STUDIES ON SERUM ELECTROLYTES AND BIOCHEMICAL PARAMETERS DURING TRANSPORTATION IN GOATS

THESIS

Submitted

In partial fulfillment of the requirements for the Degree of

MASTERS OF VETERINARY SCIENCE

IN

VETERINARY BIOCHEMISTRY

BY

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Appendix-B

DECLARATION OF THE STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled **"STUDIES ON SERUM ELECTROLYTES AND BIOCHEMICAL PARAMETERS DURING TRANSPORTATION IN GOATS"** or part thereof has not been submitted for any of the other degree or diploma of any university, nor the data has been derived from any thesis or publications of any university or scientific organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Date:
Place: Mumbai

Signature
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Appendix-C(i)

DECLARATION OF ADVISORY COMMITTEE

Mrs. PANCHAL POOJA BHALCHANDRA has satisfactorily prosecuted her course of research work for a period of not less than one semester and that the thesis entitled **"STUDIES ON SERUM ELECTROLYTES AND BIOCHEMICAL PARAMETERS DURING TRANSPORTATION IN GOATS"** submitted by her is the result of research work is sufficient to warrant its presentation to the examination in subject of **Veterinary Biochemistry** for the award of **Master of Veterinary Science (M.V.Sc.)** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

We also certify that the thesis or part thereof has not been previously submitted by her for a degree of any other university.

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Date:

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Appendix-C(ii)

CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON SERUM ELECTROLYTES AND BIOCHEMICAL PARAMETERS DURING TRANSPORTATION IN GOATS"** submitted by **Mrs. PANCHAL POOJA BHALCHANDRA** to the Maharashtra Animal Sciences University, Nagpur, in partial fulfillment of the requirement for the degree of **Master of Veterinary Science** (M.V.Sc.) has been approved by the Student's Advisory Committee after examination in collaboration with the External Examiner.

Name & Signature of External Examiner | **Signature & Seal of Head of Department** | **Signature of Guide/Advisor**

ADVISORY COMMITTEE

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ACKNOWLEDGEMENTS

It is my proud privilege to express my sincere gratitude to my research guide Dr. S. H. Dalvi, Associate Professor and Head, Department of Veterinary Biochemistry, Mumbai Veterinary College for the scholastic guidance, continuous inspiration, critical appreciation and above all providing me the foundation for independent thinking during the course of investigation and preparation of this manuscript. I also thank him for inculcating in me a part of his professional attitude and scientific temper.

I remain indebted to the members of advisory committee Dr. D. G. Dighe, Professor, Department of Veterinary Preventive Medicine and Jurisprudence and present Associate Dean, KNPVS, Shirawal. I owe a great debt of gratitude to Dr. R. B. Ambade, Assistant Professor, Department of Veterinary Biochemistry for his invaluable advice, academic guidance, responsible criticism and continuous encouragement during course work. I am very thankful to Dr. R. S. Deshmukh, Assistant Professor, Department. of Animal Genetics and Breeding for their guidance during preparation of my thesis.

I am highly obligated to the staff of Advy Chemicals, Phalegaon, Kalyan Dist. Thane. Dr. Santosh Salvi, Deputy general manager (veterinary services); Dr. Satam, Dr Gopale Veterinary officers; and Dr. Padhye, Veterinary officers for permitting and helping me to collect samples and data from their valuable animals.

I express sincere gratitude to Prof. Dr. A. S. Ranade, Associate Dean, Mumbai Veterinary College, Mumbai for providing me facilities needed for my research.

My great thanks to Dr. A. S. Nagvekar, Associate Professor, Department of Veterinary Physiology, Dr. P. M. Kaple sir, Assistant Professor of Department of Veterinary Biochemistry, PGIVAS, Akola, Dr. S. A. Ingle, Assistant Professor of Animal Biotechnology, Dr. Gadegaonkar, Associate Professor of Animal nutrition, Dr. S. D. Ingole, Professor, Department of Physiology for their valuable guidance throughout the entire PG course. I am also thankful to Dr. Kalwaghe, Assistant Professor of Department of Veterinary Parasitology for his supportive attitude, concrete suggestions and excellent guidance during my

course. I shall ever remain thankfully indebted to Dr. S. R. Chawan, Associate Professor, Department of Veterinary Anatomy and Academic cell (PG) in-charge for his guidance and supporting in such disaster of COVID pandemic.

I am thankful to Mr. R. M. Yadav, Laboratory Assistant and Prashant Naram, Laboratory attendant for their help with ample of kindness and support in the department.

I extend my gratitude to my friends Dr. Manpreet Khajuria, Dr. Sonal Gujarmale, Dr. Deepesh Kadam and Dr. Vijay Panchal for their immense help and guidance in writing thesis. A very big thanks to Dr. Sharayu Andhale and all the known and unknown friends who put colors of joy in my life. Thanks for becoming family in such a short period of time and I wish all of you a great future ahead, may all your dreams come true.

I specially thank to my dear husband Mr. Girish Deshmukh for influencing my life in such a positive way that words cannot express my appreciation and you are truly an inspiration for me. I am very thankful to my father-in-law Mr. Satish Deshmukh, mother-in-law Mrs.Ujwala Deshmukh and all family members for being so supportive. How can I forget my little munchkins whose innocent smiles, glittering eyes and joyful laughs made me forget my all worries and tensions.

I owe all my achievements to my beloved parents for their love and support, Mrs. Lata- Mr. Bhalchandra Panchal whose constant encouragement, inspiration, support and blessings helped me make my dreams come true. Thanks for giving me a wonderful education. Whatever good in me is because of your effort, guidance and support. I couldn't have done it without you. Thank you for your endurance and for never giving up on me, even when I made it hard for you, helping me to reach the peak of my profession. I am highly blessed to have such amazing parents and grateful for all the skills and the values you have instilled in me, especially perseverance and honesty. Thank you for always going the extra mile in everything. YOU ARE ONE IN A MILLON!

Date:

Place : MUMBAI

(P. B. Panchal)

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LIST OF SYMBOLS / ABBREVIATIONS

g/dl	Gram per deciliter
mg/dl	Milligram per deciliter
Mmol/L	Mill moles per liter
IU/L	International unit per liter
g/l	Gram per liter
^{O}C	Degree Celsius
^{O}F	Degree Fahrenheit
µL	Micro liter
Std	Standard
A:G	Albumin to Globulin Ratio
p^{H}	Potential of Hydrogen
OD	Optical density
et al.	Et Alii/ Alia, And Others
i/m or IM	Intra Muscular
SE	Standard error
Sr. No.	Serial Number
/	Per
±	Plus Minus
%	Per Cent or Percentages
:	As to
<	Less Than
>	More Than
≥	More Than or Equal to
≤	Less Than or Equal to
GOD	Glucose oxidase
POD	Peroxidase
4AAP	4 – amino antipyrine
CM	Centimeter
Mins	Minutes
Conc.	Concentration

U	Unknown
ABS	Absorption
iCa	Ionized Calcium
iP	Ionized Phosphorus
ISE	Ion selective electrode
ECF	Extra cellular fluid
PTH	Parathyroid hormone
CD	Critical diffrence
ALT	Alanine Aminotransferase
SGPT	Serum Glutamic Pyruvic Transaminase
AST	aspartate aminotransferase
SGOT	glutamic-oxaloacetic transaminase
viz.	it is permitted to see/ namely/that is to say/to wit/which is/as follows
ie.	That is
wk	Week
Km	Kilometer
kg	Kilogram
h	Hour
HD	High density
LD	Lower density
RBC	Red blood cells
WBC	White blood cells
TWC	Total white cells
HB	Haemoglobin
MCHC	Mean Corpuscular Hemoglobin Concentration
CPK	Creatinine phosphokinase
LDH	Lactate dehydrogenase
DOMS	Delayed onset muscular soreness
DFD	Dark firm dry
PCV	Packed cell volume
CK	Creatine kinase

βHB	β-hydroxybutyrate
NEFA	Non-Esterified Fatty Acids
BHBA	beta-hydroxybutyric acid
CRD	completely randomized design
FDI	Feed dry matter intake
FBW	final body weight
FCR	feed conversion ratios
M^2	Meter sqare
AKP	alkaline phosphatase
ACP	acid phosphatase
AA	Ascorbic acid
PGF2α	Prostaglandin F2-alpha
N:L	Neutrophils lymphocyte ratio
LAC	Lupus Anticoagulant
BUN	Blood urea nitrogen
EEG	Electroencephaloghaphy

1. INTRODUCTION

Goat has been domesticated by man since ages for milk, meat, hair and skin. Goats are thought to have been earliest domesticated ruminant. India possesses 148.88 million. as per 20th livestock census (2019). i.e. approximately 15% of world population. In India, goat production is 0.48 million tons of meat and 4 metric tons of milk per year. It provides meat, milk and skin and plays important role in the Indian agrarian economy. Goat is also important for valuable pashmina fiber, skin and manure. Goat has distinct social, economical, managerial and biological advantages over other livestock species and very significantly contribute to the agrarian economy and play a vital role in the livelihood security of small and marginal farmers and landless labors. Goats are prolific breeder and are versatile to survive on available shrubs and trees in adverse, harsh environment in low fertile land and converting them into valuable edible protein for human use. It has comparatively shorter gestation length; better disease resistance and its husbandry involves low risk capital investment and low maintenance cost and hence considered as 'poor man' cow in India. Goat survives better under extreme agro-climatic, different geographical and environmental condition (Al-Haidary *et. al.,* 2012; Banerjee *et. al.*,2014).They can be profitably raised with low investment under most extensive and intensive systems of management.

Transportation of live animals as an inevitable husbandry practice has been recognized as one of the main causes of stress (Saeb *et al*., 2010). Handling, loading, fasting, confinement, vibrations, centrifugal forces, rapidly changing light conditions, poor air quality and mixing of unfamiliar groups are some of the potential stressors during transport (Saeb *et al.,* 2010; Zhong *et al.,* 2011). Transportation stress has considerable physiological effects such as increased adrenal cortical activity, decreased immunity, increased morbidity, decrease in meat quality and weight loss and sometimes mortality due to infectious diseases (Maejima *et al.*, 2005; Saeb *et al.,* 2010). As a result, transportation stress has both economic and animal welfare concerns, and its decrement, in order to fewer side effects, has attracted considerable attention in recent years. Transportation, as

a stressful condition, activates sympathetic nervous system and hypothalamo-pituitary- adrenal axis, which is known as stress response, and results in an increment in serum concentration of cortisol (Maejima *et al.*, 2005). Cortisol is synthesized in the adrenal cortex and is regarded as an indicator of stress in different species (Okeudo and Moss, 2005; Mohamed, 2006). Blood cortisol concentration is a well-known index of the reaction of animals to any environmental stressors and higher cortisol concentration may be required to meet the energy crisis during physical stress to the animals. It is believed that there is a positive correlation between the magnitude of stress challenge and the magnitude of change in metabolism (Saeb *et al.*, 2010). Although clinical, biochemical, hormonal, and immunological effects of transportation stress in farm animals have been evaluated, it is well established that the different animal species and even different breeds may have different responses to the same stressor (Saeb *et al.*, 2010). On the other hand, some authors believe that different sexes may respond differently to the same stressor (Baraka, 2012). While the effect of age on the response of animals to the stress has been documented (Kannan *et al.*, 2003; Zhong *et al.*, 2011), there is little information regarding the effect of sex on the abilities of animals to cope with transportation stress.

Goats are frequently undergoing various types of stresses such as physical, nutritional, chemical, heat etc. These animals are transported from farmer's doorstep to market, slaughter house, for exhibition or other research and production farms where they are being used for obtaining various biological products such as antiserum production. Goat does not endure transportation stress well during long journey. Industry report based on postmortem examination have indicated that goat become susceptible to respiratory infection, live weight shrinkage and immune competency after prolong journey under adverse weather condition (Kannan *et al.*, 2000). Transportation stress in animals results in decreased production, milk meat quality and quantity as well as immunity making animal more vulnerable to diseases and sometime death.

The management of goats during pre-slaughter transportation and holding could influence both profitability and animal welfare. Severe pre-

slaughter stress has been reported to adversely affect meat quality in livestock (Ashmore *et al.,* 1972; Warner *et al.*, 1986; Apple *et al.*, 1995) and poultry (Kannan *et al.,* 1997, 1998). Transportation has long been recognized as a critical phase in animal production (Hails, 1978; Dantzer and Mormed, 1979). Transportation consists of several transports, interrupted by stays in transit centers and markets. It is observed that the animals are given minimal care during this period. Possible improvement of the way the animals are treated is therefore of considerable interest, both in economic terms and form the point of view of animal welfare (Ewbank, 1973).

Animal transportation involves many stressful factors such as handling, loading unloading, oscillations, noise, poor ventilation deprivation of food and water and new environment. During transportation various physiological and biochemical changes occurs which primarily includes electrolyte imbalance, dehydration and energy deficit (Das *et al.,* 2000).

Although sufficient studies were done on the effect of transportation stress on cattle, horse, pig, camel and various wild animals till now very few studies about electrolyte and biochemical changes due to transportation stress have been undertaken in goats in prevailing climatic condition. There is paucity of study and information available on the effect of short/ long distance travelling on the electrolyte levels in goats. Some workers administered ascorbic acid prior to transportation and which had helped ameliorate adverse effect of the road transportation stress.

So, present study is undertaken to study the effect of road transportation stress on serum electrolytes levels and also some biochemical parameters in goats with following objectives.

1. To estimate the serum levels of the electrolytes viz. Na^{+}, Cl^{-}, K^{+} and Ca^{++} during preload and post transportation of goats.
2. To estimate serum levels of biochemical parameters viz. glucose, total proteins, albumin, total calcium and phosphorus during preload and post transportation of goats.

3. To find out the acclimation period required for adaptability following the road transport stress in these goats.

2. REVIEW OF LITERATURE

Mormede *et al*. (1982) conducted experiment to study the effect of transportation on blood serum composition, disease incidence and production trait in young calves in the western part of France. Sixty-two veal calves were randomly divided into two groups. The animals of the first group (short journey) left the farm of origin and arrived at the fattening unit in the evening of the same day after a short passage in a transit center. The animals of the other group (long journey) remained in the transit center, without any food or water supply during the night and were trucked about 300 km before arriving at the fattening unit. Blood was sampled in the farm of origin, on arrival at the fattening unit and one week later in order to allow a longitudinal study of the effects of transportation. A blood serum biochemical profile viz. Total proteins, albumin, glucose, urea, creatinine, cholesterol, triglyceride, total bilirubin, sodium, potassium, chloride, calcium, inorganic phosphorus and also enzymes such as AST, ALT were performed on every sample together with cortisol and immunoglobulin levels. They found that, numerous parameters were modified by the transportation but not by the journey duration. An acute dehydration was apparent in the long journey animals, in the form of an increase in plasma proteins and chloride concentrations on arrival at the fattening unit. One-week later serum glucose levels remained low in this group, showing that the feeding regimen was not able to make up the long journey induced energetic deficit. Though the production data were not different between the two experimental conditions; the animals in the long journey group displayed an increased incidence of respiratory disease. This study has provided a biological basis for improvements likely to reduce the negative consequences of transport in veal calves. At the same time calves of 1–3wk age from different origins are brought together and transported which takes 5 days long. They were given minimal care during transit. The study was done in commercial operation. Biological and economic criteria were used to assess the short-term and long-term effects of two different transport durations.

Schaefer *et al.,* (1990) conducted two experiments: (1) to identify predictive acid-base and electrolyte parameters that might be correlated with meat

quality in marketed bulls; and (2) to determine whether bulls could be treated with either glucose or electrolyte drinks while in lairage to improve electrolyte balance and meat quality. In the first experiment, 29 crossbred yearling bulls averaging 499 + 13 .4 kg were exposed to either a minimal stress of no mixing and 3 km transport (N:l3) or a moderate stress of mixing, 6 h transport 24 h off feed in lairage, plus an additional 3 km transport immediately prior to slaughter (N:16). Animals exposed to moderate stress displayed higher serum chloride values (137 mmol /L) compared to pretreatment control (121 mmol/L) or minimal stress values (118 mmol/L) ($P< 0.05$) and produced a high frequency of dark, firm and dry meat (9 out of 16 animals compared to 0 out of 13 in the control group). In the second experiment, 79 crossbred yearling bulls averaging 595+6.5 kg were divided into treatment groups of either 19 or 20 animals each and subjected to mixing, handling and a 6-h transport period after which they were left in lairage for 18-20 h before slaughter. Treatment groups were: (1) no water during lairage; (2) water only; (3) electrolyte drink; or (4) 5% glucose drink. Animals in exp. 2 given either water or no water displayed significantly higher serum sodium and chloride ion compared to animals offered an electrolyte or glucose drink. It was also found that the urine cation levels of animals offered no water or water only were significantly higher ($P<0.05$). In all animals, improved electrolyte balance coincided with improved meat quality traits and carcass yield.

Kannan *et al.* (2000, 2003) determined the live weight shrinkage and stress responses in goats due to differences in stocking density during transportation and holding. Such management of food animals prior to slaughter influences both profitability and animal well-being. 150 Spanish does were transported on two different stocking. One stock of 25 does (High Density, HD group) was given floor space of 0.18 m^2 and transported over time span of 2.5h and other stock of 50 does (Low Density, LD group) was given floor space of 0.37 m^2.The average temperature was 34.6^oC and 35^oC respectively. Their blood sample collected at 0, 1, 2, 3, 4 or 18 h after transportation time to access time course of stress responses. Individual animal weighed just before loading and after overnight holding to access shrinkage. There was significant effect of time on plasma cortisol, glucose and urea nitrogen (neutrophils, lymphocytes, monocytes

and eosinophils) and ratio of neutrophils to lymphocytes (N: L). The N:L ratio was higher at all time periods after transportation than prior to starting journey of holding, indicating effect of transportation stress on the immune system. The mean (±SE) shrinkage percent losses were 10.2 ± .68 and 9.8 ± .68 in HD and LD treatment groups, respectively. The results indicated that the stress responses of goats due to transportation begin decreasing within 3h after transportation. However, prolonged holding periods without feed may increase stress responses and bring about metabolic changes.

Daramola *et al.,* (2005) determined the haematological and biochemical parameters of West African Dwarf (WAD) goats in twenty WAD goats consisting of ten adults (3 bucks and 7 does) and ten young goats (3 buck-kids and 7 doe-kids). The means for Packed Cell Volume (PCV), Total White Cell (TWC), Red Blood Cell (RBC) and Haemoglobin (HB) were 29.4 $\pm$ 0.8%, 13.5 $\pm$ 0.8x10^3ml, 11.5 $\pm$ 0.4x10^6ml and 9.8$\pm$ 0.3g/dl respectively. There were more lymphocytes (65.8 $\pm$1.1%) than neutrophils (33.5 $\pm$1.7%) in circulation. The values obtained for serum sodium, serum total protein and serum urea levels were 135.1$\pm$1.7mmol/L,7.1 $\pm$ 0.1g/100ml and 2.7 $\pm$ 0.3mmol/L respectively. The values obtained for the serum transaminases; serum Glutamate Pyruvate Transaminases (SGPT) and Serum Glutamate Oxaloacetate Transaminases (SGOT) were 8.9$\pm$0.9IU/ litre and 20.9 $\pm$1.2IU/ litre respectively; while Alkaline Phosphatase (ALP) was 10.7$\pm$1.2 IU/ litre. There were significantly ($P< 0. 05$) higher Hb, Red Blood Cell (RBC) and Mean Corpuscular Haemoglobin Concentration (MCHC) in adult goats. Lymphocytes percentage was higher ($P<0.05$) in male goats. This study has indicated haematological and serum biochemical values and could serve as a baseline information for comparison in conditions of nutrient deficiency, physiological and health status of WAD goats kept under native husbandry system in Southern Guinea Savannah of Nigeria.

