

Original Research Article

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## Seasonal Effect of Vitamin C, Electrolyte and Jaggery Supplementation on Body Weight of Goats Transported at Different Flocking Density

Deepanshu Gupta<sup>1</sup>, Manju Ashutosh<sup>1</sup>, Gayatri Kashyap<sup>2\*</sup>, Meeti Punetha<sup>1</sup>,  
Ashutosh<sup>1</sup>, Bharti Patel<sup>1</sup>, Irshad Para<sup>1</sup> and Maneesh Ahirwar<sup>3</sup>

<sup>1</sup>Animal Physiology division, National Dairy Research Institute,  
Karnal-132001, Haryana, India

<sup>2</sup>Division of Pathology, Indian Veterinary Research Institute, Bareilly-243122, UP, India

<sup>3</sup>LPM division, National Dairy Research Institute, Karnal-132001, Haryana, India

\*Corresponding author

### ABSTRACT

Present work was conducted during two seasons (winter and hot-humid) to investigate seasonal effect of transportation of goats at different flocking densities on physiological parameters in goats (Alpine x Beetal) supplemented with Vitamin C, Vitamin C + Electrolyte and Jaggery. Goats were of 10-12 months of age from LRC, NDRI Karnal. During the journey all the animals were kept off-feed and deprived of water. The animals were divided into four groups. Group I, II and III consisted of 25 goats each that were further divided into groups of high (15) and low (10) flocking density. 3 days before start of experiment, group I goats were fed Vitamin C, group II goats were fed Vitamin C and Electrolyte and group III goats were fed jaggery only. These goats were subjected to continuous 8 hours transport in a tractor trailer measuring 12 ft x 6 ft. = 7.2 m<sup>2</sup> at an average speed of 25 km per hour for 3 days. Group IV goats served as control consisting of 10 animals and were kept in shed off fed up to 8 h on the day of transportation. Body weights were recorded before and after transportation. Body weight loss was more prominent in high flocking density goats as compared to low flocking goats in all three groups in both seasons. The lowest (P<0.05) values of body weights were recorded just after unloading in all groups, at low as well as high flocking densities in both seasons which then increased gradually after 6h of rest and feeding and reached to basal values after 24 hours after unloading. High flocking density was more stressful than low flocking density so animals should provide optimum floor space while transportation. Supplementation of Vitamin C, Vitamin C + Electrolyte and Jaggery aided in reducing transportation stress individually but Vitamin C + Electrolyte combination proved more beneficial in alleviating transportation stress in goats.

#### Keywords

Body weight,  
Electrolyte, Jaggery,  
Transportation stress  
and Vitamin C

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### Introduction

Studies regarding road transportation of livestock have revealed that the animals are exposed to numerous stressors and the

responses of the animal to them are complex, non-specific and often detrimental to their health and productivity (Minka and Ayo, 2009). Besides feed and water deprivation, livestock transport involves a complex set of

actions including handling, loading and unloading, unfamiliar environments etc. It may cause injury, reduced performance, increased morbidity and mortality rate and consequently substantial economic losses due to loss of live weight and poor meat quality (Knowles *et al.*, 1999a; Fazio and Ferlazzo, 2003 and Minka and Ayo, 2007a).

Transportation stress in animals has been scientifically established to produce shrinkage in body weight (Kannan *et al.*, 2002). Transportation involving extended periods without food and water resulted into an initial loss of live weight (approx. 7% in ruminants and 4% in pigs) during the first 18-24 hrs of transportation (Knowles and Warriss, 2007).

Supplementation of Vitamin C, electrolyte aided in reducing transportation stress individually, with variable effects on stress response parameters and their combination synergistically proved promising in alleviating transportation stress in goats (Minka and Ayo, 2013). The application of oral electrolyte therapy, especially if similar in constituents to interstitial fluid, seems to attenuate the changes, resulting in improving both live and carcass weights up to several percent in treated animals as well as a reduction in meat quality degradation (reduced dark cutting). These studies suggest that the use of electrolyte therapy may be an effective means of reducing stress in transported cattle (Schaefer *et al.*, 1997)

The majority of the studies conducted on the transportation of goats have been done in temperate regions of the world (Rajion *et al.*, 2001) and not in tropical conditions. Measures aimed at alleviating road transportation stress in goats are still limited (Galipalli *et al.*, 2004 and Minka and Ayo, 2007b). The aim of present study was to investigate the synergistic effect of treatment with ascorbic acid, electrolytes and jiggery on body weights of

goats at different flocking densities, in hot humid and winter conditions.

