RESEARCH ARTICLE

Effect of Water Restriction and Rehydration on Haemato-Biochemical, Enzymatic and Hormonal Activity of Hoggets during Summer Season

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Abstract

Present experiment was conducted with the objective to study the effect of water restriction and rehydration on haemato-biochemical, hormonal and enzymatic activity of indigenous sheep under intensive production system. Eighteen farm born unshorn hoggets (25-30 kg) of Patanwadi and Marwari breeds were randomly distributed in to three treatment groups on the basis of body weight comprising of six in each group *viz.*, T_1 Control (*ad libitum* water), T_2 (20% water restriction) and T_3 (40% water restriction). The experiment was conducted in summer season for 30 days *i.e.* 28 days of water restriction and 2 days of rehydration phase. The feed, in accordance with physiological and production needs of the animals, was offered twice a day (09:00 and 18:00 hrs). Water intake was recorded thrice a day (09:00, 14:00 and 19:00 hrs) and blood samplings was done on day 0, day 28 and after 48 hrs of rehydration. The values of haemoglobin, were significantly decreased, while, serum urea, uric acid, alkaline phosphatase, creatinine phosphokinase, cortisol, triiodothyronine and aldosterone were significantly ($p < 0.05$) increased in water restricted groups of animals on 28th day, with significant improvement in values on 48 hrs of rehydration in most of the traits. However, the decrease in glucose was non-significant between 0 and 28 days and no change was noted in thyroxin levels due to water restriction or rehydration. It indicated that water restriction resulted significant changes in blood variables of hoggets. Blood variables recovered significantly after 48 hr of rehydration, but the serum cortisol, urea, AKP, CPK and T_3 values till did not attain normalcy, thereby demonstrating that the animals did not recover completely from dehydration stress.

Keywords: Blood profile, Hogget, Rehydration, Summer, Water restriction

Ind J Vet Sci and Biotech (2021): 10.21887/ijvsbt.17.2.9

Introduction

Small ruminants are an integral part of farming systems in the arid and semi-arid regions of the world. These areas are characterized by fluctuating precipitation, water scarcity and unpredictable weather. Irregular rainfall of these areas leads to limited availability of water (Iniguez, 2005). Drinking water is an important requirement for livestock and the lack of a sufficient source of water can be a critically limiting factor in animal physiology and productivity (Alamer, 2010). Animals living in deserts and arid regions have acquired various adaptation mechanisms and are able to maintain a high water economy by efficiently using their bodily reserves; therefore, the production performance of such animals are maintained within an acceptable range during periods of water scarcity. Compared to other species, ruminants are more resistant to the effects of dehydration, because of a energy deficiency as a result of the reduced intake of dry matter (Casamassima *et al*., 2016).

Water restriction in warm environment leads to increased haemoglobin level due to haemoconcentration (Li *et al*., 2000). The study carried out on water-restricted Comisana sheep revealed a significant increase of some blood metabolites like sodium, creatinine, urea and potassium (Casamassima *et al*., 2008). The transfer function of the kidney is also altered under water stress with slower glomerular filtration and higher urea re-absorption (Kataria and Kataria, 2007). The present study was aimed at investigating blood variables in intensively reared indigenous sheep in response to different levels of water restriction in summer season under intensive production system.

Materials and Methods

The experiment was conducted at Livestock Farm Complex, College of Veterinary Science and Animal Husbandry, AAU,

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How to cite this article: Patel, N.R., Modi, R.J., Islam, M., & Wadhwani, K.N. (2021). Effect of Water Restriction and Rehydration on Haemato-Biochemical, Enzymatic and Hormonal Activity of Hoggets during Summer Season. Ind J Vet Sci and Biotech, 17(2): 48-51.

Source of support: Nil

Conflict of interest: None.