Averos *et al.,* (2007) analyzed the influence of commercial transport conditions on the stress serum parameters of pigs transported to slaughter during different seasons. One hundred and sixty-two pigs weighing 98 kg and of both sexes were studied. A total of seven transports were performed in summer and in

winter conditions, with durations of 1 h and 13 h within each season. Serum cortisol, glucose, creatine phosphokinase (CPK), lactate dehydrogenase (LDH), albumin and total protein concentrations were measured. All variables increased during transport and decreased during lairage ($P< 0.001$), with cortisol values being 3.47 ± 0.19, 8.52 ±0.28, and 6.96 ± 0.18 µg/dl at loading, unloading and exsanguinations, respectively, except for glucose (0.54 ± 0.03, 0.44 ± 0.04, and 0.86 ± 0.03 g/l). Short journeys did not allow the total recovery from the loading stress. A certain level of dehydration was observed, especially during lairage on the longest journeys (increase of 6.87 ± 1.29 g/l for total proteins; $P < 0.01$). Winter transports were slightly more stressful, with poorer recovery during lairage. Females showed higher stress reactivity. Genetics modulated the effect of the rest of influencing factors, with individuals showing a rougher reaction in short and winter conditions, but with lower dehydration levels. Under Mediterranean commercial conditions, stress in transported slaughter pigs was largely determined by season and genetics, so that an adaptation of handling procedures to these seasonal variations appears crucial if transport stress is to be reduced. Also, an improvement in stress resistance could be obtained by controlling the halothane gene of pigs.

Ayo *et al.,* (2009) studied the responses of serum electrolytes of goats to twelve hours of road transportation during the hot-dry season in Nigeria, and the effect of pretreatment with ascorbic acid. Twenty goats which served as the experimental group were administered ascorbic acid (AA) at a dosage rate of 100 mg/kg body mass, while 20 others served as controls and were given 10 ml each of sterile water. Forty minutes after the administration and loading, the goats were transported for 12 h. handling and loading of the experimental and control groups of goats decreased ($P < 0.05$) the potassium and sodium serum concentrations. The concentration of serum chloride, sodium and calcium increased significantly ($P<0.05$) immediately post-transportation, while potassium and magnesium decreased ($P < 0.05$) in the control goats. In AA-treated goats sodium and magnesium concentrations decreased abruptly ($P<0.05$), while calcium increased significantly ($P<0.05$) after transportation. Handling, loading and transportation adversely affected the electrolyte balance of the goats which suggested respiratory

alkalosis, dehydration and muscular damage in the transported goats, and the administration of AA alleviated the adverse effects of road transportation stress on serum electrolytes.

Das *et al*. (2010) studied some genetic and non-genetic factors affecting the levels of serum Na, K, Ca, P, Mg, AKP and ACP from 246 kids at 1 month of age belonging to three genetic groups viz. Assam Local, ½ Beetal-½ Assam Local and ¾ Beetal - 1/4 Assam Local goats maintained at the Experimental Livestock Farm, Department of Animal Physiology, Goat Research Station, Burnihat and the Livestock Research Station, Mandira, Assam Agricultural University. The least-squares means for serum Na, K, Ca, Mg, P, AKP and ACP levels were 158.14 ± 0.65mEq/l, 5.69 ±0.07mEq/l, 8.08 ± 0.05 mg%, 2.62 ± 0.02 mg%, 5.36 ± 0.05 mg%, 16.54 ± 0.37 KAU and 1.51± 0.04 KAU respectively. The effects of genetic group, sex of kid, kidding order, season of kidding and type of birth on Na and ACP levels at 1 month of age were non-significant. Sex of kid had significant effect on K level at 1 month of age. All the other factors had non-significant effect on K level. Genetic group and sex of kid exerted significant effect on Ca, P and AKP level at 1 month of age. Effects of all the other factors on these traits were not significant. Genetic group had significant effect on Mg level at 1 month of age. All the other factors had non-significant effect on Mg level.

Dias *et al.,* (2010) analyzed hematological and biochemical parameters, including plasma electrolytes and thyroid hormones, in 73 clinically healthy Churra-da-Terra-Quente ewes, a typical breed from the northeast of Portugal. The hemogram values were: erythrocytes 9.8±1.5×1012/L; hemoglobin 118.1±19.1g/L; hematocrit 40.8±5.9%; leukocytes 5.7±1.8×109 /L; and platelets 544.3±177.2×109 /L. The thrombin time was 17.3±1.7 seconds. The values of biochemical parameters were: total protein 76.4±6.1g/L; glucose 2.87±0.60mmol/L; total cholesterol 1.65±0.33mmol/L; aspartate aminotransferase 155.9±49.2U/L; alanine aminotransferase 23.2±9.6U/L; γ-glutamyl transferase 48.0±18.7U/L; total alkaline phosphatase 121.6±76.1U/L; glutamate dehydrogenase 6.4±3.7U/L; urea 7.32±2.22mmol/L; creatinine 123.0±54.1µmol/L;

total calcium 2.53±0.25mmol/L; phosphorus 2.10±0.46mmol/L; magnesium 1.01±0.09mmol/L; sodium 152.04±3.65mmol/L; potassium 4.7±0.4mmol/L; ionized calcium 1.32±0.07mmol/L; total thyroxine 111.75±42.29nmol/L; total tri-iodothyronine 1.01±0.28nmol/L; free T4 11.93±1.78pmol/L; free T3 4.22±1.33pmol/L; and thyroid-stimulating hormone 0.18±0.19μIU/mL Although differences among the Churra-da-Terra-Quente breed and other breeds may occur, the hematological and biochemical parameters, plasma electrolytes, and thyroid hormones, for this indigenous breed, were generally situated within the reference intervals previously reported for sheep.

Minka and Ayo., (2010) studied the effects of handling, loading and 12h of road transportation during the hot-dry season on muscular metabolism of 20 experimental goats administered orally with 100 mg/kg body weight of ascorbic acid (AA) dissolved in 10 ml of sterile water, and other 20 control goats given equivalent of sterile water 40 min prior to transportation were investigated. The result obtained post-transportation showed that handling, loading and transportation were stressful to the goats, especially the control goats and resulted into muscular damage and the development of delayed-onset-muscular-soreness (DOMS), which may lead to dark-firm-dry (DFD) syndrome meat with undesirable effects on its quality. In the experimental goats administered AA such transportation effects were minimal or completely abolished. The result demonstrated that AA reduced the incidence of DOMS and muscular damage in transported goats; therefore it may be used to improve the welfare and quality of meat obtained from goats subjected to long period of road transportation under adverse climatic conditions.

Hossan Shaikat *et al.,* (2013) had undertaken 6-month long study to determine various hemato-biochemical profiles of indigenous goats (Capra hircus) in Bangladesh. Blood samples were collected from goats of different ages of 5 Upazilla of Chittagong. A total of 120 goats (60 Black Bengal and 60 Jamnapari) having > 6 months of age were included. The whole blood was analyzed for hematology, and plasma and serum samples for biochemical analysis. The study found higher number of RBC and PCV in the goats of age 48 months and above.

Besides, total protein was found higher (78.9 ± 14.5g/L) in the goats of 6-24 months of age. WBC, lymphocytes, RBC, PCV, ALT, and AST were significantly higher in Jamnapari than Black Bengal goats.

Yaqub *et al.,* (2013) carried out investigation to determine changes in serum electrolytes and liver enzymes during the estrous cycle in Red Sokoto goats. Eleven (11) apparently healthy Red Sokoto goats were synchronized with a single injection of 7.5 mg of PGF2α. The goats were bled via jugular venipuncture in estrus or late estrus, metestrus/early diestrus, mid-diestrus and late diestrus/prestrus. Mean serum sodium, potassium and chloride levels non-significantly fluctuated during the estrous cycle. Calcium levels in estrus or late estrus were higher ($P < 0.05$) than in late diestrus/pro-estrus. There was a positive correlation between oestradiol and calcium concentrations ($r = 0.771$; $P < 0.05$). Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) concentrations non-significantly fluctuated during the estrous cycle. Progesterone and AST concentrations were correlated ($r = 0.925$; $P < 0.05$) during the estrous cycle. In conclusion, some serum electrolytes and liver enzymes fluctuated and correlated with ovarian steroids in different phases of the estrous cycle. The information generated may be useful as physiologic reference values for reproductive herd health management.

Romero *et al.,* (2014) studied to determine the effect of in-farm handling of steers, road transport by truck, or slaughterhouse lairage affect blood stress indicators. Total of 65 castrated Zebu steers were randomly selected and transported during 4 h in the same truck, under similar handling conditions. Blood samples were taken by jugular or coccygeal venipuncture at the farm, at the slaughterhouse, and during exsanguinations to measure plasma cortisol, glucose, lactate, creatine kinase (CK), ß-hydroxybutyrate (ßHB), creatinine, total protein, urea, packed cell volume (PCV) values, white blood cells (WBC) and neutrophils: lymphocytes ratio (N/L). The reports revealed that, pre-slaughter handling did not have a negative influence on protein metabolism nor did it cause dehydration. ß-hydroxybutyrate and lactate values did not change ($p>0.05$). Transportation increased cortisol, glucose, creatine kinase concentrations and N/L ratio. In

conclusion pre-slaughter handling causes stress in cattle that may alter numerous physiological variables.

Okoruwa and Ikhimioya (2014) carried out an experiment to determine the replacement value of plantain and mango peels combination for elephant grass, using hematological indices and serum biochemical profile by dwarf goats. Eighteen West African dwarf goats with average weight of 6.00±0.57kg and aged between 6 to 7 months old were used for the study in the Department of Animal (sheep and goat unit), Ambrose Alli University, Ekpoma between July and October 2012. The dwarf goats were allotted to three dietary treatments (T1, T2 and T3) with six animals per treatment in a complete randomized design. The compared diets were; T1 (elephant grass and concentrate in a ratio of 68:32 which served as control group), T2 and T3 68:32 (Combination of plantain with mango peels and concentrates in ratios of 55:13:32 and 50:18:32 respectively). Results showed that initial hemoglobin (8.08g/dl), white blood cell (8.96x109/l), sodium (119.62mmol/l), phosphorus (4.00mg/dl), potassium (4.59mmol/l) and final white blood cell (11.02x109/l), cholesterol (69.03mg/dl), creatinine (1.02mg/dl), sodium (130.72mmol/l), phosphorus (4.01mg/dl) were significantly ($P<0.05$) highest with animals on T1. Animals on T2 had the highest ($P<0.05$) in initial glucose level (76.02mg/dl).

El-Khasmi *et al.,* (2015) investigated the effect of transport distance on some blood physiological indicators of stress and biomarkers of oxidant stress in camels. Transport distances were categorized as short (72-80km), medium (160-170km) and long (350-360km) distance. Hematocrit, cortisol, glucose, lactate, malondialdehyde and catalase increased gradually and significantly ($P<0.05$) with transport distance, and that over longer distance these parameters were more significant ($P<0.005$) compared with short-distance. The serum levels of cortisol (ng/mL), glucose (mM) and LAC (mM) of camels travelling for medium distance (160-170 Km) were significantly ($P<0.05$) higher than those measured in camels subjected to short transport distance (72-80 Km) (respectively 152.4±25.18 vs. 88.32±19.4;7.08±0.21 vs. 5.07±0.28 and 12.99±0.16 vs. 9.97±0.31). These parameters became higher ($P<0.005$) when camels were

transported for a long- distance (350-360 Km) (respectively 231.7±23.75; 9±0.35 and 14.88±0.29). A positive correlation (P<0.001) was obtained between cortisol, glucose, lactate, malondialdehyde and catalase. They concluded that, road transport is very stressful in camel, and the effects of this stress on the relevant indicators raising much with distance and advised future work should focus on the effect of transport distance on some quality indicators of camel meat.

Pradhan (2016) reported and compared the hematological and serum biochemical profile of Black Bengal goat and Koraput sheep from Angul district in central Odisha, India. One hundred and twenty-five blood samples (97 Black Bengal goat and Koraput 28 sheep) were collected and their blood glucose, hemoglobin and serum biochemical parameters, cholesterol, aspartate transaminase (AST), alanine aminotransferase (ALT) and lactate dehydrogenase (LDH) were determined by using spectrophotometer. Parameters were compared between Black Bengal goat and Koraput sheep. It was observed that glucose (P=0.001), LDH (P=0.001) and ALT (P=0.001) concentrations differed significantly between Koraput sheep and Black Bengal goats. Mean blood glucose (mg/dl) levels reported were 70.6±8.6 (range 49.0-91.0) and 63.08±14.0 (range 42.0-77.0) in Black Bengal goats and Koraput sheep respectively. The studied parameters were compared between buck and Black Bengal goats and also between young Black Bengal goats (less than 12 months old) and adults (more than 12 months old). It was found that age and gender did not affect these hematological and serum biochemical parameters. Koraput sheep have overall higher values for hematological and serum biochemical parameters than Black Bengal goats.

Tajik *et al.,* (2016) studied the effect of transportation stress on serum concentrations of cortisol, thyroid hormones, β-hydroxybutyrate, non-esterified fatty acids, plasma total protein and glucose in Iranian Cashmere (Raini) goats. On the first day, blood samples from 10 Raini goats (5 males and 5 non-lactating non-pregnant females) were collected at 8 A.M. (T1), and after 3h food and water deprivation (T2). On the second day, samples were collected at 8 A.M. (T3), and after 3h transport (T4). Final blood sample was taken 24 h after transport ended

(T5). They reported that, food and water deprivation caused a significant decrement in serum cortisol, and a significant increase between T2 and T3. Transportation caused a significant increase in serum cortisol, and the increase continued until T5. Serum T3 showed a marginally significant decrease due to the food and water deprivation. Serum T4 and NEFA significantly increased between T2 and T3. No significant change in serum concentrations of glucose, fT3, fT4, T3 /T4 ratio and BHBA in different samplings were observed. The study showed that short road transport had a significant effect on some stress biomarkers in Cashmere goats; however, it takes a longer time before hormonal control of metabolism can be affected.

Ochi *et al.,* (2016) determined the effect of long-distance (approximately 600 km) road transportation on the blood biochemistry of laboratory animals. They investigated the changes in serum biochemical parameters in healthy cynomolgus monkeys and beagle dogs transported by truck from Osaka to Tsukuba, Japan. The concentrations of serum cortisol, total bilirubin and aspartate aminotransferase in monkeys increased during transportation. Serum cortisol and total bilirubin levels in dogs also increased during transportation, but serum triglyceride decreased. Serum parameter values in truck-transported monkeys and dogs returned to baseline levels within two weeks following arrival. Taken together, these results suggest that a two-week acclimation period is the minimum duration required for adaptation following road transportation.

Attia (2016) studied the effect of heat stress on the physiological, some hematological and biochemical parameters. Twenty-five goats were exposed to the daytime (30 days) after an initial 7-day shading period, while another 10 goats were exposed to the shading regimen throughout the entire 30 days as a control group. Heat stressed goats showed the decrease of the feed intake, body weight and growth rate. Physiologically, the rectal temperature, respiration and heart rates were observed to be significantly higher. Moreover, the red blood cells count (RBCs), hemoglobin concentration (Hb), and packed cell volume (PCV) were significantly increased, whereas an insignificant change in white blood cells count

(WBCs). Also, the serum total proteins, albumin, glucose, urea and creatinine levels were significantly decreased. On the other hand, cortisol level was significantly increased in heat stressed goats. There results indicated that heat stress produced a significant alteration in the physiological, some hematological and biochemical parameters.

Kalio and Anyanwu (2016) conducted study to investigate the performance and hemato-biochemical parameters of WAD Does fed crop by-products: Yam peels(T1YP) Cassava peels (T2CP), Sweet potato peels (T3SPP) and Ripe plantain peels (T4RRP) in humid tropical Cross Rivers State of Nigeria. Sixteen (16) twenty (20) weeks old West African Dwarf (WAD) Doe's with average initial body weights of 7.308 ± 1.41 kg were used. The four crop by-products used were replicated 4 times with 1 Doe per replicate in a completely randomized design (CRD). Feed dry matter intake (FDI), final body weight (FBW), final weight gains (FWG) and feed conversion ratios (FCR) were significantly ($P < 0.05$) different. The blood biochemistry for the WAD Does in all the treatment groups fell within the reference range for normal goats in terms of Glucose (2.7-4.2 mmol/L), Creatinine (59.7-134.8 μmol/L), Cholesterol (1.54 mmol/L), BUN (32. 25 – 37.30 mg/dl), K (3.8-5.7 mmol/L), Na (136.6 – 151.5 mmol/L), Cl (100.3-111.5 mmol/L), Ca (2.25-2.90 mmol/L), P (3.7-5.7 mg/dl) respectively. The WAD Does fed with T2CP exhibited superior performance characteristics. Consequently, the utilization of crop by-products used in this study has no deleterious effects on the nutritional and health conditions of the WAD Does and is recommended for use in goat production systems.

Al-Bulushi *et al.,* (2017) studied some hematological and biochemical parameters of different goat breeds in Sultanate of Oman. A total of 30 healthy animals of different Omani goat breeds were selected randomly from different areas in Sultanate of Oman. The blood samples were collected from the jugular vein into two tubes for blood hematology and biochemical analysis. Result indicated that no statistically significant variation in most hematological and biochemical parameters was found among the Omani goat breeds. The results of blood hematology revealed that the mean white blood cells (14.6±3.32 ×103 /μL),

and the percentage of neutrophils in Omani goats (60.87±8.46%) were higher than that in most goat breeds. Higher values of red blood cells (12.8±1.28 ×106 /µL), hemoglobin (10.4±1.92 g/dl), hematocrit (38.29±4.06%), and lower values of mean corpuscular HGB concentration (27.05±3.5 g/dl) were observed in Omani goat breeds comparing to that in the other goat breeds. Lower values of total bilirubin (0.22±0.03 mg/dl), blood urea nitrogen (14.62±2.66 mg/dl), and cholesterol (48.58±19.05 mg/dl) were found in Omani goat breeds when compared to that of the other goat breeds. In their study, mean albumin concentration was lower than that reported in Sahel and red Sokoto breeds, but it was slightly higher than that reported in Saanen and WAD goat breeds. The differences in serum albumin values (3.07±0.25 vs. 2.76±0.48 g/dl) may be caused by liver diseases, malnutrition and dehydration.

Gupta *et al.,* (2019) conducted study to investigate the seasonal effects of transportation of goats (Alpine x Beetle) at different flocking densities, supplemented with Vitamin C in group I, Vitamin C + Electrolyte in group II and Jaggery in group III, 3 days before transport of animal, during winter and hot-humid seasons. The goats were selected from LRC, NDRI Karnal and were of 10-12 months old. Each group consisted of 25 goats each, divided into high (15) and low (10) flocking densities, transported for 8h with average speed of 25 Km/h. All the animals were kept off-feed and deprived of water during the transportation period. Physiological responses (Respiration rate, rectal temperature, Pulse rate and Skin temperature) were recorded before and after transportation. A significant increase ($P<0.05$) in ST, RT, RR and PR were recorded just after unloading in both the flocking density groups and during both seasons which then declined to basal values ($P<0.05$) within 6-12 hours post transportation. Supplementation with Vitamin C, Vitamin C + Electrolyte and Jaggery aided in reducing transportation stress but Vitamin C + Electrolyte combination proved more beneficial in alleviating transportation stress in goats.