## **Materials and Methods**

Animal experimentation was performed in compliance with regulations set by the Livestock Research Centre, NDRI and approved by the Institutional Animal Ethics Committee (IAEC). Cross bred goats (Alpine x Beetle) of 10-12 months of age were selected for experiment from LRC, NDRI Karnal, which is situated at an altitude of 250 meters above mean sea level and at 29 °42' N latitude and 77° 02' E longitudes. The maximum temperature recorded goes up to 45° C in summer and minimum temperature 3.5° to 4° C in winter. The average rainfall is about 700 mm. The whole experiment was conducted in two seasons: during hot humid season (September-October) and during winter season (December-January).

The animals were divided into four groups: Group I, II and III consisted of 25 goats each, that were further divided into groups of high (15) and low (10) flocking density. These goats were subjected to continuous 8 hours transport in a tractor trailer measuring 12 ft x 6 feet = 7.2 m<sup>2</sup> at a minimum speed of 25 km per hour for 3 days. During the journey all the animals were kept off-feed and deprived of water. The trailer was divided into two parts of 3 m<sup>2</sup> each. Floor area for transportation was calculated and 0.20 m<sup>2</sup> per goat/sheep weighing up to 20-25 kg of body weight, were classified as low flocking density. Similarly, for high density group the floor area was calculated and 0.14 m<sup>2</sup> per goat/sheep weighing up to 20-25 kg of body weight was considered. In group III, the body weights of animals taken under study varied between 16-20 kg. Further group I goats were fed vitamin C, group II goats were fed vitamin C and electrolyte and group III goats were supplemented with jaggery three days before

the start of experiment. Group IV: This group consisted of 10 growing goats that were maintained under goat section of the LRC, NDRI, Karnal receiving all normal management inputs as practiced at goat unit of the institute. This group was never transported and kept without feed, water and fodder in an enclosure/shed till the completion of 8 hours transportation activity/process for other goat groups. All the goats were maintained under goat section of the LRC, NDRI, Karnal received all normal management inputs as practiced at goat unit of the institute.

Group I was fed vitamin C at a dose of 180 mg/kg.bwt/day/animal orally. Group II was fed with vitamin C + electrolyte (180 mg/kg.bwt/day/animal of vitamin C + 7 g / animal / day Electral powder) and group III was fed jaggery @ dose of 200 g/animal/day orally with small amount of concentrate

The vehicle used for transportation was tractor trailer covered on all sides with wire mesh. The tractor was driven by three licensed and trained drivers alternately for 2.5 hours to 3 hours on the day of experiment, thus accounting for total 8 hours duration of continuous transportation. The average speed of vehicle was maintained on an average of 25 km per hour. The average floor area on the trailer for transportation of experimental goats was decided on the basis of studies carried out and available reports/ literature (The Australian Standards and Guidelines for the Welfare of Animals – Livestock Transport version 1.1 26 September 2011; Ministry Of Environment and Forests, 2009) in the country and outside country. The trailer measuring 12 ft x 6 ft = 7.2 m<sup>2</sup> was divided into two parts of 3 m<sup>2</sup> each. The duration of animal transport for each group was 3 days in each season. Body weights of goats were measured with the help of electronic weighing balance early in the morning before feeding on each day of sampling and expressed in kg.

Data analysis was carried out using SAS 9 software licensed to NDRI. Mean values at different sampling times were compared with respective basal mean values of each group using one way ANOVA with posttest as Dunnett's multiple comparison.

