GAVIN PUBLISHERS

Journal of Pharmacovigilance and Pharmacotherapeutics

Medani AB, et al. J Pharmacovigil Pharm Ther: JPPT-110.

DOI: 10.29011/JPPT-110. 100110

Research Article

Risk Assessment of PolyDADMAC in Drinking Water

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Citation: Medani AB, El Badwi SMA, Amin AE (2017) Risk Assessment of Poly DADMAC in Drinking Water. J Pharmacovigil Pharm Ther: JPPT-110. DOI: 10.29011/JPPT-110. 100110

Received Date: 25 May, 2017; **Accepted Date:** 17 July, 2017; **Published Date:** 24 July, 2017

Abstract

The Effect of the oral doses of Poly DADMAC on Nubian goats was examined. Goat kids were divided into three groups, group 1 were undoes the control that received Nile water as their sole source for drinking purposes. Poly DADMAC was given in drinking water to goat kids at 15 and 20 mg/kg bwt/day for 10 weeks. Difficult respiration, staggering gait in goats that received a daily dose of 15 mg/kg/day (group 2) with mortality rate of 33.3%Remarked dullness and frequent urination were seen in goat that were receiving a daily dose of 20 mg/kg/day (group 3) those goats were also suffering from difficulty in respiration, arched posture and finally recumbency with mortality rate of 66.6%. Chemical investigations included enzymatic activities of ALP, AST, CK, ALT and LDH and metabolic changes of albumin, urea, total protein, cholesterol, Bilirubin, glucose and creatinine were detected. The serum concentrations of GPT, LDH, Creatinine, Urea and CK, showed significant increase ($P<0.05$-$P<0.001$) and on microscopy, Hemorrhagic Lungs, Inflamed Hearts and Intestines in Addition to Necrosis of the Renal Tubules and livers were spotted with blood. In conclusion, Poly DADMAC was found to be toxic to Nubian goats. These findings were in consistent with our previous study that proved toxicity of both Alum and Poly DADMAC to New Zealand rabbits and toxicity of Alum to Nubian goats.

Keywords: Drinking Water Treatment Chemicals; Nubian Goats; Poly DADMAC; Ruminants

Introduction

Poly DADMAC with the chemical name, Polydiallydimethyl-Ammonium Chloride, is one of several synthetics and cationic organic poly-electrolytes which are used widely in drinking water treatment Polyelectrolyte Products used in the water supply industry may contain in addition to polyelectrolyte, measurable amounts of certain contaminants like Dimethylamine, Allylchloride and Diallylether [1,2].

Objectives: To investigate the toxic effect of PolyDADMAC at 15 and 20 mg/kg to Nubian goat kids.

Materials and Methods

Nine (5-7) months old male Nubian goat kids were used, the animals were allotted randomly to three groups. Goat kids of group 1 were the undosed controls. Poly DADMAC was obtained from Khartoum Water Corporation at El Mugran and given at 15 mg/kg/day to goats of group 2 and 20 mg/kg/day to goats of group 3. Doses were dissolved in Nile water and administered orally by bottles.

Dosing was contuined for 10 weeks.Serum was analysed for the Activities of Aspartate Transaminase (AST), Alanine Transaminase (ALT), Alkaline Phosphatase (ALP), Lactate Dehydrogenase (LDH), Creatinine Kinase (CK), and for the concentration of urea, uric acid, total protein,albumin,glucose, creatinine and cholesterol.

Histopathological examination were done for specimens of liver, kidneys, heart, spleen, lung and intestine.The mean values±SEM was calculated for each parameter. Results were statistically analysed by Students - t-test .

Results and Discussion

Goats of group 2, showed staggering gait, difficult respiration and mortality of 33.3%, while goats of group 3 stand with arched back (Figure 1) and were examining difficult respiration, Anorexia with mortality rates of 66.6%.

Figure 1: Arched back in a goat of group 3.

Table 1 and 2 showed the serum concentrations of AST, ALT and LDH which were significantly increase (P<0.01-P<0.001) in the two groups and serum concentrations of ALP were decreased (P<0.05) in both group compared to the control group. On the other hand, there were significant increase (P<0.01)-P<0.01) in both group in urea and creatinine. Other parameters showed no significant difference from undo control.

Group No	ALP (i.u/l)	AST (i.u/l)	CK(i.u/l)	ALT(i.u/l)	LDH (i.u/l)
G_1	151.38± 3767	33.81± 4.43	1.90± 0.26	18.37± 1.61	40.80± 0.35
G_2	103.90± 17.24*	137.70± 9.12**	3.90± 1.14*	38.09± 2.09**	71.27± 0.76***
G_3	114.20± 9.11*	159.00± 5.30***	2.33± 0.29*	42.37± 3.06**	61.10± 2.11**
Values are expressed as means±S.E; * = P≤0.05; **= P≤0.01; ***= P≤0.05; G1=control; G2= 15 mg/kg polyDADMAC; G3 = 20 mg/kg polyDADMAC					

Table 1: Analysis of variance and means±S.E of enzyme levels of serum of goats treated with polyDADMAC.