Antunovic *et al.,* (2019) conducted research to determine the hemato-biochemical profile and blood acid– base status of Croatian spotted goats in a traditional Mediterranean production system. The 60 non-gravid female Croatian

spotted goats of different ages were included in the research. They were divided into four groups of 15 goats according to age: group I – ≤ 1 year old; group II – 2–3 years; group III – 3–6 years; and group IV – 7–10 years. Hematological parameters were determined in whole blood, biochemical parameters in serum and acid–base status in plasma by automatic analyzer. Total leukocyte number, hemoglobin and mean corpuscular volume in the blood were the highest, while mean hemoglobin concentration in erythrocytes was the lowest in yearlings compared to other groups. Concentrations of urea, Mg, Cl, Non-esterified fatty acids and lactate were the highest in yearlings. Concentrations of Ca, Na, total cholesterol, high-density lipoprotein, very low-density lipoprotein and beta hydroxybutyrate as well as the activity of alanine aminotransferase (ALT) were higher in older goats compared to yearlings, while the opposite was determined for the activities of creatine kinase (CK) and alkaline phosphatase (ALP). The results indicated that in group-I, the levels of serum total proteins (g/dl), Albumin (g/dl), Globulin(g/dl), A/G ratio, Glucose (mmol/l), Calcium(mmol/l), Phosphorus (mmol/l), Na (mmol/l), K (mmol/l), Cl (mmol/l) were 8.03, 3.25,4.78,0.69, 2.18,2.28,2.70,140.6,3.18 and 109.4 respectively.

Zulkifli *et al.,* (2019) investigated the effect of sea and road transport on the physiological response of cattle. The animals were transported by sea (14 d) from Darwin Port, Australia, to Pasir Gudang Port, Johor, Malaysia. Thereafter, the animals were road transported (330 km) from Pasir Gudang Port to University Putra Malaysia (UPM). The objective of the current study was to evaluate the effects of sea and road transport on the acute phase proteins (APP), cortisol, metabolic, hematological and electroencephalographic (EEG) responses of Brahman crossbred heifers. Sixty Brahman crossbred heifers were subjected to 14 d of transportation by sea from Darwin Port, Australia, to Pasir Gudang Port, Johor, Malaysia, and 330 km of road transportation. Results revealed that the intensity of response for most blood biochemical parameters increased significantly and were different from the baseline values taken while the animals were in Darwin Port, Australia. Hematological results obtained also revealed a significant increase and were different from the baseline values. Cortisol and APP (bovine alpha 1-acid glycoprotein and serum amyloid - A) values increased

significantly and were different from the baseline values. Hematological parameters, APP, cortisol and EEG data (alpha, beta, delta and theta waves, total power and median frequency) decreased significantly following 4- and 7-days' post-transport, suggesting a recovery of the animals from the stressfulness of transport. In conclusion, the current results revealed that the concentrations of biochemical and hematological parameters, cortisol, APP and EEG data were affected by both sea and road transport. From the results of the various blood stress indicators and brain activity of the animals, both sea and road journeys were found to be stressful to the animals. However, the animals recovered from the stressful transport journeys following 4 and 7-days post-transport.

Ajagbe (2019) conducted 60-day feeding trial with 40 growing West African Dwarf bucks aged 5–7 months with an initial average weight of 5.25 kg ± 0.35 to determine their hematological and serum biochemical parameters. The goats were randomly allocated to five treatments namely: T1 (100% urea-treated cassava peel), T2 (60% untreated cassava peel + 40% cassava foliage), T3 (60% untreated cassava peel + 40% poultry manure), T4 (60% untreated cassava peel + 20% cassava foliage + 20% treated cassava peel), and T5 (60% untreated cassava peel + 20% cassava foliage + 20% poultry manure) in a complete randomized design. Each treatment was split into eight replicates. At the end of the feeding trial, blood samples were collected from four goats per treatment to evaluate the hematological indices viz. packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), hemoglobin, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and MCH concentration (MCHC). Serum parameters determined were total protein (g/dL), albumin (g/dL), globulin (g/dL), creatinine (mg/dL), alkaline phosphatase (ALP) (iu/L), alanine transaminase (ALT) (iu/L), aspartate aminotransferase (AST) (iu/L), and urea (iu/L). PCV, RBC and WBC showed significant ($P>0.05$) difference among the treatment groups while other hematological parameters examined showed no significant differences ($P>0.05$). Serum biochemical parameters indicated that total protein ranged from 4.10 to 5.18 g/dL, albumin: 1.90–2.55 g/dL, creatinine: 0.08–1.28 mg/dL, ALP: 53.18–96.95 iu/L, ALT: 138.75–176.50 iu/L, globulin: 2.20–3.03 iu/L, AST: 16.18–17.58 iu/L, and urea: 17.60–23.75 iu/L. All the

values obtained for hematological and serum biochemical parameters were within the normal ranges for growing goats.

Ramesh *et al.,* (2019) undertook comparative analysis of serum biochemical parameters during different physiological conditions within Hassan breed of sheep in Karnataka. From each flock, 2 groups of animals i.e., pregnant and lactating animals of >2 years of age were selected. Blood samples, each of 5-10 ml, were collected from jugular vein of each animal into sterile vacutainer with and without anticoagulant. The study revealed no significant difference in the values of total protein, urea, albumin, sodium, ALT, creatinine, total bilirubin, direct bilirubin, AST and cholesterol between pregnant and lactating ewes. Whereas, significantly higher value of serum calcium and potassium were observed in pregnant ewes than in lactating ewes and significantly higher serum glucose was observed in lactating ewes compared to pregnant ewes.

Manuelian *et al.,* (2020) conducted study to describe metabolic, oxidative, and mineral blood profiles of Saanen does through lactation compared with Mediterranean breed clusters (Maltese and Rossa Mediterranean, and Jonica, Garganica, and Girgentana). Milk and blood samples of 57 dairy goats (9–10 goats per breed) were collected from the 2nd to the 30th week of lactation every 2–3 weeks. Saanen showed greater milk yield and somatic cell score, and lower fat and protein percentage through lactation ($p< 0.05$) than the Mediterranean breed clusters. Blood analysis revealed that stage of lactation had a greater impact than breed cluster, except for uric acid, alkaline phosphatase, and aspartate aminotransferase. Plasma non-esterified fatty acids indicated a greater negative energy balance in Saanen than the other breed clusters during early and medium lactation stages ($p < 0.05$). Serum Cl, Mg, and Ca increased in all the breed clusters from early to the following stages of lactation ($p < 0.05$). No significant peroxidant/antioxidant imbalances were detected in any of the three clusters during the entire lactation. In conclusion, Mediterranean breeds tended to recover earlier from negative energy balance than Saanen, but effects of breed or stage of lactation on long-term oxidative stress indicators were not evident.

3. Material and Method

The research work was undertaken at the Department of Veterinary Biochemistry , Mumbai Veterinary College, Parel, Mumbai- 400 012 and Advy Chemicals Pvt.Ltd. farm located at Phalegaon, Kalyan, Dist.Thane, Maharastra.

3.1 Experimental Animals:

The experiment was conducted on 50 healthy adult goats irrespective of any sex, age and breed. Goats were road transported for 6 hr. in truck in standing position without feed and water available during transportation period. Average ambient temperature and relative humidity on the day of transportation was 31^{O}C/ 51% at Sangamner (loading place) and in Thane (Unloading place) it was 35^{o}C and 47.5% respectively.

3.2 Collection and preservation of blood sample:

Blood samples (3-5 ml) were collected from adult goats before loading them in tempo/ truck for transportation. after 8hrs of transportation, these goats were unloaded at Advy Chemicals Pvt. Ltd. farm located at Phalegaon, Kalyan, Dist. Thane second blood collection were carried out immediately after the unloading of these animals. Third and fourth blood sample collections were carried out thereafter, weekly interval for next two weeks. Serum was obtained immediately after collection by centrifugation @3000 rpm for 10 minutes and stored at -20^{o}C till to be analyzed.

3.3. Estimation of Electrolytes:

The electrolytes were estimated by using ISE (ion selective electrode) AGD EL-120 auto-electro analyzer, which consist Sodium, Potassium, Chloride, ionised calcium and reference electrods. Each electrode has membrane which is selective for the specific ions moving across membrane. The membrane is an ion exchanger resulting in the membrane potential or measuring voltage, which is built-up between the sample and membrane.

The difference in concentration between the inner electrolyte and the sample causes an electro-chemical potential to form across the membrane of the active electrode. The potential is conducted by a highly conductive, inner

electrode to an amplifier. The reference electrode is connected to ground as well as to the amplifier.

3.4. Estimation of biochemical parameters:

The blood was processed to estimate serum Glucose, Total Protein, Albumin, Globulin, Total Calcium and Phosphorus by using AGD Biochemical autoanalyzer (semiautomatic). While Sodium, Potassium, Chloride and Calcium with the help of AGD ion selective electrolyte analyser (ISE). All these analysis were carried out in Department of Veterinary Biochemistry Department, Mumbai Veterinary College, Parel, Mumbai.

3.4.1. Estimation of Serum Glucose –

Glucose estimation is carried out by "Enzymatic GOD-POD" method. Glucose oxidase (GOD) converts the sample glucose into gluconate and hydrogen peroxidase (H_2O_2). Hydrogen peroxide in presence of Peroxidase (POD) oxidises the chromogen 4 – amino antipyrine / phenolic compound to a red coloured compound. The intensity of the red coloured compound is proportional to the glucose concentration and is measured at 505nm.

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\text{GOD}} \text{Gluconic Acid} + H_2O_2$$

$$2H_2O_2 + \text{4-aminoantipyrine} + \text{phenol} \xrightarrow{\text{POD}} \text{Red Quinone} + 4\ H_2O$$

Reagent:

Phosphate buffer	200mmol(p^H=7.0)
GOD	>5000IU/l
POD	>3000IU/l
4AAP	0.28mmol/l
Phenol	16 mmol/l
Standard	100mg/dl
Sample	Serum

Reagent preparation:

The regent and standard were ready to use

Reaction	End point (Increasing)
Wavelength	505nm (492-520nm)

Light Path	1cm
Reaction Temprature	$37^{O}C$
Blank / Zero setting	Reagent
Reagent volume	1000µL
Sample volume	10µL
Incubation time	10mins
Standard Concentration	100mg/dl
Low Normal	70mg/dl
High Normal	110mh/dl
Linearity	700mg/dl

Test procedure:

All the contents of the kit were brought to room temperature prior to use.

	Blank	**Standard**	**Sample**
Reagent	1000 µL	1000 µL	1000 µL
Distilled water	20 µL	-	-
Standard	-	20 µL	-
Sample	-	-	20 µL

Calculations:

$$\text{Conc.of U} = \frac{\text{Conc.of Std.}}{\text{Conc. of Std} - \text{Abs. of Reagent Blank}} \times \text{Abs.of U- Abs. of Reagent Blank}$$

Where,

U= Unknown

Std.= Standard.

3.4.2. Estimation of Serum Total Protein –

Total protein method is estimated by Biuret method. Cupric ions in an alkaline solution react with the peptide bonds of proteins and polypeptide bonds of proteins and polypeptide containing at least two peptide bonds to produce a violate coloured complex. The absorbance of the complex is directly proportional to the concentration of protein in the sample which is measured at 546nm (530-580).

$$Cu^{++} + \text{Protein} \xrightarrow{OH^-} \text{Cu -Protein complex}$$

Reagent :

Cupric sulphate 6mmol/l

Potassium iodide 15mmol/l

Tartarate 20mmol/l

Standard 6g/dl

Sample : Serum

Reagent preparation :

The regent and standard were ready to use

Reaction	End point (Increasing)
Wavelength	546nm (530-580nm)
Light Path	1cm
Reaction Temperature	$37^{O}C$
Blank / Zero setting	Reagent
Reagent volume	1000µL
Sample volume	10µL
Incubation time	5mins
Standard Concentration	6.0g/dl
Low Normal	6.2g/dl
High Normal	8.0mg/dl
Linearity	12.0g/dl

Test Procedure :

All the contents of the kit were brought to room temperature prior to use.

	Blank	Standard	Sample
Reagent	1000 µL	1000 µL	1000 µL
Standard	-	20 µL	-
Sample	-	-	20 µL

Calculations :

$$\text{Total Protein (g/dl)} = \frac{\text{A sample}}{\text{A standard}} \times \text{Conc. of Std (g/dl)}$$

3.4.3. Estimation of Serum Albumin –

Albumin estimated Bromocresol-green method. At pH 5.0, Albumin is positively charged and it binds with anionic Bromocresol-green to produce blue green complex. The colour produced is measured at 630nm (600-650nm). The colour produced is stable for 10 minutes.

$$\text{Albumin + BCG} \xrightarrow{\text{pH4.3}} \text{Albumin – BCG Complex}$$

Reagent :

Bromocresol green 750mmol/l

Succinic Acid 350mmol/l

Standard 4g/dl

Sample : Serum

Reagent preparation:

The regent and standard were ready to use

Reaction	End point (Increasing)
Wavelength	630nm (600-650nm)
Light Path	1cm
Reaction Temperature	$37^{O}C$
Blank / Zero setting	Reagent
Reagent volume	1000µL
Sample volume	10µL
Incubation time	5mins
Standard Concentration	4.0g/dl
Low Normal	3.8g/dl
High Normal	5.4mg/dl
Linearity	8.0g/dl

Test procedure:

All the contents of the kit were brought to room temperature prior to use.

	Blank	**Standard**	**Sample**
Reagent	1000 µL	1000 µL	1000 µL
Standard	-	10 µL	-
Sample	-	-	10 µL

Calculations:

$$\text{Albumin (g/dl)} = \frac{\text{A sample}}{\text{A standard}} \times \text{Conc. of Std (g/dl)}$$

3.4.4 Estimation of Serum Globulin

Globulin (g/dl) = Total Protein – Albumin.

3.4.5. Estimation of Serum Total Calcium

At acidic pH the Ca^{++} forms a complex with Arsenazo III, the colour intensity of which is directly proportional to the concentration of calcium in the sample.

Ca^{++} + Arsenazo III $\xrightarrow{\text{Acidic Medium}}$ Ca- Arsenazo III complex (Purple)

Reagent :

Imifazole buffer p^H7.0 100mmol/l

Arsenazo III 100mmol/l

8-Hydroxyquinoline 5mmol/dl

Standard 10mg/dl

Sample: Serum

Reagent preparation:

The regent and standard were ready to use

Reaction	End point (Increasing)
Wavelength	630nm (620-650nm)
Light Path	1cm
Reaction Temperature	37^OC (R.T.)
Blank / Zero setting	Reagent
Reagent volume	1000µL
Sample volume	25µL
Incubation time	5mins
Standard Concentration	10mg/dl
Low Normal	8.8g/dl
High Normal	10.2mg/dl
Linearity	16.0mg/dl

Test procedure :

All the contents of the kit were brought to room temperature prior to use.

	Blank	**Standard**	**Sample**
Reagent	1000 µL	1000 µL	1000 µL
Standard	-	25 µL	-
Sample	-	-	25 µL

Calculations:

$$\text{Calcium (mg/dl)} = \frac{\text{A sample}}{\text{A standard}} \times \text{Conc. of Std (mg/dl)}$$

3.4.6. Estimation of Serum Phosphorous

Inorganic phosphorus reacts with molybdate to form a heteropolyacid complex. The sulfuric acid eliminates the need to prepare a protein free filtrate. The absorbance at 340nm is directly proportional to the inorganic phosphorus level in the sample.

Phosphate + Aluminium Molybdate $\xrightarrow{H2SO4}$ Heteropolyacid – Phosphomolybdic complex

Reagent:

Ammonium Molybdate 0.3mmol/l

Sulphuric Acid 1.0%

Standard 5mg/dl

Sample: Serum

Reagent preparation:

The regent and standard were ready to use

Reaction	End point (Increasing)
Wavelength	340nm
Light Path	1cm
Reaction Temperature	37^{O}C (R.T.)
Blank / Zero setting	Reagent
Reagent volume	1000µL

Sample volume	10µL
Incubation time	5mins
Standard Concentration	5.0mg/dl
Low Normal	3.0g/dl
High Normal	4.5mg/dl
Linearity	10.0mg/dl

Test procedure:

All the contents of the kit were brought to room temperature prior to use.

	Blank	**Standard**	**Sample**
Reagent	1000 µL	1000 µL	1000 µL
Standard	-	10 µL	-
Sample	-	-	10 µL

Calculations :

$$\text{Phosphorus conc.(mg/dl)} = \frac{\text{A sample}}{\text{A standard}} \text{ x Conc. of Std (mg/dl)}$$

Statistical Analysis –

Results of various parameters recordedfor the experimental animals were tabulated and data were statistically analysed by CRD as per Snedecor and Cochran (1994).

4. RESULTS & DISCUSSION

4.1 Sodium

Sodium is the major extracellular cation and is a primary determinant of plasma osmolality and extracellular fluid volume. Sodium concentration is inextricably linked with ECF volume; therefore, interpretation of sodium levels should always include consideration of the hydration status. The body attempts to maintain a constant ECF volume, as major changes in ECF volume can have profound effects on cells. The kidney plays a critical role in maintenance of ECF volume, via sodium and water retention in response to antidiuretic hormone and aldosterone. Thirst is also stimulated by decreases in ECF volume or increases in effective osmolality. Regulation of body water is accomplished through osmoreceptors and baroreceptors, with the kidney being the main organ where sodium is retained. Sodium concentrations can also be affected by epinephrine, which stimulates renin release and sodium absorption. This effect is transient, an increase in sodium concentration of between 5-10 mEq/l was seen in goats 60 minutes after injection of 2 mg epinephrine and sodium normalized by 90 minutes (Abdelatif and Abdalla, 2012)

In a healthy animal, thirst, and excretion of concentrated urine are the two mechanisms defend against hypernatremia. An increase in serum sodium and associated hyperosmolality create thirst, and water intake lowers serum sodium to a normal level. By excreting concentrated urine, the kidneys try to conserve water. Thus, hypernatremia and hyperosmolality are prevented. Hypernatremia develops when there is no access of drinking water. Acute hypernatremia may cause lethargy, irritability, and weakness. These signs and symptoms may progress to seizures and coma.

In our study the mean ±SE levels of serum sodium during transportation period in goats is presented in Table: and its analysis of variance in Table 1.0 and 1.0 depicted in Fig.1 Serum sodium levels at preloading, after unloading and at 1^{st} and 2^{nd} week after unloading were 134.90± 2.02,147.37 ±1.75, 145.92±0.96 and 145.58±1.09 mmol/l respectively. In our study mean serum sodium level ranged from 134.90 ±2.02 to 147.37 ±1.75 mmol/l during transportation. There was significant increased ($P<0.01$) in the level of serum

sodium immediately after transportation of these animals. The levels then came to its preloading value at 1st week after transportation and remained same at 2nd week after transportation in these animals.

Preloading mean ± SE serum sodium level observed in our study was within normal range for goats and were comparable with value reported by Daramola *et al.* (2005) in WAD goats, Tambuwal *et al* (2002) in Red Sokoto goats, Oduye and Adadevoh (1976) in WAD sheep, Abdolvahabi *et al.* (2016) in Sannen goat kids, Affan. *et al.* (2018) in healthy Boer goat, Soares *et al.* (2018) in dairy goats during the period of transition and also reported by Njidda *et al.* (2014) in adult sheep at semi-arid environment of Northern Nigeria. The levels of serum sodium are also an agreement the reports of Aynalen Gemechu and Kibeb (2017) in healthy local breed of sheep in Ethiopia.

