'STUDIES ON CLINICO- HAEMATO-BIOCHEMICAL ASPECTS AND CHEMOTHERAPY OF TROPICAL BOVINE THEILERIOSIS'

THESIS

Submitted to the

Rajendra Agricultural University

(Faculty of Post- Graduate Studies)

Pusa (Samastipur), Bihar

In Partial fulfillment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

IN

(VETERINARY MEDICINE)

By

NAVIN KUMAR

Registration No.M/V, Med/44/2004-05

Department of Veterinary Medicine

Bihar Veterinary College

Patna- 800 014

2007

"STUDIES ON CLINICO-HAEMATO-BIOCHEMICAL ASPECTS AND CHEMOTHERAPY OF TROPICAL BOVINE THEILERIOSIS"

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

(FACULTY OF POST-GRADUATE STUDIES)

PUSA (SAMASTIPUR), B I H A R

In Partial fulfillment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

IN

(VETERINARY MEDICINE)

By

Navin Kumar

Registration No. - M/V.Med/44/2004-2005.

DEPARTMENT OF VETERINARY MEDICINE

BIHAR VETERINARY COLLEGE

P A T N A – 800 014

2007

Dedicated

to my

beloved

Parents

DEPARTMENT OF VETERINARY MEDICINE
BIHAR VETERINARY COLLEGE, PATNA- 14
RAJENDRA AGRICULTURAL UNIVERSITY,
PUSA (SAMASTIPUR), BIHAR.

Dr. Subhash Prasad Verma
M.V.Sc., Ph.D.
Univ. Professor & Head
(Deptt. of Veterinary Medicine)
& Assoc. Dean-cum-Principal
Bihar Veterinary College, Patna- 14.

CERTIFICATE-I

This is to certify that the thesis entitled ***"STUDIES ON CLINICO-HAEMATO-BIOCHEMICAL ASPECTS AND CHEMOTHERAPY OF TROPICAL BOVINE THEILERIOSIS"*** submitted in partial fulfillment of the requirements for the Degree of **Master of Veterinary Science (Veterinary Medicine)** to the faculty of post-graduate studies, Rajendra Agricultural University, PUSA, Samastipur, Bihar is the record of bonafide research work carried out by **DR. NAVIN KUMAR, Registration No.-M/V.Med/44/2004-05,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

S Verma 25/06/07

(S.P. Verma)
Major Advisor

Endorsed

S Verma 25/06/07

(S.P. Verma)
(Chairman/Head of Department)

DEPARTMENT OF VETERINARY MEDICINE
BIHAR VETERINARY COLLEGE, PATNA- 14
RAJENDRA AGRICULTURAL UNIVERSITY,
PUSA (SAMASTIPUR), BIHAR.

CERTIFICATE –II

We, the undersigned members of the Advisory Committee of **DR. NAVIN KUMAR (Registration No.-M/V.Med/44/ 2004-05),** a candidate for the Degree of **Master of Veterinary Science** with Major in **Veterinary Medicine,** have gone through the manuscript of the thesis and agree that the thesis entitled ***"STUDIES ON CLINICO-HAEMATO-BIOCHEMICAL ASPECTS AND CHEMOTHERAPY OF TROPICAL BOVINE THEILERIOSIS"*** may be submitted by **DR. NAVIN KUMAR** in partial fulfillment of the requirements for the degree.

(S.P. Verma)
Chairman, Advisory Committee

Members of Advisory Committee :

1. **Dr. C. Jayachandran,**
   Head of Department
   Department of Vety. Pharmacology & Toxicology
   Bihar Veterinary College, Patna-14.

2. **Dr. K.G. Mandal,**
   Sr. Assistant Professor
   Deptt. of Animal Breeding & Genetics
   Bihar Veterinary College, Patna-14.

3. **Dr. G.P. Roy**
   Sr. Assistant Professor
   Deptt. of A.R.G.O.
   Bihar Veterinary College, Patna-14.

(Nominee of Dean Post Graduate Studies).

DEPARTMENT OF VETERINARY MEDICINE
BIHAR VETERINARY COLLEGE, PATNA- 14
RAJENDRA AGRICULTURAL UNIVERSITY,
PUSA (SAMASTIPUR), BIHAR.

CERTIFICATE-III

This is to certify that the thesis entitled ***"STUDIES ON CLINICO-HAEMATO-BIOCHEMICAL ASPECTS AND CHEMOTHERAPY OF TROPICAL BOVINE THEILERIOSIS"*** submitted by **DR. NAVIN KUMAR, Registration No.- M/V.Med/44/2004-05,** in partial fulfillment of the requirements for the Degree of **Master of Veterinary Science (Veterinary Medicine)** of the Faculty of Post-Graduate Studies, Rajendra Agricultural University, PUSA, Samastipur, Bihar was examined and approved on 16/06/2008.