## **Results and Discussion**

Meteorological data in the month of Sep-Oct and Dec-Jan THI was 77.14 and 58.74 respectively. This suggests a hot humid (HH) and winter seasons in Karnal, India. The average ( $\pm$  SE) values of body weight (Kg) in groups (group I, group II, group III and group IV) of goats at low and high flocking density, during winter and hot-humid seasons have been presented in table 1 and graphically depicted in figure 1. The analysis of variance for body weight has been presented in table 2.

During winter season body weight of group I goats was significantly ( $P < 0.05$ ) lower at unloading ( $22.78 \pm 0.16$ ) with body weight shrinkage of 3.87 % as compared to normal basal body weight ( $23.69 \pm 0.14$ ) in low density goats before transportation, but 24 hours after transportation body weight returned to normal basal level whereas in high flocking density the body weight shrinkage was 5.79% after unloading. Similarly the body weight shrinkage were also reported in hot humid season in low as well as in high flocking density goats up to 4.85 % and 6.15% respectively, after unloading. In group II, during winter season the body weight shrinkage was 2.82% for low flocking density and 3.41% in high flocking density goats after transportation. The body weight shrinkage in high flocking density goats was 4.69 % in hot humid season whereas low flocking density goats showed only 2.54% shrinkage which was minimum among all the groups. The maximum body weight shrinkage was reported in group III as compared to group I and II goats.

**Table.1** Average values of Body weight (Kg) in goats transported at different flocking densities during winter and hot humid seasons

Transportation Groups /	WINTER		HOT HUMID	
	Low Flocking Density	High Flocking Density	Low Flocking Density	High Flocking Density
<b>Vitamin C (Group I)</b>				
Before Loading	23.69±0.14 <sup>hy</sup>	23.50±0.11 <sup>ex</sup>	21.78±0.24 <sup>ew</sup>	21.67±0.21 <sup>fw</sup>
After Unloading	22.78±0.16 <sup>ez</sup>	22.14±0.11 <sup>dy</sup>	20.72±0.20 <sup>cx</sup>	20.33±0.23 <sup>ew</sup>
6h Post	22.58±0.13 <sup>ez</sup>	22.00±0.10 <sup>dy</sup>	20.50±0.16 <sup>cx</sup>	20.00±0.17 <sup>dw</sup>
12h Post	22.83±0.13 <sup>fz</sup>	22.25±0.09 <sup>dy</sup>	20.83±0.19 <sup>cx</sup>	20.42±0.16 <sup>ew</sup>
24h Post	23.17±0.09 <sup>gz</sup>	22.75±0.09 <sup>ey</sup>	21.33±0.19 <sup>dx</sup>	20.75±0.18 <sup>ew</sup>
48h Post	23.67±0.17 <sup>hz</sup>	23.42±0.11 <sup>ey</sup>	21.75±0.21 <sup>ex</sup>	21.08±0.16 <sup>ew</sup>
<b>Vitamin C and Electrolyte Mixture (Group II)</b>				
Before Loading	23.64±0.12 <sup>hx</sup>	23.61±0.13 <sup>dx</sup>	21.86±0.25 <sup>ew</sup>	21.92±0.20 <sup>fw</sup>
After Unloading	22.97±0.13 <sup>gz</sup>	22.81±0.13 <sup>dx</sup>	21.31±0.24 <sup>dx</sup>	20.89±0.22 <sup>ew</sup>
6h Post	22.83±0.15 <sup>fz</sup>	22.67±0.13 <sup>dy</sup>	21.00±0.22 <sup>dx</sup>	20.42±0.25 <sup>ew</sup>
12h Post	23.00±0.14 <sup>gy</sup>	23.00±0.12 <sup>ey</sup>	21.33±0.23 <sup>dx</sup>	20.75±0.24 <sup>ew</sup>
24h Post	23.33±0.11 <sup>hz</sup>	23.25±0.12 <sup>ey</sup>	21.75±0.21 <sup>ex</sup>	21.25±0.25 <sup>ew</sup>
48h Post	23.83±0.11 <sup>hy</sup>	23.75±0.14 <sup>ey</sup>	22.25±0.18 <sup>dx</sup>	21.58±0.20 <sup>fw</sup>
<b>Jaggery Solution (Group III)</b>				
Before Loading	19.45±0.46 <sup>cy</sup>	19.48±0.46 <sup>by</sup>	17.78±0.50 <sup>bx</sup>	17.09±0.42 <sup>cw</sup>
After Unloading	17.99±0.43 <sup>az</sup>	17.38±0.30 <sup>ay</sup>	16.32±0.44 <sup>ax</sup>	15.43±0.35 <sup>aw</sup>
6h Post	18.45±0.41 <sup>by</sup>	19.43±0.46 <sup>bz</sup>	16.58±0.40 <sup>ax</sup>	16.11±0.45 <sup>bw</sup>
12h Post	19.37±0.45 <sup>cx</sup>	19.45±0.48 <sup>bx</sup>	17.05±0.45 <sup>bw</sup>	17.00±0.42 <sup>cw</sup>
24h Post	19.52±0.46 <sup>cx</sup>	19.47±0.45 <sup>by</sup>	17.09±0.42 <sup>bw</sup>	17.17±0.43 <sup>cw</sup>
48h Post	19.45±0.47 <sup>cy</sup>	19.45±0.46 <sup>by</sup>	17.74±0.50 <sup>cx</sup>	17.12±0.42 <sup>cw</sup>
<b>Control (Group IV)</b>				
Before Loading	21.23±0.88 <sup>az</sup>	21.43±0.88 <sup>bz</sup>	20.86±0.88 <sup>aw</sup>	19.86 ±0.78 <sup>cx</sup>
After Unloading	20.74±0.90 <sup>az</sup>	20.94±0.90 <sup>bz</sup>	20.41±0.87 <sup>bw</sup>	18.91 ±0.75 <sup>cx</sup>