In the present study there was significant increased ($P<0.01$) in the level of serum sodium immediately after transportation of these animals. These results are in agreement with the reports of Schaefer *et al.* (1990). They reported significant ($p<0.01$) increased in serum level of sodium after transportation in bulls.

In conclusion, in our study, the increased in the levels of serum sodium seems to be due to transportation stressors, which primarily include off feed and water, crowding and poor ventilation which resulted in dehydration. The levels of serum sodium, came to its preloading value at 1st week after transportation which indicate proper hydration of these animal at farm.

4.2 Potassium

Potassium is the major intracellular cation in the body. The intracellular concentration of potassium is about 140–150 mEq/l and in blood it is 3.5–5 mEq/l. Serum contains a slightly higher concentration of K^+ than plasma because K^+ is released from red blood cells during clot formation. Potassium is necessary for several cellular functions, which primarily includes protein biosynthesis, regulation of pH and enzyme activation. Most important function of K^+ is the maintenance of the resting membrane potential for cellular excitability and contraction and nerve transmission. The high intracellular K^+ concentration is maintained by the Na/K-ATPase located in the cell membranes of all animal cells.

The kidney is the primary route for K^+ excretion. In general, K^+ excretion in the urine, parallels dietary intake. The K^+ is also excreted via GIT.

The mean ±SE levels of serum potassium during transportation period in goats is presented in Table 2.1 and its analysis of variance in Table 2.0 and depicted in Fig.2 Serum potassium levels at preloading, after unloading and at 1st and 2nd week after unloading were 4.96 ±0.09,4.74 ±0.07, 5.11 ±0.04 and 5.40 ±0.07 mmol/l respectively. In our study mean serum potassium level ranged from 4.74 ±0.07 to 5.40 ±0.07 mmol/l during transportation. There was significant decreased ($P<0.01$) in the level of serum potassium immediately after transportation of these animals. The levels then increased non-significantly to its preloading value at 1st week after transportation and increased significantly ($P<0.01$) at 2nd week after transportation in these animals.

Preloading mean ± SE serum potassium level observed in our study was within normal range for goats and were comparable with value reported by Daramola *et al.*(2005) in WAD goats, Tambuwal *et al.* (2002) in Red Sokoto goats, Oduye and Adadevoh (1976) in WAD goats, Waziri *et al.* (2010) in WAD goats, Aynalem *et al.* (2017) in local breed of Sheep in Ethiopia. Our results are also consistent with the reports of Affan *et al.* (2018) in healthy Boer goat. The levels of potassium in our study are also comparable with the reports of Njidda *et al.* (2014) in adult sheep at semi-arid environment of Northern Nigeria and the reports of Gemechu and Kibeb (2017) in healthy local breed of sheep in Ethiopia. Das (2010) reported the mean level of 5.70±0.07 Meq/l of potassium in Assam local breed and Assam local crossed with Beetal breed of goat.

In the present study there was significant decreased ($P<0.01$) in the level of serum potassium immediately after transportation of these animals. The mean serum potassium level obtained at preloading decreased significantly after transportation. Similar results are reported by Ayo *et al.* (2009) in Nigerian goats after 12 hrs of road transportation. The decreased in the serum level of potassium after stressful transportation may be due to skeletal muscle damage. Potassium released from working muscle under stress or exercise, due to change in membrane permeability and increased cellular turnover. Similar observations on decreased serum potassium were reported by Montane *et al.* (2002) in human after

completion of exercise and transportation of roe deer and in cattle (Parker *et al.*, 2003), horses (Codazza et al.,1974)due to muscular damage. However, Soares *et al.* (2018) during the period of transition reported no significant change in the level of potassium in dairy goats.

4.3 Chloride

Chloride is an inorganic anion. It is distributed exclusively within the extracellular fluid and the interstitial fluid compartment. Chloride is the major anion associated with sodium in the ECF. Normal serum chloride concentrations range from 96 to 106 mEq/l in goats. Chloride is the principal anion of the extracellular fluid and vital for both serum electroneutrality and acid-base homeostasis.Chloride is vital for maintenance of serum electroneutrality, acid-base balance, fluid homeostasis, osmotic pressure, hydrochloric acid production in the gastrointestinal tract, renal function, and for electrical activity in general. Chloride is identified as the primary factor influencing the occurrence of metabolic alkalosis and non-anion gap metabolic acidosis in critical illness.

The mean ±SE levels of serum chloride during transportation period in goats is presented in Table: 3.0 and its analysis of variance in Table 3.1 depicted in Fig.3 Serum chloride levels at preloading, after unloading and at 1st and 2nd week after unloading were 96.73 ±1.78,106.29 ±1.28, 108.8±0.96 and 106.26±1.13 mmol/l respectively. In our study mean serum chloride levels ranged from 96.73 ±1.78 to 108.8±0.96 mmol/l during transportation. Mean preloading serum chloride levels in our study is slightly higher than the values of 91.0±1.2mmol/l reported by Ayo *et. al.*(2009). There was significant increased ($P<0.01$) in the level of serum chloride immediately after transportation of these animals. The levels did not come to its preloading value at after transportation till 2nd week after transportation and remained slightly higher.

Ayo *et. al.* (2009) reported chloride levels of 91.0±1.2 and 89.0±2.2 mmol/l in control and experimental group respectively immediately after loading in Nigerian goats. This insignificant change in chloride concentration was recorded post loading suggest that, the stress induced by handling and loading did not induced acidosis. However, the significant ($p<0.01$) increased in the chloride concentration post transportation affected their acid base balance which might

have resulted into stress acidosis. In our study there is significant increased in the serum chloride levels immediately after transportation. Similar observations were reported in horses by Davidson *et al.* (2004), Montane *et al.* (2002) in roe deer. However, results are disagreed with that of Parker et al (2003) who failed to record any change in serum concentrations of chloride in cattle after 48 hr transportation.

4.4 Ionized Calcium (iCa)

Approximately 40% of serum total calcium is bound to proteins, mostly to albumin and also to some extent globulins. The remaining 10% is complexed with anions such as phosphate, bicarbonate, and citrate. Ionized calcium plays a significant role in cellular metabolic functions, such as muscle contraction, nerve impulse transmission, activation of enzyme, blood coagulation, hormone secretion etc. Plasma ionized calcium is maintained within narrow limits by the interplay between resorption by the intestine, bone, and kidney. Redistribution of Ca among the three plasma pools can occur acutely or chronically, by changes in the concentration of protein, small anions or alteration in pH. Ionized Ca is kept in the narrow reference range of 4.5-5.5mg /dl by an integrated homeostatic mechanism involving parathyroid hormone and 1, 25 dihydroxy vitamin D axis. The concentration of ionized calcium dependent on blood pH and increased in levels occurs when pH falls and vice versa.

In our study the mean ±SE levels of ionized calcium during transportation period is presented in Table: 4.0 and its analysis of variance in Table: 4.1 and depicted in Fig.4.1Serum ionized calcium levels at preloading, after unloading and at 1st and 2nd week after unloading were 5.70 ± 0.09, 5.14 ± 0.19, 5.20 ± 0.17 and 5.57 ± 0.10mg/dl respectively. Mean serum ionized calcium level ranged from 5.14 ± 0.19 to 5.57 ± 0.10 mg/dl through preloading, after unloading, 1st week and 2nd week after the transportation which is more than half of the total serum calcium observed in this study. Preloading ionized calcium levels observed in our study was within normal range for goats and was comparable with range reported by Jackson and Cockcrof (2002) in sheep and Dias *et al.* (2010) in Churra-da-Terra-Quente ewes from the Portugal. After going through the literature, it is found that, no study has been undertaken to established

the levels of ionized calcium during transportation in goats and available to compare with our finding.

The ionized calcium significantly ($p<0.05$) decreased after transportation in these goats and remained at lower level up to 1st week after transportation. The level again increased significantly nearly to its preloading value at 2nd week after transportation. The significant decreased in the levels of ionized calcium after transportation could be due to entry of calcium in the muscle and transport tetany which occurs after transportation stress with minimal or no access of food and water.

4.5 Total Proteins

Serum or plasma total proteins represent the total amount of proteins in blood serum form three major groups and have various functions. Albumin constitutes approximately 60%, fibrinogen 4%, and globulins 36% of total plasma protein. In blood plasma, the most abundant protein is albumin, which helps to maintain the colloidal osmotic pressure of the blood. The plasma total protein is mainly composed of albumin in animals and this protein acts as a carrier for transport of different components such as hormones, fatty acids and amino acids etc. Additionally, albumin is as a large amino acid and proteins reservoir in body. Protein measurements may reflect the nutritional state. Majority of plasma proteins are synthesized in liver, with albumin representing their largest quantitative part. Individual protein fractions, or blood serum proteins, have different functions and their identification is used also as a diagnostic tool. Physical and psychic exertions occurring during road transportation of food animals disrupt their homeostasis and metabolism and consequently, increase activity of enzymes and hormones (Ayo and Oladele, 1996; Adenkola and Ayo 2009).

The mean ±SE levels of serum total proteins during transportation period in our study is presented in Table: and its analysis of variance in Table 5.0 and depicted in Fig.5 Serum Total proteins levels at preloading, after unloading and at 1st and 2nd week were 6.33± 0.07, 7.47 ± 0.17 , 6.50 ± 0.08 and 6.63 ± 0.01 g/dl respectively.The total proteins level ranged from 6.33± 0.07 g/dl to7.47 ± 0.17 through preloading, after unloading, 1st week and 2nd week after

transportation. Preloading total proteins levels observed in our study were within normal range for goats and were with a mean reported by Ghanim *et .al*., (2016, 6.28 ± 0.37 g%) in local breed of goat, Oduye and Adadevou,(1976, 6.36±0.80gm/dl), Adejinmi and Akinboade,(2000 ,7.50±0.80gm/dl), Kamalu *et al.* (1988; 5.28-6.65gm/dl), Daramola *et al.* (2005) in West African Dwarf goats and Okoruwa (2014) in Dwarf goats. But slightly lower than the reports of Antunovic *et al.*, (2019) in creation spotted goats.

Maximum level total proteins of 7.48 $\pm 0.17^{b}$ g% was observed immediately after transportation i.e., after unloading. There was significant increased ($P<0.01$) in the level of serum total proteins, immediately after transportation of these animals. In our study goats had been transported in truck for about 6 hrs. During transportation the goat might undergone various transportation stress due to handling them during loading in truck, new environment, crowding, water and feed deprivation during the journey, oscillations etc. Proteins are constantly synthesized by the liver at the rate to maintain the normal range of the plasma proteins. Its level is affected by the hydration status of the animal. In our experiment during transportation animals were undergone various transportation stress. Among these stresses water and feed deprivation and increased heat due to crowding might be resulted in dehydration, which in turns increased relative concentration of serum proteins after unloading samples of the goats. The levels of total proteins at 1^{st} and 2^{nd}week after unloading the goat were similar to the preloading and there was no significant difference found. This indicates the animals were rehydrated after unloading and thereafter.

In contrast to our findings significant reduction in total proteins, albumin and globulin levels has been reported by Dangi *et al.* (2012) during heat stress in goats. However, findings of Okoruwa (2014) are consistent with our study, reported increased total proteins and albumin in goats during heat stress could be due to dehydration response to increased respiratory rate. Mormede *et al.* (1982) also reported significant increase in serum total protein and albumin in calves after subjected them to long journey travel. Plyaschenko and Sidorov (1987) reported an increased haemoglobin concentration and an elevated blood

level of total cholesterol, lactic acid, total protein, gamma-globulins in pigs transported for a distance of 150 km in 3-4hr.

Parker *et al.*, (2003) reported increase in serum total proteins levels when animals suffer from dehydration as a result of long hour journeys. Brown *et al.* (1999) noted that pigs subjected to 24 h of road transportation suffered severe dehydration as the concentrations of plasma total protein and albumin were increased significantly and returns to normal after animals were hydrated at lairage. This result was similar to that observed in sheep (Knowles *et al.*, 1995) and cattle (Knowles *et al.*, 1999; Parker *et al*., (2003). During a 19 h road transport of calves, the levels of total protein increased after the journey in all groups during both winter and summer periods (Knowles *et al.*, 1999).

In conclusion,in our study, the increased in the levels of serum total proteins seems to be due to transportation stressors, which primarily include off feed and water, crowding and poor ventilation which resulted in dehydration.

4.6 Albumin

Albumin constitute approximately 60% of total plasma proteins.It is the most abundant protein in blood which helps to maintain the colloidal osmotic pressure of the blood and also acts as a carrier for transport of different components such as hormones, fatty acids and amino acids etc.

The mean ±SE levels of serum albumin during transportation period is presented in Table6.0 and its analysis of variance in Table and 6.1 depicted in Fig.6 Serum albumin levels at preloading, after unloading and at 1st and 2nd week after unloading were, 3.13 ± 0.08 , 3.90 ± 0.08, 3.08 ± 0.08 and 3.13 ± 0.08 g/dl respectively. The albumin level ranged from 3.13± 0.08 to 3. 90 ± 0.08 g/dl during transportation period.The levels of albumin followed a same trend of serum total proteins. Preloading serum albumin levels observed in our study were within normal range for goats and are comparable with the range reported by Njidda *et al.* (2014) in semi-arid environment of Northern Nigerian three indigenous popular breeds of the sheep. Okoruwa (2014) in Dwarf goat in Nigeria, Mormede *et al.* (1982) in young calves. However, Soares *et al.* (2018) reported slightly lower serum albumin levels in dairy goat during the period of transition than our finding in present study. Regarding total proteins and albumin many workers

reported, increased in the levels of total proteins and albumin when the animal is subjected to the heat stress (Adelatif *et al.*, 2009., Al -Eissa *et al.*, 2012., Riberro *et al.*, 2018). However, Helal *et al.* (2010) reported decreased in the level of total proteins and albumin and globulin in Balady goats during heat stress.

In conclusion, the levels of albumin followed a same trend of serum total proteins in our study. The increased in the levels of serum total proteins seems to be due to transportation stressors, which primarily include off feed and water, crowding and poor ventilation which resulted in dehydration.

4.7 Globulin

Serum globulin concentration was calculated by subtracting serum albumin from total proteins. The mean ±SE levels of serum globulins during transportation period is presented in Table7.0 and its analysis of variance in Table 7.1 and depicted in Fig7. Serum globulin levels at preloading, after unloading and at 1^{st} and 2^{nd} week after unloading were, 3.10 ± 0.08 , 3.58 ± 0.16, 3.49 ±0.13 and 3.50 ± 0.12 g/dl respectively. The globulin level ranged from 3.10 ± 0.08 to 3.58± 0.16 g/dl during transportation period.

Preloading serum globulin levels observed in our study were within normal range for goats,but slightly higher than the values reported by Okoruwa (2014) in Dwarf goats and Mormede *et al.* (1982) in calves. But lower than the reports of Njidda *et al.* (2014) in Yankasa and Ouda sheep and Soares (2018) in dairy goats during transition period.

In conclusion, the levels of globulin followed a same trend of serum total proteins and albumin in our study.

4.8 Total Calcium

Calcium is the most abundant cation in the body. Out of total calcium present in the body of the animal, 99% is present in the bone in the form of hydroxyapatite, and the remaining 1% is found in the teeth, soft tissues, plasma, and cells. The plasma/serum total calcium concentration in goat range between 8.4–12.8 mg/dl (Dias *et al.*, 2010) and circulates in three forms. About 50% of Ca^{2+} exists as free or ionized form. Approximately 40% of total calcium is bound to proteins, mostly to albumin and also to some extent globulins. The remaining

10% is complexed with anions such as phosphate, bicarbonate, and citrate. Calcium plays a significant role in cellular metabolic functions, such as muscle contraction, nerve impulse transmission, activation of enzyme, blood coagulation, hormone secretion. Plasma calcium is maintained within narrow limits by the interplay between resorption and formation of Ca^{+2} by the intestine, bone, and kidney. Consequently, hypocalcaemia or hypercalcaemia may lead to severe cellular dysfunction and overall affects the production and reproduction in goats.

The mean ±SE levels of total calcium during transportation period in our study is presented in Table:1 and its analysis of variance in Table 1.1 and depicted in Fig.1. Serum Total calcium levels at preloading, after unloading and at $1^{st}$and 2^{nd} week after unloading were 8.79±0.14, 10.80±0.20, 8.56±0.20 and 8.65±0.27mg/dl respectively. Mean serum total calcium level ranged from 8.78 to 10.79mg/dl through preloading, after unloading, 1^{st} week and 2^{nd} week after the transportation. Preloading total calcium levels observed in our study was within normal range for goats and were comparable with range reported by Daramola *et al.* (2005) in West African Dwarf goats, Ayo *et al.* (2009) as basal level in Red Sokoto or Maradi goats.

Maximum level total calcium of 10.79mg% was observed immediately after transportation i.e., after unloading. There was significant increased ($P<0.01$) in the level of calcium immediately after transportation of these animals. In our study goats had been transported in tempo for about 6 hrs. During transportation the goat might undergone various transportation stress due to handling them during loading in tempo, new environment, crowding, poor ventilation, water and feed deprivation during the journey, oscillations etc. These types of stresses may stimulate secretions of corticosteroids and other stress hormones which might have increased the level of blood calcium after travelling. Zulkifi *et al.*(2010) studied physiological responses in goats subjected to road transportation under hot humid tropical conditions and reported significant increase in serum cortisol level after transportation. Paula *et al.* (2018) in their review article on "stress, glucocorticoid and bone in mammals and fish", reported that, glucocorticoids hormones exert positive role during bone modelling and remodelling as they promote osteoblastogenesis. The role of endogenous

glucocorticoids on bone mineral metabolism in response to stress and the regulatory loop between glucocorticoids and parathyroid peptides which the key regulator of calcium homeostasis. They further concluded that, in response to variety of stressful situations in vertebrates, bone appears to be a target organ for stress induced glucocorticoids produced by HPA axis activation. In mammals elevated glucocorticoids causes bone resorption which alter the mineral balance and damage to the bone and may elevate calcium due to direct action of osteoblast. Our results also corroborate with the findings of Cobb (1985) in male white rats. He reported increased in the serum calcium by 8% in stressed rats compared with unstress rats and further added that the rise in the serum calcium was mediated by parathyroid hormone. Adel *et al.* (1983) demonstrated enhanced PTH action on isolated perfused bone from glucocorticoid treated dogs. Brown *et al.* (1977 and 1978) could able to demonstrate that adrenaline stimulation of PTH release from isolated bovine parathyroid cells. From these studies it would appears that, two most stress hormones i.e., glucocorticoids and catecholamines mediates the role of PTH by direct stimulation of PTH release or by sensitizing bone to PTH action thus increasing serum calcium levels. Similarly, Balabunova *et al.* (1986) reported that, under stress condition plasma PTH increased up to 50% and adrenaline affected PTH in plasma by calcium independent mechanism in Merino sheep. Crookshank *et al.* (1979) reported effect of transportation and handling of calves had slightly increased level of calcium and magnesium at 1 day. Our finding corroborates with the reports of Ayo *et al.* (2009). They reported that the serum total calcium concentration increased significantly post transportation from preloading 2.2 mmol/l to 4.1mmol/l post-transportation in Red Sokoto or Maradi goats. While the values were returned to normal baseline 3 days post-transportation period.