Submitted: 12/11/2020 **Accepted:** 21/05/2021 **Published:** 25/06/2021

Anand (Gujarat) in summer season (May-June). During the trial, maximum and minimum temperature was 41.5 °C and 25.5 °C, respectively. Eighteen Patanwadi and Marwari hoggets (25-30 kg) were selected as experimental animals and randomly divided into three treatment groups on the basis of body weight, *viz.*, T_1 Control group (*ad. lib.* water), T_2 (20% water restriction), and T_3 (40% water restriction). In T_1 group, measured quantity of water was offered *ad libitum* at 9.00, 14.00 and 19.00 h, while in T_2 and T_3 groups water was offered only once at 9.00 h. The water intake of experimental animals was assessed individually by offering *ad libitum* water of known quantity using measuring cylinder during the adaptation period of 15 days, and this formed the basis for 20% and 40% restriction of water in treatment groups subsequentky. Each treatment comprised of six animals and duration of experiment was 30 days, *i.e.,* 28 days of water restriction and after that 48 hr of rehydration phase. During rehydration phase, *ad libitum* but measured quantity of water was offered to all the animals and leftover also measured to calculate actual amount of water intake.

Measured quantity of wheat straw was offered twice a day *ad libitum i.e.,* at 9.00 and 18.00 hrs, and 250 gm of concentrate was offered at 8:30 am to all the animals during entire experiment. Leftover of wheat straw was measured on next day morning to calculate actual intake. Blood samples were taken from fasting animals at 07:00 am at Day 0 & 28 of water restriction, and after 48 hr of rehydration. The whole blood was used to estimate haemoglobin (g/dl) and PCV (%) by using automated blood cell counter (Mindray – BC -2800 VET). Serum glucose (GOD/POD method), urea (GLDH kinetic method) and uric acid (uricase) concentrations were estimated using kit provided by Coral Clinical Systems, India. Serum alkaline phosphatase and creatine phosphokinase were measured using commercial kits supplied by Cayman, USA. Serum triiodothyronine (T3), thyroxin (T4), cortisol and aldosterone concentrations were estimated by standard RIA technique. RIA kits were procured from Immunotech - SAS © 2016, Beckman Coulter, Inc. Marseille, France. The results of the experiment were expressed as means ± SEs and were analyzed by factorial CRD (Snedecor and Cochran, 1994).

Results and Discussion

The results on the effect of water restriction and rehydration on different haemato-biochemical parameters of hoggets are presented in Table 1. The values of haemoglobin and PCV were significantly ($p < 0.05$) decreased from Day 0 to Day 28 in experimental animals maintained under 20% and 40% water restriction as compared to control group, and then improved to near normal values after 48 hr of rehydration. Significant ($p < 0.05$) decrease in haemoglobin concentration has been reported in goats after 72 hrs of water restriction (Adogla and Aganga, 2000), 30 to 50% water restriction in male goats (Ajibola, 2006) and once in three days watering in Awassi ewes (Hamadeh *et al.*, 2006). Alamer (2006) reported mild effect of water deprivation on PCV during the first day, but it showed a steady and significant ($p < 0.05$) increase as the water deprivation period advanced. This may be due to haematic concentration induced by water restriction (Hamed *et al.*, 2007; Gupta, 2013). In our study, the haemoglobin and PCV recovered significantly ($p < 0.05$) after 2nd day of rehydration in water restricted groups of animals.

The serum glucose values were statistically similar among three groups on all three days, and on 28th day in particular, which concurred with Abdelatif *et al*. (2010) and Gupta (2013). However, serum glucose levels were decreased non-significantly on 28th day in 20% and 40% water restricted groups over zero day, and were improved again after 48 hr of rehydration at par with zero day values due to increased feed intake after rehydration. Serum urea levels were significantly ($p < 0.05$) increased in water restricted groups of animals, which dropped down significantly ($p < 0.05$) after 48 h of rehydration in hoggets maintained on 20% and 40% water restriction but still the values were higher than normal levels