Between rows a, b, c and d and between columns w, x, y and z differed significantly (P<0.05)

**Table.2** Analysis of variance for body weight in transported goats

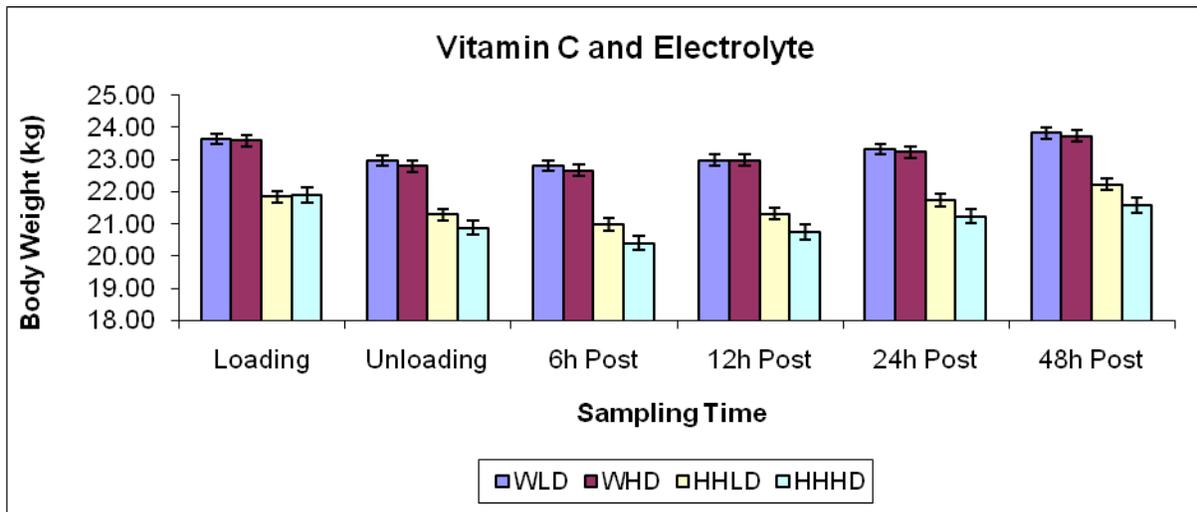
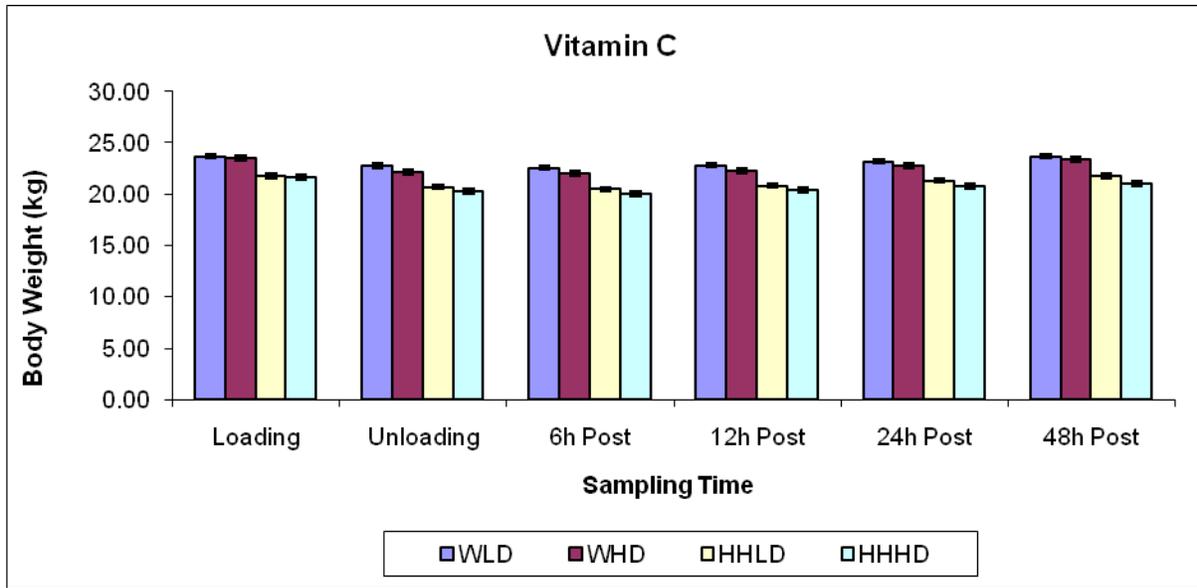
Source of variation	Df	Mean Sum Squares
Between Seasons	1	1172.55**
Between Densities	3	405.55**