Klaus-Dietrich (1985) noted that stress induced cell stimulation, results in drasticpotential change of the cell from the resting potential to the action potential. During any type of stress, the calcium concentration in the interstitial fluids also increases due to high production of catecholamines. Calcium increase in the extracellular fluids leads to a considerable intensification of the contractility of muscle cells, including the heart muscle cells. Calcium ions also take part in the

release of acetylcholine and transmission of nerve impulses to functional tissues like muscles. Therefore, increases in muscles activities of stressed animal results from a rise in calcium ion concentration in the extracellular tissue fluid.

In conclusion the increased in the levels of serum total calcium seems to be due to transportation stressors, which may include handling of animals during their loading and unloading, new environment, off feed and water, oscillations and noise during travel and poor ventilation and crowding, which takes via stimulation of adrenals and stress hormone like cortisol and adrenaline secretion and its effect on mineral metabolism.

4.9 Phosphorus

Approximately 85% of the animal's body phosphate pool present within the skeleton. The remaining 15% is stored as high-energy phosphates or in its free form, where it acts as a substrate for adenosine triphosphate (ATP) production. A significant portion of the body's non-skeletal phosphate stores resides within skeletal muscle either as free inorganic phosphorus (Pi) or bound within high-energy phosphate molecules, such as ATP, adenosine diphosphate (ADP), adenosine monophosphate (AMP) or phosphocreatine. Accordingly, phosphate plays a crucial role in energy metabolism. Trauma and critical illness result in a hypermetabolic state in which energy expenditure increases. The impact of stress, trauma and critical illness on the body's phosphate stores and phosphate-dependent metabolic reactions is poorly understood. Although all aspects of how the body meets the demand for increased phosphate utilization are not known, there are several impacts on phosphate concentration which includes: the impact of increased phosphate demand for ATP production, effect on circulating and tissue phosphorus concentration, renal phosphate retention and excretion, importance of glucocorticoids and interactions with other metabolic pathways (Porter *et al.*, 2017).

The mean ±SE levels of serum phosphorus during transportation period is presented in Table: 9.0 and its analysis of variance in Table 9.1 and depicted in Fig. 9.0 Serum phosphorus levels at preloading, after unloading and at 1st and 2nd week after unloading were 5.40 ± 0.12, 6.13 ± 0.27, 5.26 ± 0.10 and 5.33±0.11mg/dl. Mean serum phosphorus level ranged from 5.26 ± 0.10 to 6.13 ±

0.27 mg/dl during preloading, after unloading, 1st week and 2nd week after the transportation. The levels increased significantly after unloading.

The mean ±SE preloading levels of serum phosphorus in our study are comparable with the previous studies and reports of Ayo *et al.* (2009) in preloading values of Nigerian goats , Soares *et al.* (2018) in dairy goats and Das *et al.* (2010) in Assam local breed and Assam local crossed with Beetal breed of goat. However, the preloading levels of serum phosphorus are slightly lower the values reported by Daramola *et al.* (2005), Akinrinmade & Akinrinmade (2012),Oduye and Adadevou,(1976) in West African Dwarf goats, Antunovic *et al.* (2019) in Croatian Spotted goats and Hossan Shaikat *et al.* (2013) in Black Bengal and Jamunapari goats .

Maximum level of serum phosphorus (6.13 mg%) was observed immediately after transportation i.e. after unloading. There was significant increased ($P<0.01$) in the level of serum phosphorus immediately after transportation of these animals. These findings however contradictory with the reports of Ayo *et al.*(2009) in Nigerian goats. They reported that handling, loading, transportation and administration of ascorbic acid (AA) did not affected the serum phosphate concentrations after road transportation of Nigerian goats.

Galyean *et al.* (1981) reported plasma phosphate ion concentration to be higher in fasted and transported animals for 32 h. There was a trend for plasma concentrations of phosphate ion to be higher in the feed-deprived group than in the control. However, Parker *et al.* (2003) observed no significant increases in calcium and phosphate ions in both control and experimental groups in *Bos Indicus* steer after a long transportation. The levels of serum phosphorus came to its preloading value within 1 week after unloading of these animals in our study.

4.10 Glucose

Glucose is the principal source of energy for mammalian cells. Glucose is derived from digestion of dietary carbohydrates, breakdown of glycogen in the liver this provides stores for maintaining glucose in blood during fasting or food-deprived states. In ruminants, the main source of glucose is gluconeogenesis from volatile fatty acids mainly propionate absorbed from rumen by fermentation. Blood glucose concentration is influenced by hormones which

facilitate its entry into or removal from the circulation. The hormones affect glucose concentrations by modifying glucose uptake by cells, promoting or inhibiting gluconeogenesis or affecting glycogenesis and glycogenolysis. The most important hormone involved in glucose metabolism is insulin which has hypoglycemic effect. Other hormones having opposite action of insulin effect are glucagon, growth hormone, catecholamines, and corticosteroids.

The mean ±SE levels of serum glucose during transportation period in goats in our study is presented in Table10.0 and its analysis of variance in Table10.1 and depicted in Fig.10. Serum glucose levels at preloading, after unloading and at 1st and 2nd week after unloading were 56.58±0.44 ,63.63±1.64, 54.21±0.76 and 50.66±0.97 mg/dl respectively. In our study mean serum glucose level ranged from 50.66 to 63.62 mg/dl during preloading, after unloading, 1st week and 2nd week after the transportation. There was significant increased ($P<0.01$) in the level of serum glucose immediately after transportation of these animals. The levels then came to its preloading value at 1st week after transportation. There is significant decreased in the level of serum glucose at 2nd week after transportation in these animals, but was within the normal range for goats.

Preloading mean ± SE serum glucose level observed in our study was within normal range for goats and were comparable with range reported by Waziri *et al.* (2010) and Kamalu *et al.* (1988) in WAD goats, Dias *et al.* (2010) in Churra-da-Terra -Quente ewe in north east Portugal, Akinrinmade & Akinrinmade (2012)in WAD goats and Njidda *et al.* (2014) in sheep at Northern Nigeria. But higher than the report of Opara *et al.* (2010) in WAD goats and Aynalem et al., (2017) in local breed sheep at Ethopia.

In our study there was significant increased ($P<0.01$) in the level of serum glucose immediately after transportation of these animal. The goats were transported in truck for about 6 hrs. During transportation the goat might undergone various transportation stress due to handling them during loading, new environment, crowding, poor ventilation, water and feed deprivation during the journey, oscillations etc. These types of stresses may stimulate secretions of corticosteroids and catecholamines and other stress hormones which might have

increased the level of blood glucose after travelling. Zulkifi *et al.* (2010) studied physiological responses in goats subjected to road transportation under hot humid tropical conditions and also reported significant increased ($p<0.001$) in serum cortisol and glucose level after transportation. Our results are corroborate with the findings of Nwe *et al.* (1996), Kannan *et al.* (1997, 1998, 2000, 2003), Rajion *et al.* (2001). These workers reported increased in serum levels glucose in goats after road transportation. Romero *et al.* (2014) also reported increased in blood glucose after4 hr transportation of Zebu steer and El Khasmi *et al.* (2015) in dromedary camel.

Elevation of cortisol due to transportation stress may have stimulated gluconeogenesis and contributed to increased glucose level (Malheiros *et al.*, 2003). The release of adrenaline and noradrenaline in response to handling fear during loading at the initial stage may also have stimulated hepatic glycogenolysis leading to hyperglycaemia in our animals. Similar type of transportation stress study conducted by Kannan *et al.* (1997, 1998, 2000, 2003) in goats. They reported that, plasma glucose concentration was as low as baseline concentration at preload sampling increased gradually during the loading and transportation. Glucose concentration remained elevated during first 2 hrs after transportation and begins decreasing after 3hrs. Nwe *et al.* (1996) also reported that plasma glucose concentrations returned to baseline value at 3 hrs after a 6hr journey in male adult Japanese native goats.

In our study, the levels serum glucose came to its preloading value at 1st week after transportation. Minka and Ayo (2010) also reported plasma glucose concentration increased significantly immediately after transportation from preloading value and the elevated glucose level was returned to its preloading level 12 hrs after transportation in goats. In our study there is significant decreased in the level of serum glucose at 2nd week after transportation in these animals.

In conclusion, the increased in the levels of serum glucose immediately after transportation seems to be due to transportation stressors, which may include handling of animals during their loading and unloading, new environment, off feed and water, oscillations and noise during travel and poor

ventilation and crowding, which takes via stimulation of adrenals and stress hormone like cortisol and adrenaline secretion and its effect on glucose metabolism. These hormones are considered to be hyperglycaemic.

Table 1.0 Mean ± S.E. of serum sodium (mmol/l) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	147	159.7	146	149	CD (0.01)=5.601 CD(0.05) =4.262
2	**94**	123	184.5	179	144	
3	**95**	130	198.8	158	149	
4	**96**	123	124.2	147	157	
5	**97**	127	167.6	144	148	
6	**98**	128	148	143	142	
7	**99**	118	139	140	146	
8	**100**	127	145	153	145	
9	**101**	136	160	148	152	
10	**102**	184	107	145	152	
11	**103**	109	155	140	152	
12	**104**	157	153	146	142	
13	**105**	136	144	148	152	
14	**107**	142	142	149	155	
15	**108**	143	153	142	159	
16	**109**	143	146	145	156	
17	**110**	128.2	152	145	151	
18	**111**	145	145	151	148	
19	**112**	139	148	154	147	
20	**113**	137	144	148	159	
21	**114**	142	147	146	145	
22	**115**	127	141	147	142	
23	**116**	145	149	146	147	
24	**117**	135	145	146	146	
25	**118**	157	150	146	146	
26	**119**	138	145	143	150	
27	**120**	137	147	139	149	
28	**121**	141	144	146	149	
29	**122**	130	148	137	146	
30	**123**	137	136	146	141	
31	**124**	141	143	144	154	
32	**125**	154	143	144	140	
33	**126**	147	143	146	142	
34	**127**	149	145	139	124	
35	**128**	133	147	139	140	

36	**132**	136	144	141	145	
37	**137**	109	144	149	146	
38	**138**	105	148	148	141	
39	**139**	141	145	137	144	
40	**140**	123	147	147	138	
41	**141**	116	147	148	148	
42	**142**	131	148	142	150	
43	**143**	138	143	148	139	
44	**144**	135	142	142	147	
45	**145**	123	141	146	121	
46	**146**	104	153	138	149	
47	**148**	116	143	149	138	
48	**149**	143	145	160	139	
49	**150**	141	145	137	144	
50	**151**	149	145	139	124	
	Mean±SE	**134.90±2.02^{b}**	**147.38±1.75^{a}**	**145.92±0.96^{a}**	**145.58±1.09^{a}**	

Means with different superscripts differ significantly

Table 1.1 Analysis of variance of data of serum sodium ion during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	4954.265	1651.422	13.971	0.000
Error	196	23168.550	118.207	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 7.579

Table 2.0 Mean ± S.E. of serum potassium (mmol/l) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	4.87	6.07	4.67	4.77	CD (0.01)=0.262 CD(0.05) =0.200
2	**94**	4.51	6.16	6.7	5.18	
3	**95**	6.09	5.16	5.21	6.49	
4	**96**	4.44	4.61	5.39	6.02	
5	**97**	4.48	6.21	5.22	6.13	
6	**98**	5.37	4.77	5.45	5.84	
7	**99**	4.9	4.64	5.14	5.62	
8	**100**	4.4	4.39	5.16	4.97	
9	**101**	5.15	4.3	4.76	5.34	
10	**102**	6.4	4.24	4.49	4.64	
11	**103**	4.47	4.48	5.56	4.88	
12	**104**	5.45	5.24	5.07	5.22	
13	**105**	4.77	4.05	5.04	5.11	
14	**107**	4.89	4.39	5.11	5.97	
15	**108**	4.7	4.57	4.86	5.96	
16	**109**	6.49	5.09	5.38	5.43	
17	**110**	4.36	4.63	4.91	6.24	
18	**111**	5.25	4.82	4.82	5.2	
19	**112**	5.3	5.25	4.61	4.81	
20	**113**	5.07	4.56	5.21	6.81	
21	**114**	5.03	4.37	4.88	5.32	
22	**115**	4.79	5.01	5.33	5.16	
23	**116**	4.81	4.23	4.93	5.08	
24	**117**	4.51	4.47	4.94	5.27	
25	**118**	6.68	4.43	4.92	5.28	
26	**119**	5.1	4.84	5.1	5.26	
27	**120**	4.56	4.38	5	5.95	
28	**121**	5.28	4.61	5.05	4.85	
29	**122**	5.4	5.04	4.98	6.09	
30	**123**	4.65	4.22	5.27	5.54	
31	**124**	5.05	4.91	5.13	4.9	
32	**125**	5.57	4.5	5.02	5.4	
33	**126**	5.71	4.73	5.06	5.58	
34	**127**	5.23	4.69	5.31	5.08	
35	**128**	4.81	4.76	5.22	5.46	

36	**132**	5.39	5.09	5.29	5.67	
37	**137**	3.42	4.9	5.37	5.06	
38	**138**	3.65	4.64	4.63	5.47	
39	**139**	5.11	4.41	5.07	5.01	
40	**140**	4.11	4.55	5.19	6.12	
41	**141**	4.88	4.51	5.21	4.91	
42	**142**	4.57	4.04	4.8	4.55	
43	**143**	6	4.45	4.97	5.74	
44	**144**	4.66	4.75	5.07	5.35	
45	**145**	4.8	5.31	5.3	5.73	
46	**146**	3.59	4.17	5.32	5.03	
47	**148**	4.75	5.06	5.3	5.75	
48	**149**	4.41	5.02	4.66	4.56	
49	**150**	5.11	4.41	5.07	5.01	
50	**151**	5.23	4.69	5.31	5.08	
	Mean±SE	**4.96±0.09^{b}**	**4.74±0.07^{c}**	**5.11±0.05^{b}**	**5.40±0.07^{a}**	

Means with different superscripts differ significantly

Table 2.1 Analysis of variance of data of serum potassium during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	11.506	3.835	14.803	0.000
Error	196	50.784	0.259	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 10.076

Table 3.0 Mean ± S.E. of serum chloride (mmol/l)during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	105	72	103	108	CD (0.01)=4.872 CD(0.05) =3.707
2	**94**	93	104.9	149	107	
3	**95**	99	89.5	103	113	
4	**96**	89	122.3	108	113	
5	**97**	87	77.8	106	120	
6	**98**	101	107.6	113	111	
7	**99**	89	107	116	107	
8	**100**	89	85.6	105	115	
9	**101**	95	119	108	103	
10	**102**	145	92	102	110	
11	**103**	86	111	113	100	
12	**104**	113	122	109	114	
13	**105**	92	106	106	107	
14	**107**	99	103	107	111	
15	**108**	93	108	113	113	
16	**109**	97	119	107	103	
17	**110**	93.4	106	109	114	
18	**111**	100	110	101	107	
19	**112**	108	111	101	110	
20	**113**	99	110	108	117	
21	**114**	86	107	103	110	
22	**115**	96	102	107	99	
23	**116**	94	109	105	108	
24	**117**	103	106	106	112	
25	**118**	127	107	103	104	
26	**119**	100	105	107	114	
27	**120**	99	105	114	109	
28	**121**	107	112	108	99	
29	**122**	101	112	113	113	
30	**123**	82	101	110	111	
31	**124**	106	108	108	102	
32	**125**	94	107	109	99	
33	**126**	103	110	103	112	
34	**127**	105	109	111	90	
35	**128**	102	108	112	104	

36	**132**	105	107	108	105	
37	**137**	62	109	108	104	
38	**138**	73	113	103	110	
39	**139**	99	108	112	108	
40	**140**	90	107	111	117	
41	**141**	81	104	112	102	
42	**142**	97	107	109	106	
43	**143**	92	108	105	107	
44	**144**	91	108	111	102	
45	**145**	106	110	109	81	
46	**146**	72.2	104	111	100	
47	**148**	90	111	106	102	
48	**149**	97	110	106	82	
49	**150**	99	108	112	108	
50	**151**	105	109	111	90	
	Mean±SE	**96.73±1.78^{b}**	**106.29±1.28^{a}**	**108.80±0.96^{a}**	**106.26±1.13^{a}**	

Means with different superscripts differ significantly

Table 3.1 Analysis of variance of data of serum chloride ion during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	4257.301	1419.100	15.871	0.000
Error	196	17524.817	89.412	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 9.047

Table 4.0 Mean ± S.E. of serum ionized calcium (mg/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	5.8	6.32	6.1	5.72	CD (0.01)=0.397
2	**94**	6.16	5.21	5.3	5.23	
3	**95**	5.55	6.32	6.12	5.11	
4	**96**	4.81	5.21	5.4	4.81	
5	**97**	6.09	4.89	4.9	6.03	
6	**98**	4.9	5.53	5.4	4.8	
7	**99**	5.89	5.61	5.6	5.46	
8	**100**	5.19	5.94	5.89	5.6	
9	**101**	4.81	7.64	7.2	4.6	
10	**102**	6.42	5.11	5.2	6.12	
11	**103**	6.3	5.5	5.4	6.6	
12	**104**	5.9	3.29	4.1	6.1	
13	**105**	5.35	7.4	7.1	5.31	
14	**107**	5.32	5.3	5.5	5.6	
15	**108**	6.64	2.84	2.9	6.1	
16	**109**	5.83	3.2	3.3	6.1	
17	**110**	5.93	3.5	4.5	4.9	
18	**111**	6.12	4.6	4.3	6.2	
19	**112**	5.68	6.32	6.4	5.8	
20	**113**	4.41	5.21	6.6	4.1	
21	**114**	5.79	4.89	5.8	5.32	
22	**115**	6.2	5.53	5.1	6.1	
23	**116**	5.43	5.61	5.5	4.89	
24	**117**	6.11	5.94	5.61	6.33	
25	**118**	6.74	7.64	6.9	6.55	
26	**119**	4.47	5.11	4.99	4.51	
27	**120**	5.8	5.5	5.61	5.7	
28	**121**	6.16	3.29	4.9	6.23	
29	**122**	5.55	7.4	6.89	5.51	
30	**123**	4.81	5.3	5.6	4.19	
31	**124**	6.09	2.84	3.1	5.99	
32	**125**	4.9	3.2	3.8	4.8	
33	**126**	5.89	3.5	3.4	5.9	
34	**127**	5.19	4.6	5.1	5.2	
35	**128**	4.81	6.32	5.32	4.12	

36	**132**	6.42	5.21	5.13	6.24	
37	**137**	6.3	4.89	4.9	6.25	
38	**138**	5.9	5.53	5.21	6.1	
39	**139**	5.35	5.61	5.52	5.57	
40	**140**	5.32	5.94	5.91	5.41	
41	**141**	6.64	7.64	6.99	6.54	
42	**142**	4.81	5.11	5.3	4.68	
43	**143**	6.42	5.5	5.6	6.1	
44	**144**	6.3	3.29	2.99	6.13	
45	**145**	5.9	7.4	8.1	4.99	
46	**146**	5.35	5.3	4.99	5.36	
47	**148**	5.32	2.84	3.12	5.23	
48	**149**	6.64	3.2	3.23	6.54	
49	**150**	5.1	3.5	3.99	5.32	
50	**151**	6.3	4.6	4.3	6.51	
	Mean±SE	**5.70 ± 0.09^{a}**	**5.14 ± 0.19^{c}**	**5.20 ± 0.17^{bc}**	**5.57 ± 0.10^{ab}**	