Table 1: Hemato-biochemical variables of control and water-restricted hoggets

Variables	*T_1 (Control)*	*T_2 (20% water restriction)*	*T_3 (40% water restriction)*
Hb (g/dl)			
Day 0	11.23 ± 0.55	11.17^{X} ± 0.32	10.37^{Y} ± 0.37
Day 28	11.43^{A} ± 0.32	9.33^{BY} ± 0.81	8.77^{BZ} ± 0.10
48 hr after RH	11.63^{A} ± 0.16	10.93^{BX} ± 0.28	11.07^{ABX} ± 0.08
PVC (%)			
Day 0	33.70 ± 1.64	33.50^{X} ± 1.51	31.10^{Y} ± 1.11
Day 28	34.30^{A} ± 0.96	28.00^{BY} ± 0.51	26.30^{BZ} ± 0.29
48 hr after RH	34.90^{A} ± 0.48	32.80^{BX} ± 0.83	33.20^{ABX} ± 0.25
Glucose (mg/dl)			
Day 0	32.00 ± 0.93	29.33^{XY} ± 1.71	29.33^{XY} ± 1.23
Day 28	30.33 ± 0.95	27.17^{Y} ± 0.79	28.17^{Y} ± 1.54
48 hr after RH	32.33 ± 0.99	31.50^{X} ± 0.72	31.67^{X} ± 0.67
Urea (mg/dl)			
Day 0	23.50^{B} ± 0.67	23.17^{BZ} ± 0.79	25.50^{AZ} ± 0.76
Day 28	28.67^{B} ± 0.42	37.33^{AX} ± 0.67	38.67^{AX} ± 1.67
48 hr after RH	24.50^{B} ± 0.99	31.00^{AY} ± 0.45	32.67^{AY} ± 0.84
Uric acid (mg/dl)			
Day 0	0.53 ± 0.03	0.55^{Z} ± 0.04	0.57^{Y} ± 0.15
Day 28	0.80 ± 0.10	1.60^{X} ± 0.04	1.58^{X} ± 0.08
48 hr after RH	0.68 ± 0.10	0.93^{Y} ± 0.11	0.62^{Y} ± 0.14

RH-rehydration, Values with superscripts A, B within a row differ significantly ($p < 0.05$).
Values with different superscripts (X,Y,Z) within a column differ significantly ($p < 0.05$).

Table 2: Enzymatic and hormonal variables of control and water-restricted hoggets

Variables	T_1 (Control)	T_2 (20% water restriction)	T_3 (40% water restriction)
Alkaline Phosphatase (U/L)			
Day 0	49.00 ± 2.00	45.67^{Y} ± 1.61	42.83^{Y} ± 0.70
Day 28	61.50 ± 1.43	57.83^{X} ± 2.27	61.83^{X} ± 1.58
48 hr after RH	55.67 ± 2.14	58.00^{X} ± 3.21	59.00^{X} ± 2.18
Creatinine Phosphokinase (U/L)			
Day 0	45.00 ± 3.34	46.33^{Y} ± 3.09	51.67^{Y} ± 1.63
Day 28	47.00^{B} ± 1.77	60.33^{AX} ± 4.39	62.00^{AX} ± 2.11
48 hr after RH	50.83 ± 6.26	63.17^{X} ± 4.39	61.33^{X} ± 1.56
Cortisol (ng/ml)			
Day 0	65.33 ± 3.81	71.50^{Z} ± 3.12	60.83^{Z} ± 2.29
Day 28	93.00^{C} ± 9.16	124.00^{BX} ± 12.27	169.00^{AX} ± 3.21
48 hr after RH	97.33 ± 7.94	101.67^{Y} ± 7.99	109.33^{Y} ± 5.70
Triiodothyronine (ng/ml)			
Day 0	1.51 ± 0.22	1.31^{Y} ± 0.16	1.43^{Z} ± 0.22
Day 28	1.36 ± 0.44	1.70^{XY} ± 0.28	1.85^{YZ} ± 0.19
48 hr after RH	1.35 ± 0.25	2.07^{X} ± 0.25	2.45^{X} ± 0.12
Thyroxin (ng/ml)			
Day 0	58.67 ± 6.14	54.50 ± 4.87	56.67 ± 2.62
Day 28	65.17 ± 6.66	55.92 ± 7.83	64.33 ± 8.64
48 hr after RH	60.33^{AB} ± 8.21	49.00^{B} ± 5.60	70.67^{A} ± 6.01
Aldosterone (ng/ml)			
Day 0	13.50 ± 1.36	13.83^{Y} ± 0.83	14.17^{Y} ± 1.08
Day 28	15.33^{B} ± 2.25	37.33^{AX} ± 2.94	43.67^{AX} ± 5.60
48 hr after RH	17.50 ± 0.99	19.83^{Y} ± 2.89	24.00^{Y} ± 2.88