Between Treatments	17	294.37**
Season x Treatments	17	5.36*
Densities x treatments	51	2.69*
With in	1206	2.26
Total	1295	-

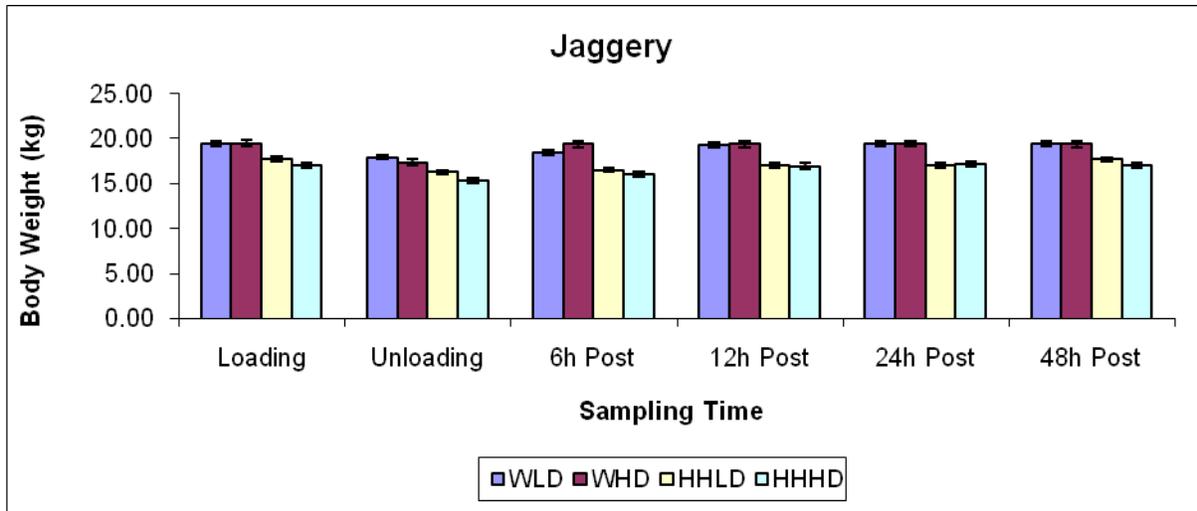
P< 0.05\*P< 0.01\*\*

**Electrolyte which is based on W.H.O formulae manufactured by FDC limited trade name - Electral is used which supplies electrolytes in the following concentrations:**