Means with different superscripts differ significantly

Table 4.1 Analysis of variance of data of serum ionized calcium during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	11.289	3.763	3.677	0.013
Error	196	200.566	1.023	-	-
Total	199	-	-	-	-

$P<0.01$

Coefficient of Variation =18.716

Table 5.0 Mean ± S.E. of serum total protein (g/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	6.64	7.5	6.1	6.2	CD (0.01)=0.406 CD(0.05) =0.309
2	**94**	5.6	11	5.8	5.5	
3	**95**	6.5	7.1	6.6	6.7	
4	**96**	6.7	7.2	6.9	6.23	
5	**97**	6.9	5.42	6.4	6.57	
6	**98**	6.7	5.87	6.12	6.2	
7	**99**	6.8	7.75	6.23	6.32	
8	**100**	6.2	6.69	7.8	7.1	
9	**101**	6.69	6.13	6.7	6.2	
10	**102**	6.47	7.09	6.5	6.4	
11	**103**	6.51	8.1	6.6	6.5	
12	**104**	7.1	8.01	7.6	7.15	
13	**105**	6.73	7.09	6.5	6.65	
14	**107**	6.6	8.5	6.3	6.23	
15	**108**	6.24	8.6	7.01	7.46	
16	**109**	6.85	6.02	7.1	7.2	
17	**110**	5.91	6.5	6.1	6.5	
18	**111**	5.6	8.2	5.4	5.5	
19	**112**	5.8	8.6	7.56	8.1	
20	**113**	6.5	7.2	6.5	6.6	
21	**114**	6.78	8.1	6.48	6.45	
22	**115**	6.4	8.5	6.5	6.53	
23	**116**	5.65	9.5	6.31	6.23	
24	**117**	6.08	7.5	6.7	6.15	
25	**118**	6.4	6.8	6.5	6.5	
26	**119**	5.38	8.5	7.89	8.1	
27	**120**	5.99	8.01	5.88	5.99	
28	**121**	5.3	6.5	6.99	8.25	
29	**122**	7.4	9.2	7.1	8.13	
30	**123**	6.27	6.5	6.5	6.51	
31	**124**	5.63	6.9	5.33	5.8	
32	**125**	6.2	8.6	5.14	5.21	
33	**126**	5.91	6.9	6.1	6.34	
34	**127**	6.25	6.45	6.29	6.35	
35	**128**	5.92	9.01	6.6	6.8	

36	**132**	6.62	8.06	6.52	6.5	
37	**137**	6.18	9.5	6.21	6.66	
38	**138**	6.64	6.77	6.6	6.74	
39	**139**	6.39	6.28	6.49	6.5	
40	**140**	6.63	5.9	6.63	6.75	
41	**141**	5.61	6.87	5.55	5.49	
42	**142**	6.83	9.01	6.12	6.51	
43	**143**	6.21	7.5	6.31	8.4	
44	**144**	7.52	6.74	7.1	7.25	
45	**145**	6.55	6.3	6.54	6.66	
46	**146**	5.59	8.4	7.62	7.1	
47	**148**	6.09	5.9	6.01	7.2	
48	**149**	6.51	8.7	6.53	6.1	
49	**150**	6.25	6.45	6.29	6.35	
50	**151**	6.4	5.9	6.63	6.75	
	Mean±SE	**6.33 ± 0.07^{b}**	**7.48 ± 0.17^{a}**	**6.51 ± 0.08^{b}**	**6.63 ± 0.01^{b}**	

Means with different superscripts differ significantly

Table 5.1 Analysis of variance of data of serum total protein during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	38.747	12.916	20.753	0.000
Error	196	121.980	0.622	-	-
Total	199	-	-	-	-

$P<0.01$

Coefficient of Variation = 11.710

Table 6.0 Mean ± S.E. of serum albumin (g/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	3.81	3.81	3.8	3.8	CD (0.01)=0.274 CD(0.05) =0.208
2	**94**	2.79	4.02	3.5	4.1	
3	**95**	3.48	3.75	2.29	2.29	
4	**96**	3.5	3.5	3.29	3.29	
5	**97**	3.01	3.01	4.49	4.49	
6	**98**	3.05	3.16	3.52	3.52	
7	**99**	3.46	4.02	2.85	2.85	
8	**100**	3.43	3.99	3.12	3.12	
9	**101**	3.63	3.65	4.09	4.09	
10	**102**	3.26	3.69	3.85	3.85	
11	**103**	3.68	4.05	3.48	3.48	
12	**104**	3.34	4.95	2.16	2.16	
13	**105**	3.83	3.22	2.58	2.58	
14	**107**	3.88	3.44	2.98	2.98	
15	**108**	3.58	3.65	3.54	3.54	
16	**109**	2.96	4.42	2.84	2.84	
17	**110**	3.42	4.65	2.89	3.1	
18	**111**	2.9	4.98	2.86	2.86	
19	**112**	2.92	4.45	3.58	3.58	
20	**113**	3.3	4.32	2.9	3.11	
21	**114**	4.07	4.42	3.08	3.08	
22	**115**	3.1	4.18	2.34	2.34	
23	**116**	3.7	4.15	2.44	2.44	
24	**117**	2.95	4.85	1.33	1.33	
25	**118**	3.08	3.38		2.56	
26	**119**	3.34	4.21	3.53	3.53	
27	**120**	3.01	4.1	2.49	2.49	
28	**121**	2.35	3.09	2.59	3.6	
29	**122**	3.21	4.32	3.27	3.7	
30	**123**	2.99	4.7	3.71	3.71	
31	**124**	3.91	3.74	3.91	3.91	
32	**125**	3.12	3.67	3.12	3.12	
33	**126**	2.67	3.37	2.67	2.67	
34	**127**	2.9	4.08	2.9	2.9	
35	**128**	3.58	3.78	3.58	3.58	

36	**132**	2.98	3.47	2.98	2.98	
37	**137**	2.94	4.45	2.94	2.94	
38	**138**	3.89	4.73	3.89	3.89	
39	**139**	2.91	4.01	2.91	2.91	
40	**140**	2.48	3.04	2.48	2.48	
41	**141**	3.18	4.02	3.18	3.18	
42	**142**	2.98	3.37	2.98	3.1	
43	**143**	2.95	3.99	2.95	3.5	
44	**144**	3.41	3.99	3.41	3.41	
45	**145**	3.86	3.06	3.86	3.86	
46	**146**	2.77	4.06	2.77	2.77	
47	**148**	2.97	3.04	2.97	2.97	
48	**149**	2.71	4.16	2.71	2.71	
49	**150**	2.9	3.08	2.9	2.9	
50	**151**	3.4	3.65	2.48	2.48	
	Mean±SE	**3.23±0.06^{a}**	**3.90±0.08^{b}**	**3.08±0.08^{a}**	**3.13±0.08^{a}**	

Means with different superscripts differ significantly

Table 6.1 Analysis of variance of data of serum albumin during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	4495.355	1498.452	26.672	0.000
Error	196	11011.361	56.180	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 17.306

Table 7.0 Mean ± S.E. of serum globulin (g/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	2.83	3.69	2.3	2.4	CD (0.05)=0.349
2	**94**	2.81	6.98	2.3	1.4	
3	**95**	3.02	3.35	4.31	4.41	
4	**96**	3.2	3.7	3.61	2.94	
5	**97**	3.89	2.41	1.91	2.08	
6	**98**	3.65	2.71	2.6	2.68	
7	**99**	3.34	3.73	3.38	3.47	
8	**100**	2.77	2.7	4.68	3.98	
9	**101**	3.06	2.48	2.61	2.11	
10	**102**	3.21	3.4	2.65	2.55	
11	**103**	2.83	4.05	3.12	3.02	
12	**104**	3.76	3.06	5.44	4.99	
13	**105**	2.9	3.87	3.92	4.07	
14	**107**	2.72	5.06	3.32	3.25	
15	**108**	2.66	4.95	3.47	3.92	
16	**109**	3.89	1.6	4.26	4.36	
17	**110**	2.49	1.85	3.21	3.4	
18	**111**	2.7	3.22	2.54	2.64	
19	**112**	2.88	4.15	3.98	4.52	
20	**113**	3.2	2.88	3.6	3.49	
21	**114**	2.71	3.68	3.4	3.37	
22	**115**	3.3	4.32	4.16	4.19	
23	**116**	1.95	5.35	3.87	3.79	
24	**117**	3.13	2.65	5.37	4.82	
25	**118**	3.32	3.42	6.5	3.94	
26	**119**	2.04	4.29	4.36	4.57	
27	**120**	2.98	3.91	3.39	3.5	
28	**121**	2.95	3.41	4.4	4.65	
29	**122**	4.19	4.88	3.83	4.43	
30	**123**	3.28	1.8	2.79	2.8	
31	**124**	1.72	3.16	1.42	1.89	
32	**125**	3.08	4.93	2.02	2.09	
33	**126**	3.24	3.53	3.43	3.67	
34	**127**	3.35	2.37	3.39	3.45	
35	**128**	2.34	5.23	3.02	3.22	

36	**132**	3.64	4.59	3.54	3.52	
37	**137**	3.24	5.05	3.27	3.72	
38	**138**	2.75	2.04	2.71	2.85	
39	**139**	3.48	2.27	3.58	3.59	
40	**140**	4.15	2.86	4.15	4.27	
41	**141**	2.43	2.85	2.37	2.31	
42	**142**	3.85	5.64	3.14	3.41	
43	**143**	3.26	3.51	3.36	4.9	
44	**144**	4.11	2.75	3.69	3.84	
45	**145**	2.69	3.24	2.68	2.8	
46	**146**	2.82	4.34	4.85	4.33	
47	**148**	3.12	2.86	3.04	4.23	
48	**149**	3.8	4.54	3.82	3.39	
49	**150**	3.35	3.37	3.39	3.45	
50	**151**	3	2.25	4.15	4.27	
	Mean±SE	**3.10±0.08^{a}**	**3.58±0.16^{b}**	**3.49±0.16^{ab}**	**3.50±0.12^{ab}**	

Means with different superscripts differ significantly

Table 7.1 Analysis of variance of data of serum globulin during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	6.852	2.284	2.874	0.037
Error	196	155.763	0.795	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 26.095

Table 8.0 Mean ± S.E. of serum calcium (mg%) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	10.51	10.35	9.81	10.2	CD (0.01)=0.763 CD(0.05) =0.581
2	**94**	9.6	10.67	8.92	9.1	
3	**95**	8.48	11.75	10.01	9.9	
4	**96**	9.12	13	10	10.5	
5	**97**	9.43	10.37	11.39	11.5	
6	**98**	8.97	10.05	9.33	8.33	
7	**99**	8.32	11.02	10.2	11.5	
8	**100**	9.59	8.83	10.09	10.2	
9	**101**	8.15	10.37	9.7	11.3	
10	**102**	9.96	10.61	8.57	9.5	
11	**103**	8.82	8.84	7.92	7.85	
12	**104**	10.43	10.22	9.12	9.23	
13	**105**	8.98	10.06	10.12	11.2	
14	**107**	9.54	10.8	10.6	11.6	
15	**108**	7.38	10.04	9.33	9.22	
16	**109**	9.69	10.55	11	11.5	
17	**110**	8.22	10.41	10.32	10.2	
18	**111**	8.15	10.1	9.81	9.72	
19	**112**	9.27	11.05	10.27	1.23	
20	**113**	9.23	11.83	8.2	9.35	
21	**114**	8.63	10.31	9.91	9.15	
22	**115**	7.56	9.44	10.2	10.36	
23	**116**	7.65	9.4	7.23	10.4	
24	**117**	8.37	10.12	9.17	3.11	
25	**118**	8.46	8.53	6.04	7.5	
26	**119**	10.93	10.62	6.83	7.8	
27	**120**	8.59	10.48	8.47	8.56	
28	**121**	7.58	9.72	6.88	7.6	
29	**122**	7.11	11.22	8.51	7.8	
30	**123**	8.69	9.91	7.48	7.5	
31	**124**	10.92	10.63	7.77	7.4	
32	**125**	7.4	11.72	7.65	7.52	
33	**126**	7.55	10.54	6.38	7.16	
34	**127**	8.48	10.82	6.66	7.6	
35	**128**	9.53	10.64	7.68	7.8	

36	**132**	7.34	9.92	7.02	7.3	
37	**137**	9.21	9.48	7.48	7.5	
38	**138**	8.68	12.06	7.6	8.5	
39	**139**	7.78	9.94	6.76	6.58	
40	**140**	7.93	12.56	9.28	9.26	
41	**141**	8.8	10.38	7.43	7.53	
42	**142**	8.7	12.27	5.5	9.1	
43	**143**	8.44	11.26	7.17	6.9	
44	**144**	8.94	12.07	8.69	8.4	
45	**145**	8.11	17.9	8.79	8.1	
46	**146**	7.76	11.25	7.43	8.56	
47	**148**	10.32	11.12	8.3	8.45	
48	**149**	11.71	11.19	9.21	8.9	
49	**150**	8.48	10.82	6.66	7.6	
50	**151**	7.93	12.56	9.28	9.26	
	Mean±SE	**8.79±0.14^{b}**	**10.80±0.20^{a}**	**8.56±0.20^{b}**	**8.65±0.27^{b}**	

Means with different superscripts differ significantly

Table 8.1 Analysis of variance of data of serum Calcium during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	6.852	2.284	2.874	0.037
Error	196	155.763	0.795	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 16.103

Table 9.0 Mean ± S.E. of serum phosphorus (mg/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	4.98	5.5	5.98	4.59	CD (0.01)=0.602 CD(0.05) =0.458
2	**94**	5.81	7.5	5.62	6.02	
3	**95**	6.06	6.2	6.05	5.05	
4	**96**	4.09	4.9	4.56	4.6	
5	**97**	5.75	7.37	5.26	5.3	
6	**98**	5.2	7.12	5.54	5.5	
7	**99**	4.67	7.58	6.81	6.9	
8	**100**	5.22	6.29	4.63	5.32	
9	**101**	5.08	3.44	5.56	5.38	
10	**102**	4.45	5.3	5.65	5.7	
11	**103**	6.13	4.28	5.71	5.83	
12	**104**	7.02	4.55	4.25	4.25	
13	**105**	4.87	5.73	4.56	4.35	
14	**107**	4.46	5.27	4.85	4.55	
15	**108**	4.37	4.15	4.8	4.26	
16	**109**	7.15	5.01	5.52	5.62	
17	**110**	4.22	4.6	5.1	5.23	
18	**111**	4.26	2.87	4.83	4.9	
19	**112**	3.75	4.49	6.67	6.7	
20	**113**	5.16	5.39	5.12	5.24	
21	**114**	5.18	7.12	4.75	4.75	
22	**115**	5.82	7.3	5.95	5.15	
23	**116**	4.07	9.71	4.05	5.13	
24	**117**	6.22	9.2	5.26	4.95	
25	**118**	5.65	9.29	6.4	6.21	
26	**119**	6.13	10.5	5.24	5.58	
27	**120**	6.13	9.5	5.67	5.61	
28	**121**	6.11	9.62	5.16	4.99	
29	**122**	4.97	6.47	4.28	4.52	
30	**123**	5.48	8.05	5.29	5.21	
31	**124**	5.61	6.84	5.29	5.26	
32	**125**	5.07	7.84	5.21	5.64	
33	**126**	4.88	5.66	4.28	4.58	
34	**127**	5.84	7.2	4.69	4.18	
35	**128**	4.72	5.78	7.51	7.15	

36	**132**	7.5	7.53	4.7	4.26	
37	**137**	4.99	3.89	5.27	5.13	
38	**138**	4.59	4.13	5.55	5.47	
39	**139**	5.29	2.66	5.19	5.26	
40	**140**	4.99	4.72	4.22	5.34	
41	**141**	4.57	4.64	5.3	5.69	
42	**142**	5.72	4.57	5.11	5.22	
43	**143**	5.7	4.04	5.64	5.74	
44	**144**	7.06	8.39	4.89	5.01	
45	**145**	6.74	7.64	4.67	4.72	
46	**146**	5.83	5.49	4.59	4.69	
47	**148**	5.87	4.64	5.26	6.69	
48	**149**	5.58	4.72	5.9	6.27	
49	**150**	5.84	7.1	5.32	7.75	
50	**151**	4.99	4.72	5.36	5.39	
	Mean±SE	**5.40±0.12^{b}**	**6.13±0.27^{a}**	**5.26±0.10^{b}**	**5.34±0.11^{b}**	

Means with different superscripts differ significantly

Table 9.1 Analysis of variance of data of serum phosphorus during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	24.364	8.121	5.958	0.001
Error	196	267.186	1.363	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 21.109

Table 10.0 Mean ± S.E. of serum glucose (mg/dl) during transportation in goats

Sr. No.	Sample/ Goats No.	Preloading	Unloading	1st week	2nd week	CD
1	**93**	51.3	75.5	70.5	50	CD (0.01)=3.862 CD(0.05) =2.938
2	**94**	61.4	63.5	68	47	
3	**95**	50.5	51	52	50.1	
4	**96**	53.5	86.6	68	56	
5	**97**	54.9	69	62	52	
6	**98**	56.6	68	48	60	
7	**99**	57.7	55	51	56	
8	**100**	59.8	54.9	54	53	
9	**101**	55.5	52.1	56	56	
10	**102**	60.4	56	53	64	
11	**103**	53.2	72.6	49	50.5	
12	**104**	52.6	57	58	47.5	
13	**105**	55.6	68.5	54	40.5	
14	**107**	60.1	56	53	53.5	
15	**108**	56.6	61.3	60.5	52	
16	**109**	51.1	50	51	47.3	
17	**110**	52.7	60.4	56	50.2	
18	**111**	55.2	51.5	52.5	54.5	
19	**112**	55.2	53.4	53.2	43.5	
20	**113**	54.4	52	56	51.5	
21	**114**	61.1	65	46	40.5	
22	**115**	62.6	57	49	44.5	
23	**116**	63.1	60	58	52.5	
24	**117**	58.2	65	53	57	
25	**118**	57.1	69	56	50.5	
26	**119**	56.6	74.3	54	51.5	
27	**120**	54.6	75.3	56	74.5	
28	**121**	53.1	56.6	52.5	44.5	
29	**122**	53.6	76.3	56.3	57.5	
30	**123**	56.3	52	56.2	48	
31	**124**	57.7	63	54.2	42	
32	**125**	53.2	78.1	59.2	51.5	
33	**126**	55.3	73	54.6	39.5	
34	**127**	55.4	56.2	52.3	41	
35	**128**	55.2	59.8	50.1	62.3	

36	**132**	58.9	67.3	48.5	50	
37	**137**	59.3	43.9	44.3	51.2	
38	**138**	61.7	61.5	54.1	54.1	
39	**139**	57.7	73	48.3	50.6	
40	**140**	54.4	54	49.5	47	
41	**141**	59.8	91.9	53.1	49.5	
42	**142**	61.2	61.6	62	44.5	
43	**143**	54.6	63.3	47.2	58.5	
44	**144**	56.4	92	58.3	55.2	
45	**145**	59.5	74.8	56.9	43	
46	**146**	57.6	80.7	54.7	59	
47	**148**	54.8	75.7	52.5	51.2	
48	**149**	61.2	36.6	46.2	39	
49	**150**	55.4	56.2	52.3	41	
50	**151**	55.1	54	49.5	47	
	Mean±SE	**56.58±0.44^{b}**	**63.63±1.64^{a}**	**54.21±0.76^{b}**	**50.66±0.97^{c}**	

Means with different superscripts differ significantly

Table 10.1 Analysis of variance of data of serum glucose during transportation in goats

