eventual haemolysis Olusanya and Adepoju [16]. This increase fragility values in goats has also been reported by Olusanya and Adepoju [16]. Drugs as weak acids and bases have capacity to affect the erythrocyte membrane stability. Minka and Ayo [17] reported an increase in fragility values in goats transported by roads but the increased fragility was ameliorated with pre-treatment vitamin C.

The increase in PCV, RBC, WBC MCV and MCH observed in the group administered ketamine 15 min after piroxicam treatment suggest a possible effect of drug piroxicam-ketamine interaction on blood storage organs like spleen and bone marrow causing an immediate increase in red blood cell volume. The increased MCV and MCH values seen in the group administered ketamine 15 min after piroxicam could equally be due to haemolysis of erythrocytes. The marginal decrease in PCV value in the group administered ketamine 120 min after piroxicam, may be attributable to the decreasing effect of piroxicam. These changes may be due to possible stress factors associated with anaesthetic recovery [18]. Bennet., *et al.* [19] reported a decrease PCV and RBC in dogs administered ketamine. The decrease in RBC and WBC found in the 120 min treatment interval and the decrease in WBC, and MCH observed in the 60 min treatment interval could be attributed to the cellular damage caused by ketamine/piroxicam. Bennet., *et al.* [19] reported both leucoytosis and leucopenia in dogs while Gweba., *et al.* [20] reported decreased PCV and Hb as well as slight increased WBC after xylazine administration in goats. Venkatesan., *et al.* [21] reported decreased PCV, RBC, Hb, MCV, WBC, and MCH in female Bonnet Macaques as a result of stress leading to sequestration of much volume of blood into the spleen. Abatan., *et al.* [22] also reported a slight increase in WBC counts in rats treated with piroxicam. Anaesthesia caused decreased WBC and RBC values, as a result of depression of cardiovascular function [18]. There was a marked increase in lymphocyte across all the groups expect the 15 min piroxicam-ketamine group suggesting that ketamine has immunostimulatory effect leading to lymphocytosis. Neutrophils were increased also in ketamine and piroxicam 15 min group compared to ketamine group and there was neutropaenia observed in the 60 min and 120 min ketamine-piroxicam combination groups, which could be attributed to the immunistimulatory effect of ketamine and a possible antagonism of this effect by piroxicam. There was eosinopaenia, basopaenia and monocytopaenia observed in 60 min and 120 min treatment interval groups indicating an antagonistic effect of piroxicam on ketamine. This basophilia, basopenia and monocytopenia may be attributed to leucopenia as reported in aged bonnet macaques [21]. Ismail., *et al.* [23] reported a significant leucocytosis and neutrophilia and polycythemia 24h after recovery of sheep from anaesthesia.

The increased total protein, globulin and albumin-globulin ration seen in ketamine pre-treated with piroxicam after 30 min, 60 min and 120 min more than the ketamine only group showed that piroxicam affected the plasma protein binging capacity of ketamine. Dayton [24]. reported a 47% binding capacity for ketamine while piroxicam has a 99% binding capacity The increased AST levels in all the groups, showed that both piroxicam and ketamine could be harmful to the hepatocytes. Piroxicam antagonistism to ketamine seen in ALT level 120 min post piroxicam administration may be used as marker of recovery from ketamine anaesthesia in goats. Ismail., *et al.* [21] reported normal total protein values in sheep and goats after recovery from anaesthesia. Liver enzymes including AST and ALP showed no significantly changes in sheep and goats following xylazine–ketamine–diazepam anesthesia. Decrease in ALT and ALP levels observed in the group treated with ketamine 30 min 60 min and 120 min after piroxicam treatment may suggest a possible protective effect of the piroxicam on skeletal muscles and hepatocytes. The observed increased levels of creatinine could be attributed to the nephrotoxic effect of piroxicam ketamine drug combination. Zuhair and Khaleel (26) observed no significant changes in creatinine level when ketamine was administered with diazepam. Also Ukwueze., *et al.* [27] observed no significant changes in creatinine level when ketamine was administered with propofol or xylazine. In detomidine-midazolam-ketamine combination for umbilical surgery in calves, creatinine and ALT were increased significantly [28]. Although the urea and bilirubin levels were not conspicuously changed in both control and experimental groups the effect of piroxicam on ketamine-induced increase in creatinine level, suggest that the piroxicam has nephroprotective effect. Lugo-Roman., *et al.* [29] reported low bilirubin and creatinine but increased ALT in rhesus macaque. All the changes in values were observed to still be within the normal ranges of these parameters.

Conclusion

The rates of erythrocyte osmotic fragility suggest that piroxicam could be used to alleviate the osmotic stress induced by ketamine and other possible stressors. The increase in PCV, RBC, MCV, and MCH suggests potential haematinic effect of the drugs. The decrease in WBC, neutropaenia, eosinopaenia and monocytopaenia; and the lymphocytosis and basophilia suggest the immunomodulatory effect of ketamine, uninhibited by the presence of piroxicam. The increase in creatinine suggests nephro-toxic effect of piroxicam on kidney tissue.

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