Electrolytes	mOsmol / Litre
Sodium	75
Potassium	20
Chloride	65
Citrate	10
Dextrose	75
Total Osmolarity	245

**Fig.1** Average values of Body weight (Kg) in goats transported at different flocking densities during winter and hot humid seasons





The percent body weight shrinkage in winter and hot humid seasons were 7.48%, 10.81%, 8.19% and 9.75% in low and high flocking density goats respectively, at unloading compared to basal values with significant ( $P<0.05$ ) differences. In group IV (control) during winter and summer seasons no significant variation was reported in body weights during the study. Analysis of Variance for body weight indicated that there was a significant difference ( $P<0.05$ ) between seasons, between density and between groups. There was a significant ( $P<0.05$ ) interaction between season, density and groups.

In group I and group II the body weight were either not affected by transportation or regained immediately post transportation, indicating the role of vitamin C and electrolytes in preventing body weight shrinkage due to transportation in goats. The live weight shrinkage in transported goats can be partly contributed to dehydration as represented by increased PCV of transported goats and can be also contributed to increased protein catabolism due to increased cortisol. The insignificant live body weight shrinkage in vitamin C and electrolyte group can be due to less muscle catabolism. The mechanism by which ascorbic acid (Vitamin C) reduced live weight loss during transportation may be as a result of the inhibitory role of ascorbic acid

on cortisol, the chief hormone of stress, which induces diuresis and increases elimination of the gut content (Balz, 2003; Powers and Jackson, 2008).

Knowles and Warriss (2007) reported that transportation involving extended periods without food and water results into an initial loss of live weight (approx. 7% in ruminants and 4% in pigs) during the first 18-24 hrs of transportation. Other workers have also reported that transporting animals for a long distance is found to cause a loss in live weight or carcass weight (Minka and Ayo, 2007b; 2008; Minka *et al.*, 2009; Ritter *et al.*, 2008). Warriss (1993) reported that animal loss weight when they are subjected to greater energy demand such as those needed to maintain thermoregulation in transport. Alamer and Al-Hozab (2004) found that variations in body weight loss of sheep during winter, spring and summer seasons, was mostly contributed to body water loss as related to differences in environmental temperature. The greatest body loss that was observed during summer was in association with respiratory and cutaneous water losses.

Goats transported for 12 hrs over a distance of about 350 Km revealed significant decrease in the live body weight than their preload weight. After transportation an average 5.77,

2.39 and 4.80 per cent shrinkage of the body weight was observed in group II (positive control), III (given Restobal liquid@20 ml/animal) and IV (given Stresomix premix@5gm/day/animal with gur for 10 days) respectively than their pre-transport body weight. Positive control group administered no treatment exhibited significantly ( $P<0.01$ ) higher shrinkage in body weight than the polyherbal formulation supplemented treatment groups. However, among the treatments, restobal administered group showed significantly ( $P< 0.01$ ) lower shrinkage than the Stresomix premix administered group (Ambore *et al.*, 2009). Similarly (Minka and Ayo, 2007b), reported that 8 hours transportation of Red Sokoto goats (RSG) treated with ascorbic acid (AA) lost only 1.04% compared to control goats which lost 11.9 % of their initial live weight after transportation. Transportation of goats upto 8 hours during hot humid and winter seasons induced stress as is reflected by decreased values of body weight just after unloading. Supplementation of vitamin C + electrolyte showed lesser deviations from the normal values as compared to other groups, indicating that a combination of vitamin C and electrolyte was more beneficial in reducing the transportation effect.

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