Anova Table					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	3	4495.355	1498.452	26.672	0.000
Error	196	11011.361	56.180	-	-
Total	199	-	-	-	-

P<0.01

Coefficient of Variation = 13.320

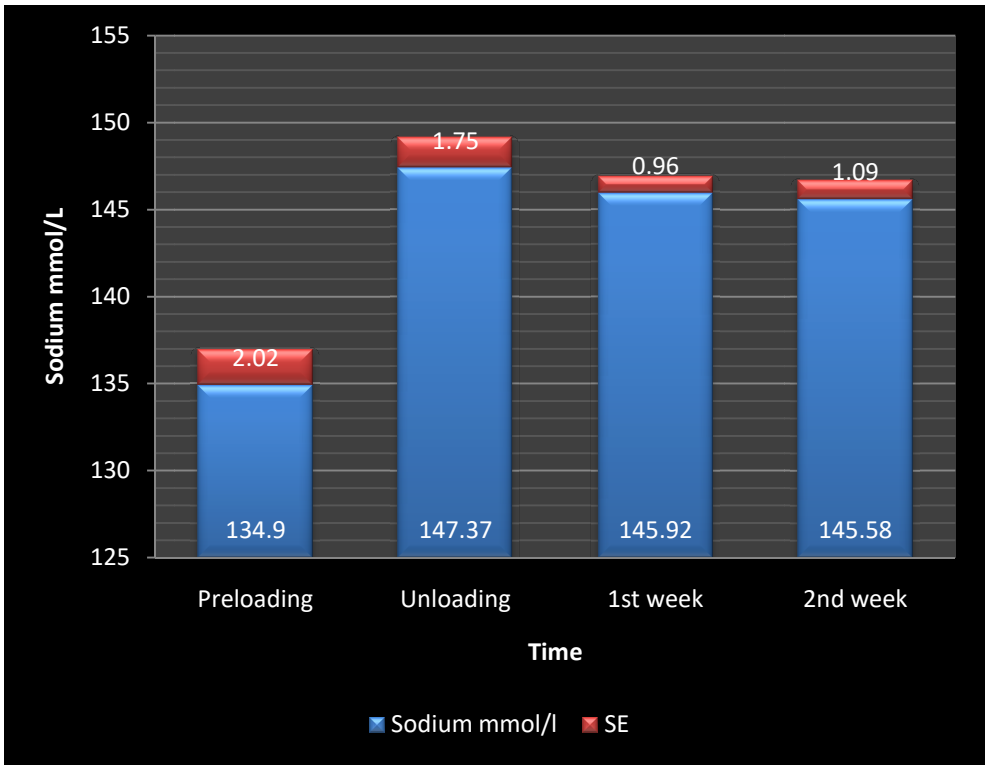

Fig 1 : Mean ± SE levels of serum sodium (mmol/L) during transportation in goats

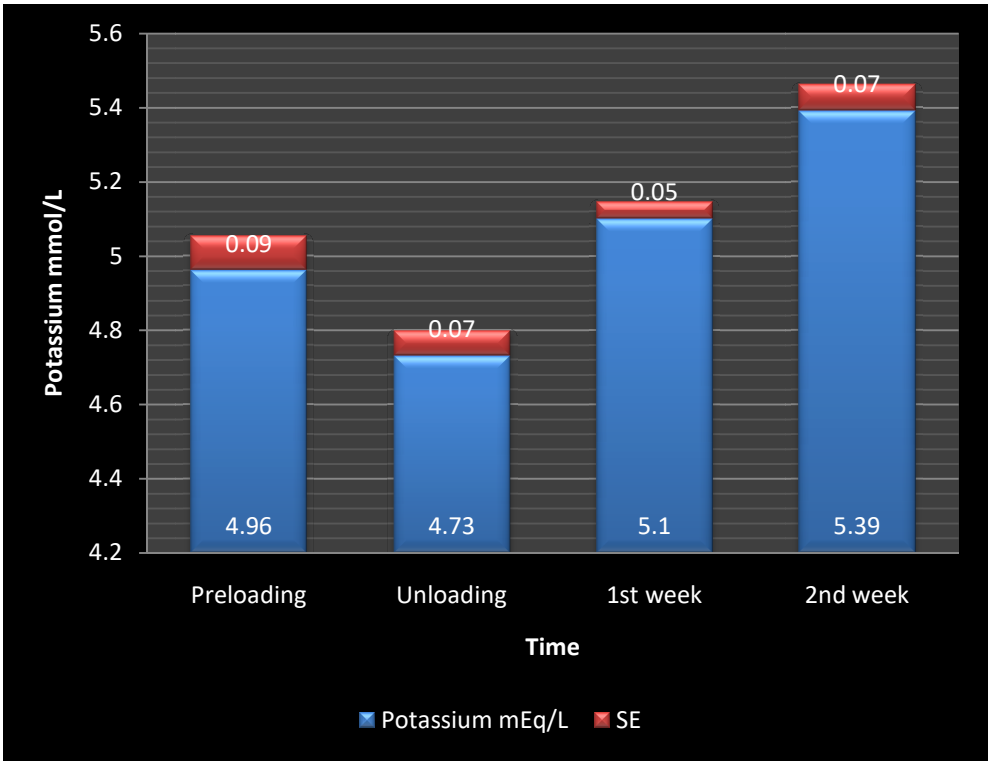

Fig 2 : Mean ± SE levels of serum potassium (mmol/L) during transportation in goats

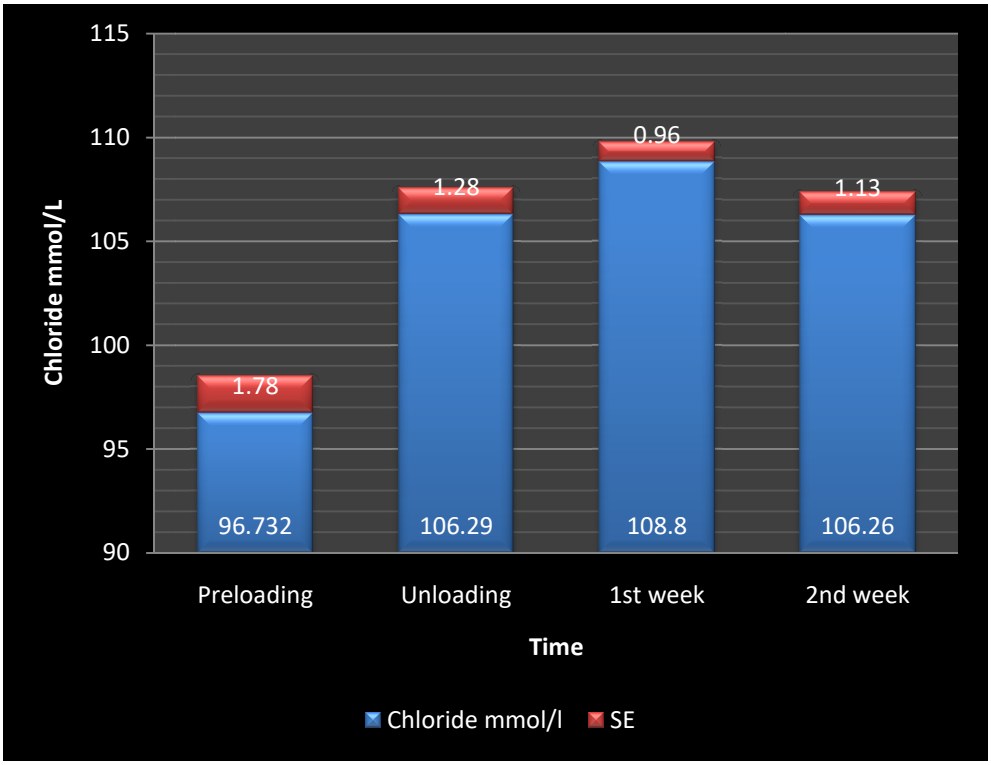

Fig 3 : Mean ± SE levels of serum chloride (mmol/L) during transportation in goats

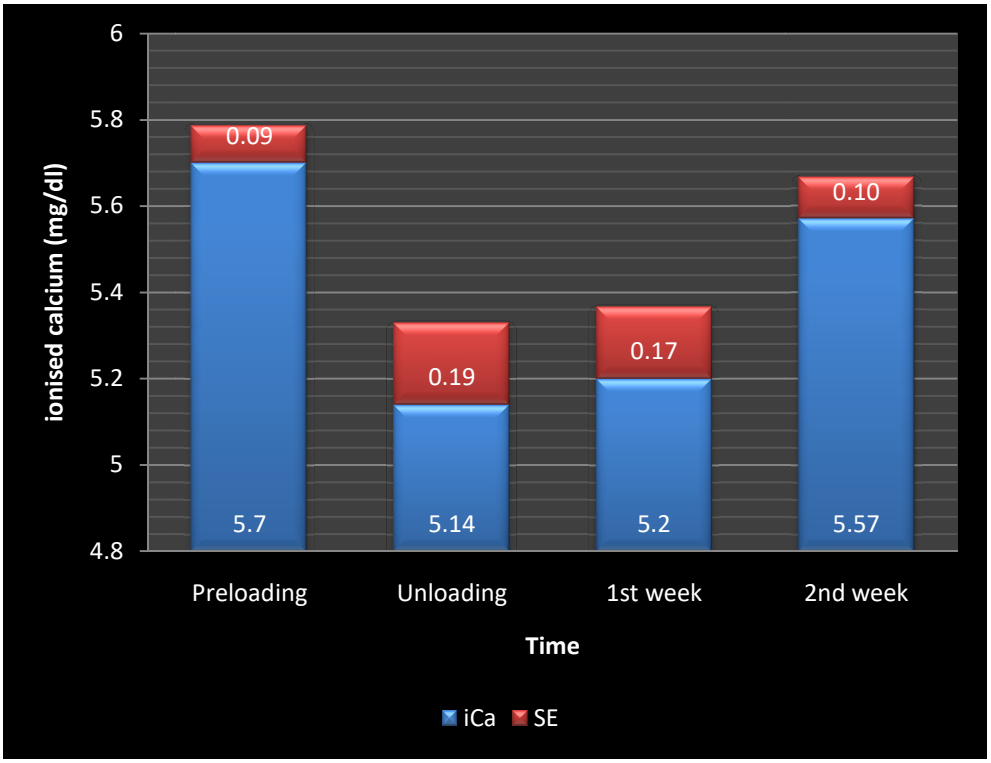

Fig 4 : Mean ± SE levels of serum ionized calcium iCa (mg/dl) during transportation in goats

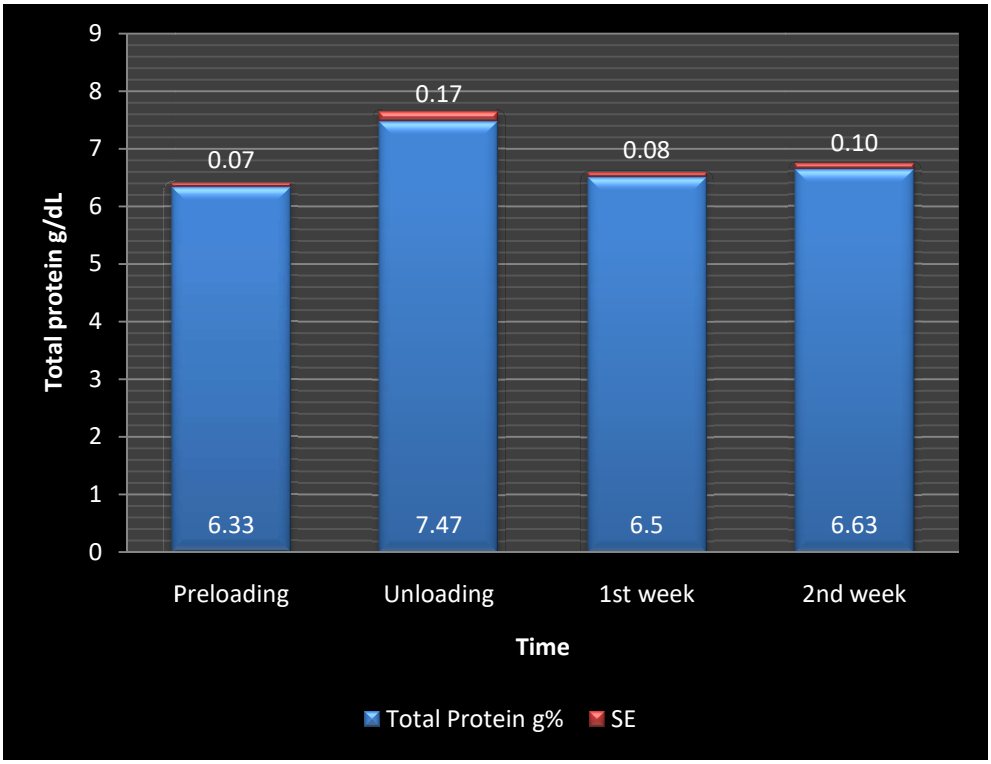

Fig 5 : Mean ± SE levels of serum total protein (g/dl) during transportation in goats

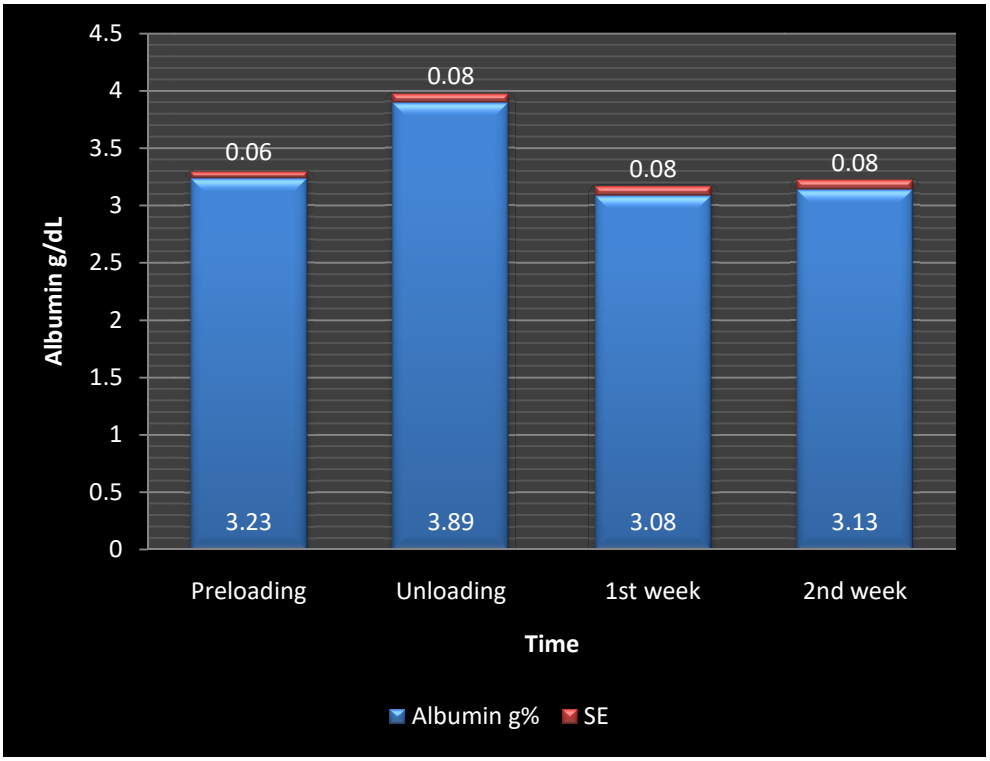

Fig 6 : Mean ± SE levels of serum albumin (g/dl) during transportation in goats

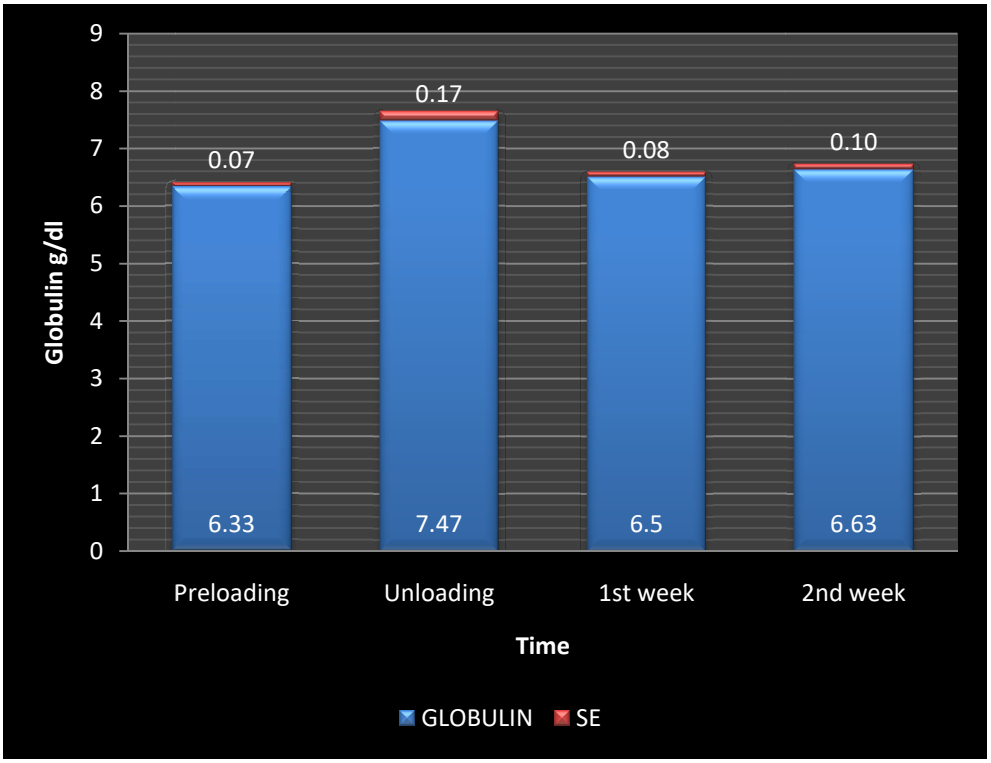

Fig 7: Mean ± SE levels of serum globulin (g/dl) during transportation in goats

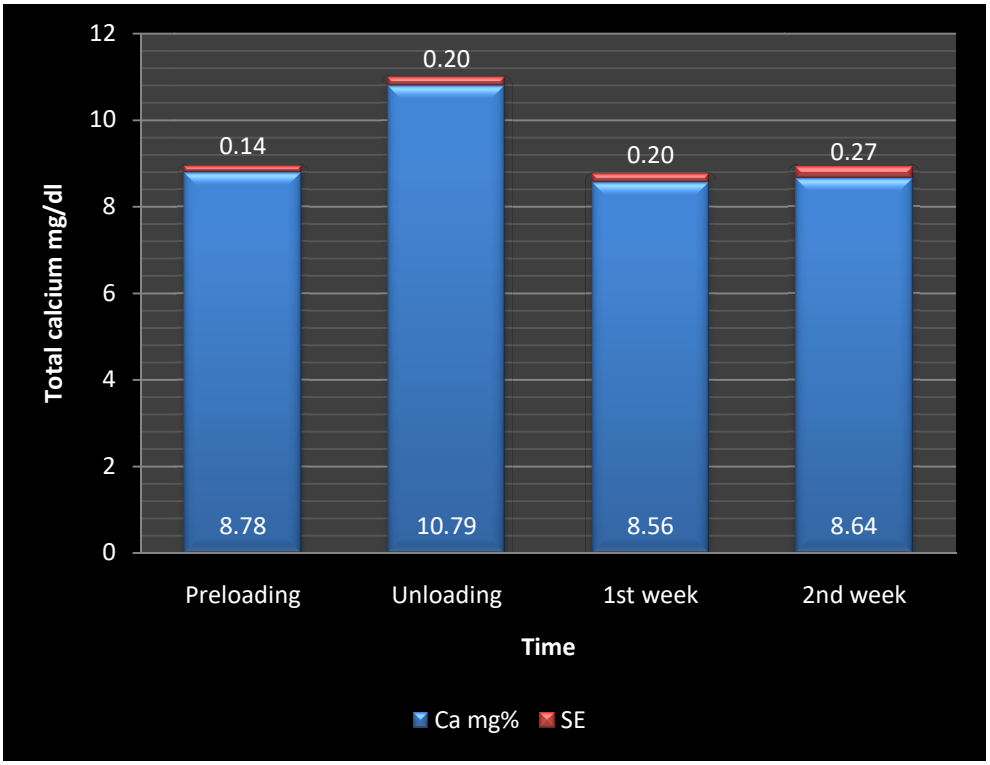

Fig 8 : Mean ± SE levels of serum total calcium (mg/dl) during transportation in goats