RH-rehydration, Values with superscripts A, B within a row differ significantly ($p < 0.05$).
Values with different superscripts (X,Y,Z) within a column differ significantly ($p < 0.05$).

on day zero. The significant ($p < 0.05$) increase in serum urea concentration in the experimental animals under 40% water restriction is attributed to haematic concentration of metabolites that leads to the inability of the kidney to perform its function (Casamassima *et al*., 2016). It may also partially be related with increase in secretion of hormone angiotensin and vasopressin which are released from neurohypophysis in response to dehydration and increase permeability of collecting ducts of kidneys and thereby promote urea reabsorption in the kidneys and reduce loss of urea concentration (Meintjes and Engelbrecht, 1999). In earlier studies also, the water deprivation was associated with significant ($p < 0.05$) increase in serum urea concentration (Alamer, 2006; Hamadeh *et al*., 2006; Abdelatif *et al*., 2010; Gupta, 2013; Khanvilkar *et al.* 2017[b]). The values of serum uric acid were statistically comparable on day 0 and 48 of rehydration among three groups, but on day 28, they were significantly increased in 20 and 40% water restricted groups. The values dropped down significantly ($p < 0.05$) after 48 hr of rehydration, yet had higher values than the zero day values. Gupta (2013) and Khanvilkar *et al.* (2017[b]) also reported significantly ($p < 0.05$) increased uric acid concentration under 20 to 50% water restriction in sheep.

Perusal of Table 2 indicated that values of alkaline phosphatase activity were comparable among treatment groups on different days, and increased significantly in 20% and 40% water restriction groups at 28 days. Khanvilkar (2014) recorded significantly ($p < 0.05$) increased AKP in the animals exposed to 50% water restriction. Creatinine phosphokinase levels increased significantly ($p < 0.05$) on 28th day in the hoggets maintained on 20% and 40% water restriction. Alkaline phosphatase and creatinine phosphokinase levels were significantly ($p < 0.05$) higher in water restricted group of animals even after 2nd day of rehydration and did not return to pre-treatment values.

Cortisol plays an important role in maintaining the water balance and plasma electrolytes (Casamassima *et al*., 2016). The cortisol levels were significantly ($p < 0.05$) increased in the experimental animals maintained on 20 and 40% water restriction. Kataria and Kataria (2007) and Khanvilkar *et al.* (2017[a]) also reported a significant increase in the concentration of cortisol in Marwari sheep and goats subjected to water deprivation for eight days or 50% of normal. The cortisol level of experimental animals dropped down significantly ($p < 0.05$) after 2nd day of rehydration in water restricted groups of animals, yet the values were significantly higher than those of day 0 in both the groups, suggesting existence of stress. These findings concurred with the report of Gupta (2013). The levels of triiodothyronine and thyroxin were comparable among treatment groups and between day 0 and day 28 in water restricted groups. The results were in agreement with Gupta (2013) and El Khashab *et al*. (2018). The triiodothyronine levels increased significantly ($p < 0.05$) after 2nd day of rehydration under 20% and 40% water restricted groups and altered the metabolic rate of animals. The serum aldosterone concentration increased significantly ($p < 0.05$) in animals exposed to 20% and 40% water restriction, and dropped down significantly ($p < 0.05$) after 2nd day of suggesting improved kidney function (Table 2). The results were in agreement with Gupta (2013).

Conclusion

The results of this study showed the important role of water, as a limiting factor for animal in environment with low water availability and useful in preventing the deleterious effects of water stress, especially in arid and semi arid region. In conclusion, water restriction by 20% and 40% resulted significant changes in blood variables of hoggets, which recovered significantly after 48 hr of rehydration, except serum cortisol, urea, AKP, CPK and T_3 values, which did not attain normalcy, thereby demonstrating that the animals did not recover completely from dehydration stress within 2 days of rehydration.

Acknowledgment

We are thankful to the Dean of the faculty and Professor and Head of Livestock Farm Complex College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand for the facilities provided for this work.

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