Group No	Albumin(mg/dl)	Uric acid(mg/dl)	Urea (mg/dl)	Total protein(mg/dl)
G_1	3.01±0.37	0.92±0.13	35.35±4.37	5.47±0.75
G_2	2.90±0.25$^{N.S}$	0.84±0.00$^{N.S}$	75.82±5.05**	5.16±0.36$^{N.S}$
G_3	3.73±0.47$^{N.S}$	1.17±0.64$^{N.S}$	79.47±0.74***	3.45±0.75$^{N.S}$
Values are expressed as means±S.E; NS= Not significant; * = P≤0.05; **= P≤0.01; ***= P≤0.05; G1=control; G2=15 mg/kg polyDADMAC; G3 = 20 mg/kg polyDADMAC.				

Table 2: Analysis of variance and mean ± S.E of metabolite levels of serum of goats treated with polyDADMAC.

Continued:

Group No	Bilirubin (mg/dl)	Glucose (mg/dl)	Creatinine (mg/dl)	Cholesterol (mg/dl)
G_1	0.18±1.25	31.08±0.87	0.21±0.04	38.10±3.59
G_2	0.36±0.62$^{N.S}$	41.07±4.95$^{N.S}$	0.58±0.04*	37.40±3.94$^{N.S}$
G_3	0.22±0.30$^{N.S}$	36.11±2.05$^{N.S}$	0.48±0.01**	30.43±3.73$^{N.S}$
Values are expressed as means±S.E; NS= Not Significant; *= P≤0.05; **= P≤0.01; ***= P≤0.05; G1=control; G2=15 mg/kg polyDADMAC; G3 = 20 mg/kg polyDADMAC.				

Table 2: Analysis of variance and means±S.E of metabolite levels of serum of goats treated with polyDADMAC

Histopathological, the liver of goats of group 2, Showed centrilobular necrosis of the hepatocytes, shrinkage of glomeruli accompanied by necrosis of the medullar tubules, haemosiderosis in the spleens, emphysema accompanied by lymphocyte infiltration in the lungs and congestion and sloughing of epithelium of the intestines. Emphysema and haemorrhage were the main signs showed by lungs of goats of group 3, (Figure 2), Spleens Showed Slight congestion and bloody spots, livers showed fatty change, congestion in the central vein and in the portal tract with focal necrosis, (Figure 3). Kidneys showed severe haemorrhage in the medulla accompanied by necrosis in the cortex and medullar tubules and the intestines showed catarrhal inflammation.

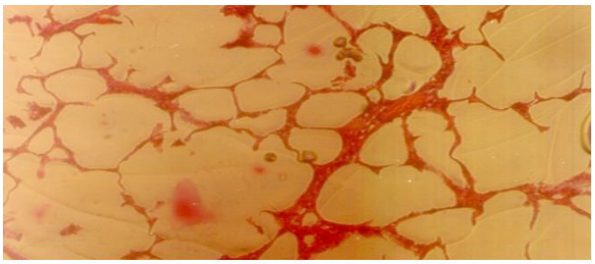

Figure 2: Lung of a goat of group 3, showed severe emphysema, edema and lymphocyte infiltration.

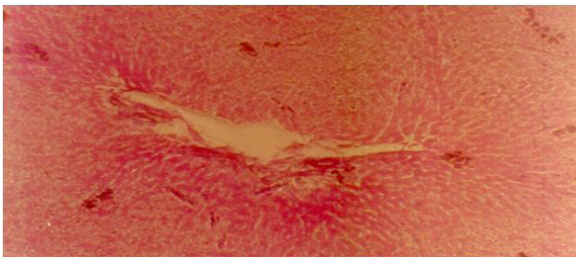

Figure 3: Fatty change, congestion in the central vein and in the portal tract with focal necrosis in liver of goat of group 3.

The elevated activities of AST, LDH, ALT and CK, accompanied by centrilobular necrosis and generalized fatty changes, are suggestive of hepatic excretory dysfunction and damage [3,4]. The increase urea and creatinine in addition to Renal Hemorrhages, Congestion, Necrosis, Shrinkage Glumeruli and the Arched Posture, were positive indicators of renal toxicity caused by the irritant polymer or its metabolites. Splendid Haemosiderosis is may be indicating the destruction of Erythrocytes. Pulmonary disorders, attributed to the direct irritant action of the drug or its metabolites on the lung. The presence of hemorrhages in different organs suggests that the polyDADMAC is an Endotheliotoxic substance.

Conclusion

Poly DADMAC was found to be toxic to Nubian goats. These findings were in consistent with our previous study, that proved toxicity of both Alum and Poly DADMAC to New Zealand Rabbits [5] and toxicity of Alum to Nubian goats [6,7].

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