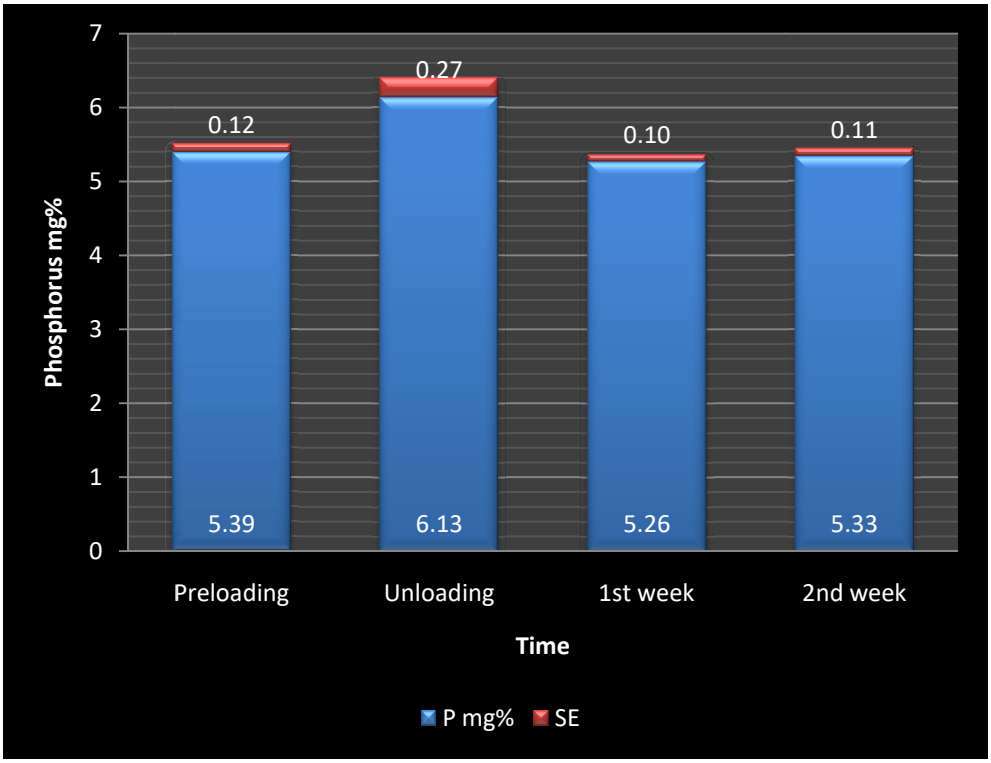

Fig 9 : Mean ± SE levels of serum phosphorus (mg%) during transportation in goats

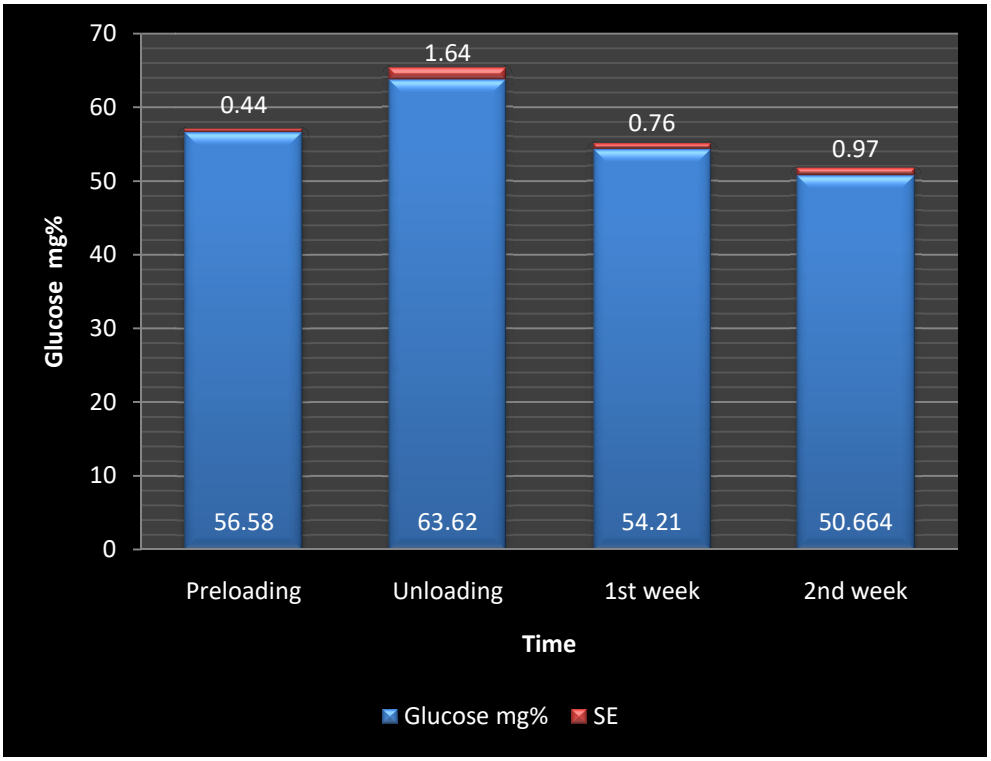

Fig 10 : Mean ± SE levels of serum glucose (mg%) during transportation in goats

5. SUMMARY AND CONCLUSIONS

The Experiment was conducted on 50 healthy adult goats which were undergone 6 hrs road transported. Blood samples were collected from these goats before loading them in truck for transportation. After transportation, these goats were unloaded at **Advy chemicals Pvt. Ltd., farm located at Phalegaon, Kalyan, Dist. Thane**, where these goats are maintained and regularly used for the collection of antisera. Feed and water were withheld during the transportation period. Blood samples were collected immediately after the unloading of these animals and thereafter, weekly for two weeks. The goats were provided with *ad-libitum* water after unloading at farm after collection of blood samples. Clear serum was separated by centrifugation. Serum samples were analyzed for Na^+, Cl^-, K^+ and Ca^+ electrolytes and other biochemical parameters viz. total proteins, albumin, total calcium, phosphorus and glucose. Total 200 samples were analyzed for electrolyte and other biochemical parameters during transportation.

5.1 Serum Electrolytes during transportation in goats

5.1.1 Sodium

In the present study serum sodium levels at preloading, after unloading and at 1st and 2nd week after unloading were 134.90±2.02, 147.37±1.75, 145.92±0.96 and 145.58±1.09 mmol/L respectively. There was significant increased ($P<0.01$) in the level of serum sodium immediately after transportation of goats. The levels then came to its preloading value at 1st week after transportation and remained same at 2nd week after transportation in these animals. The increased in the levels of serum sodium seems to be due to transportation stressors, which primarily include off feed and water, crowding and poor ventilation which resulted in dehydration. The levels of serum sodium came to its preloading value at 1st week after transportation which indicates proper hydration of these animals at farm.

5.1.2 Potassium

In the present study mean serum potassium levels at preloading, after unloading and at 1st and 2nd week after unloading were 4.96±0.09, 4.73±0.07, 5.10±0.05 and 5.39±0.07 mmol/L respectively. There was significant decreased

(P<0.01) in the level of serum potassium immediately after transportation of these animals. The mean serum potassium level obtained at preloading decreased significantly after transportation. The decreased in the serum level of potassium after stressful transportation may be due to skeletal muscle damage. Potassium released from working muscle under stress or exercise, due to change in membrane permeability and increased cellular turnover.

5.1.3. chloride

Serum chloride levels at preloading, after unloading and at 1st and 2nd week after unloading were 96.73±1.78, 106.29±1.28, 108.8±0.96 and 106.26±1.13 mmol/L respectively There was significant increased (P<0.01) in the level of serum chloride immediately after transportation of goats in our study. The levels did not come to its preloading value at after transportation till 2nd week after transportation and remained slightly higher.

5.1.4. Ionized Calcium (iCa)

In our study Serum ionized calcium levels at preloading, after unloading and at 1st and 2nd week after unloading were 5.70±0.09, 5.14±0.19, 5.20±0.17 and 5.57±0.10 mg/dl respectively. The ionized calcium significantly (p<0.05) decreased after transportation in these goats and remained at lower level up to 1st week after transportation. The level again increased significantly nearly to its preloading value at 2nd week after transportation. After going through the literature, it is found that, no study has been undertaken to established the levels of ionized calcium during transportation in goats and available to compare with our finding. iCa was analysed using ISE and is the first study to report the levels of iCa during transportation in goats.

5.2. Serum biochemical parameters during transportation in goats

5.2.1. Total Calcium

Maximum mean level of serum total calcium (10.79mg%) was observed immediately after transportation i.e., after unloading. During transportation the goat might undergone various transportation stress due to handling them during loading in tempo, new environment, crowding, poor ventilation, water and feed deprivation during the journey, oscillations etc. These

types of stresses have stimulated secretions of corticosteroids and other stress hormones like adrenaline, which might have increased the level of blood calcium after travelling.

5.2.2. Phosphorus

Maximum mean level of serum phosphorus (6.13mg%) was observed immediately after transportation i.e. after unloading. There was significant increased in the level of serum phosphorus immediately after transportation of these animals. These findings however contradictory with the reports of previous workers. They reported no change in the levels of serum phosphate after long transportation. The levels of serum phosphorus came to its preloading value within 1 week after unloading of these animals in our study.

5.2.3. Total Proteins

Total proteins levels in goats in our study at preloading, after unloading and at 1st and 2nd week after unloading were 6.33±0.07, 7.47±0.17, 6.50±0.08 and 6.63±0.01 g/dl respectively. There was significant increased ($P<0.01$) in the level of serum total proteins, immediately after transportation of these animals. In our experiment during transportation animals were undergone various transportation stress. Among these stresses water and feed deprivation and increased heat due to crowding might be resulted in dehydration, which in turns increased relative concentration of serum proteins after unloading samples of the goats.

5.2.4. Albumin

Serum albumin levels at preloading, after unloading and at 1st and 2nd week after unloading were, 3.12±0.06, 3.89±0.08, 3.08±0.08 and 3.13±0.08 g/dl respectively. The albumin level ranged from 3.12±0.06 to 3.89±0.08 g/dl during transportation period. The levels of albumin followed a same trend of serum total proteins. In our experiment during transportation animals were undergone various transportation stress. Among these stresses water and feed deprivation and increased heat due to crowding might be resulted in dehydration, which in turns

increased relative concentration of serum albumin after unloading samples of the goats.

5.2.5. Globulin

Serum globulin concentration was calculated by subtracting serum albumin from total proteins. The globulin level ranged from 3.10±0.08 to 3.58±0.16 g/dl during transportation period. In conclusion, the levels of globulin followed a same trend of serum total proteins and albumin in our study.

5.2.6. Glucose

In our study increased in the levels of serum glucose immediately after transportation seems to be due to transportation stressors, which may include handling of animals during their loading and unloading, new environment, off feed and water, oscillations and noise during travel and poor ventilation and crowding, which takes via stimulation of adrenals and stress hormone like cortisol and adrenaline secretion and its effect on glucose metabolism. These hormones are considered to be hyperglycaemic. There was significant decreased in the level of serum glucose at 2nd week after transportation in these animals.

CONCLUSIONS:

1. The levels of electrolytes viz. Na^+, K^+ and Cl^- and biochemical parameters viz. total proteins, albumin, total calcium, phosphorus and glucose were significantly increased and iCa significantly decreased after 6 hrs of road transportation of goats in our study. No clinical signs of electrolytes or biochemical disorder and fatality were observed in these animals.
2. Disturbed electrolytes and biochemical parameters due to transportation stress in these goats were returned to its normal physiological levels in our study within period of a week after unloading these individuals indicates adaptation of these goats to adverse stressful condition.
3. Feed and ad-*libitum* water should be provided and rest should be given to these animals after transportation for the restoration of the disturbed electrolyte and biochemical parameter.

4. Further detail study is required to be undertaken to study the disturbance in electrolyte, acid base and mineral balance and level of oxidative stress during long journey transportation and to assess health and meat quality in goats.

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Appendix – G

THESIS ABSTRACT

a)	Title of the thesis (in capital letters)		STUDIES ON SERUM ELECTROLYTES AND BIOCHEMICAL PARAMETERS DURING TRANSPORTATION IN GOATS
b)	Full name of student		Panchal Pooja Bhalchandra
v)	Name and address of Major Advisor		Dr. S. H. Dalvi Associate Professor and Head, Department of Veterinary Biochemistry, Mumbai Veterinary College, Parel, Mumbai-400012.
d)	Degree to be awarded		M. V. Sc.
e)	Year of award of degree		2021
f)	Major subject		Veterinary Biochemistry
g)	Total number of pages in the thesis		108
h)	Number of words in the abstract		259
i)	Signature of Student		
j)	Signature, Name and address of forwarding authority (HOD / SH)		
k)	Signature of the Associate Dean		

ABSTRACT

The present experiment was conducted on 50 healthy adult goats irrespective of age, sex and breed; to study the changes in the serum electrolyte viz. Na^+, K^+, Cl^-, Ca^{+2} and some biochemical parameters viz. total protein, albumin, globulin, total calcium, phosphorus and glucose during short term transportation in goat. The goats were road transported in truck for 6hrs. from Sangamner, Dist. Ahamadnagar, Maharashtra to Thane, Maharashtra, and changes in the levels of electrolytes and biochemical parameters due to transportation stress in these goats were studied. The average temperature and relative humidity was 31^{o}C/51% and 35 ^{o}C/47.5% at Sangamner and Thane respectively. The serum electrolytes were estimated by using Ion Selective Electrode (ISE) with the electrolyte analyzer. While biochemical parameter estimated usind semi-automatic biochemistry analyzer.

The levels of electrolytes viz. Na^+, K^+ and Cl^- and biochemical parameters viz. total proteins, albumin, total calcium, phosphorus and glucose were significantly increased and iCa significantly decreased after 6 hrs of road transportation of goats in our study. No clinical signs of disorder and fatality were observed in electrolytes or biochemical parameters.

Inorder to restoration of the disturbed electrolyte and some biochemical parameter feed, *ad-libitum* water provided and rest was given to these animals after transportation. Electrolytes and some biochemical parameters were returned to its normal physiological levels within a week after unloading these goats in our study. Further detail research required to be undertaken to study the disturbance in electrolyte, acid-base balance, mineral balance and level of oxidative stress during long journey transportation as to assess the health and meat quality in goat.

Appendix – G

प्रबंध सारांश

१.	प्रबंधाचे शिर्षक		प्रवासा दरम्यान शेळ्यांच्या रक्तजलामधील क्षार व जैवरसायनीक मापदंडात होणा-या बदलावरील अभ्यास
२.	विद्यार्थ्याचे नाव		पांचाळ पुजा भालचंद्र
३.	मार्गदर्शकाचे नाव आणि पत्ता		डॉ. एस. एच. दळवी, सहायोगी प्राध्यापक, पशुवैद्यकिय जीवरसायनशास्त्र विभाग, मुंबई पशुवैद्यकिय महाविद्यालय, परळ, मुंबई-१२.
४.	पदवी		पदव्युत्तर पदवी
५.	पदवी प्रदान करण्याचे वर्ष		२०२१
६.	मुख्य विषय		पशुवैद्यकिय जीवरसायनशास्त्र विभाग
७.	प्रबधाची एकुण पाने		१०८
८.	सारांशाचे एकुण शब्द		१९३
९.	विद्यार्थ्याची सही		
१०.	प्रबंध पाठविणा-या अधिका-याचे संपुर्ण नाव, पत्ता आणि सहि		
११.	सहयोगी अधिष्ठाता, मुंबई पशुवैद्यकिय महाविद्यालय, परळ, मुंबई-१२		

सारांश

सदर आभ्यास 50 निरोगी प्रौढ शेळ्यांवर जाती, लिंग आणि वयाचा विचार न करता करण्यात आला; ज्यांची 6 तास उभे करुन ट्रकव्दारे वाहतुक करण्यात आली. शेळ्यांना कोणत्याही प्रकराचे उणीव भरुन काढणारे द्रव्य, खनिजद्रव्य किंवा इलेक्ट्रोलाइट्स वाहतूकपूर्व दिली गेली नव्हती. या शेळ्यांना वाहतुकीसाठी ट्रकमध्ये भरण्यापूर्वी रक्ताचे नमुने घेण्यात आले होते. वाहतुकीनंतर ॲडव्ही केमिकल्स प्रा.लि., कल्याण, फालेगाव, जि.ठाणे च्या गोठ्यात शेळ्या आणल्या गेल्या. जेथे या शेळ्यांची देखभाल केली जात आणि नियमितपणे ॲंटिसेरा संकलनासाठी वापरली जातात.

शेळ्यांच्या रस्ता वाहतुकीच्या ६ तासांनंतर, रक्तजलातील इलेक्ट्रोलाईट जसेकी उदा. सोडीयम, पोटॅशियम, क्लोराईड आणि आयनाईज्ड कॅल्शीयम; तसेच विविध बायोकेमिकल घटक पातळीत उदा. एकूण प्रथिने, अल्ब्युमिन, एकूण कॅल्शियम, फॉस्फरस आणि ग्लुकोज पातळीत लक्षणीय प्रमाणात वाढले आणि आयोनीक कॅल्शीयम मध्ये लक्षणीय घट झाल्याचे आमच्या अभ्यासामध्ये आढळुन आले. परंतु, इलेक्ट्रोलाइट्स किंवा जैवरसायनीक असमतोलनीय कोणत्याही प्रकारचा परिणाम व घातक लक्षणे सदर शेळ्यांमध्ये दिसुन आली नाहीत.

शेळ्याच्या वाहतुकीनंतर विश्रांती, खाद्य व पाणी पुरक प्रमाणत पुरवण्यात आल्यावर, शेळ्यांना वाहतुकीच्या तणावातून पुर्ववत होण्यासाठी जवळजवळ एक आठवड्याचा कालावधी लागला. आमच्या अभ्यासाप्रमाणे सदर शेळ्यांना प्रवासानंतर एका आठवड्यात इलेक्ट्रोलाइट्स आणि काही बायोकेमिकल पॅरामीटर्स सामान्य शारीरिक पातळीवर परत आले. तसेच सहा तासांपेक्षा जास्त वेळ वाहतुक केल्यावर वाहतुकीचा ताण अभ्यासणे व त्याचा परिणाम शेळ्यांच्या मांसावर काय होते याचे सखोल संशोधन भविष्यात करणे आवश्यक आहे.

VITA

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