16-6-08
(N. N. Pandey)
(External Examiner.)

16/6/08
(S.P. Verma)
Chairman, Advisory Committee

Members of Advisory Committee :

1. **Dr. C. Jayachandran** 16/6/08

2. **Dr. K.G. Mandal** 16/6/08

3. **Dr. G.P. Roy** 16/6/08

(Nominee of Dean Post Graduate Studies).

ACKNOWLEDGEMENT

It gives me great pleasure to express my deep sense of appreciation and gratitude to my Major Advisor and Chairman of the Advisory Committee, Dr. Subhash Prasad Verma, Univ. Professor and Head (Department of Veterinary Medicine) & Associate-Dean-cum-Principal, Bihar Veterinary College, Patna-14, for his constant and valuable guidance, supervision, encouragement, inspiration, efforts on planning and execution of the work during the entire course of study and also for his great human gesture and incessant devotion of time during preparation of this manuscript and enlightening me with his immense knowledge and noble ideas about the problem of study.

I am extremely obliged and thankful to the learned members of my Advisory committee, Dr. C. Jayachandran, HOD, Department of Veterinary Pharmacology and Toxicology, and Dr. K.G. Mandal, Associate Professor, Department of Animal Breeding and Genetics, B.V.C., Patna for their constant help, valuable suggestions and prudent guidance which made this work possible within the stipulated time period.

I am extremely grateful to my Nominee, Dean P.G.S., Dr. G.P. Roy, Sr. Assistan, Prof., Deptt. of ARGO, B.V.C., Patna for his valuable suggestions.

I wish to express my sincere thanks and indebtedness to Dr. K.P. Mallick, Retd. Principal Scientist (Veterinary Medicine) I.V.R.I., Izatnagar for his valuable help and guidance.

I have no words to express my gratitude and indebtedness to Dr. A. Prasad, Dean, Bihar Veterinary College for providing adequate facilities to conduct this work.

My sincere indebtedness goes to Dr. H.P. Singh, Hon'ble Vice-Chancellor, R.A.U., Pusa (Samastipur), Bihar who provided adequate facilities for the research work.

I am profoundly thankful to my seniors namely Dr. Sumannath Mishra, Dr. Raj Kumar, Dr. Mukesh, Dr. Sanjay, Dr. Badal, Dr. Rajeev Ranjan, Dr. Jay Prakash, Dr. Prince, Dr. Ajeet, Dr. Prem Ranjan, Dr. Pradeep, Dr. Laxmikant, Dr. Shurtikesh,, Dr. Mritunjay, Dr. Nirbhay, Dr. Neel Kamal Nilu, Dr. Ranveer, Dr. S.M. Kushwaha, Dr. Bidya Shankar, Dr. Rajeev Bharti, Dr. Sanjeet, Dr. Arun Thakur, Dr. Naveen, Dr. Praveen, Dr. Shailendra, Dr. Pradeep Yadav, Dr. Shashi Shankar, Dr. A. Deep, Dr. Santosh and Dr. Satish for their valuable suggestions.

I would like to convey my sincere gratitude to my colleagues namely Dr. Jeevan, Dr. Prabhat, Dr. Saroj, Dr. Shashi Prakash, Dr. Saxena, Dr. Dheeraj, Dr. Rakesh, Dr. Aman, Dr. Vijay, Dr. Sachin, Dr. Monika, Dr. P. Suman, Dr. Shantanu, Dr. Ajay, Dr. Ritesh Ranjan, Dr. K.K. Azad, Dr. Dhananjay, Dr. Santosh. and lovely juniors Dr. Bipin, Dr. Ravish, Dr. Naveen Chandra, Dr. Ajay, Dr. Kamlesh, Dr. Premshankar, Dr. Binay, Shridev, Himanshu, Arjun and Nirmal for their cordial co-operation, constant help and encouragement during the period of study and thesis preparation.

My sincere thanks go to Staff members, Department of Veterinary Medicine for their help and cooperation.

I admire the patience, devotion and unfailing courtesy of Mr. Manoj Kumar, Mr. Raja and Mr. Dharmraj Choudhary of M/s Sanjeevani Art Computers, Patna, who have taken great pains to print this manuscript.

I also express sincere gratitude to my respected father Shri Binod Kumar and mother Smt. Manju Devi for their affectionate inspiration and ever-lasting endurance, sacrifice and moral support.

I have no words to pay regards to my brother Praveen Kumar and my sister Suman Kumari, who were a source of enthusiasm for me in completing this work.

I express my heart touching and warm feelings to my revered grandfather, Late Mohan Lal Agrawal and grandmother, Smt. Savitri Devi for their blessings, enthusiastic moral support, inspiration and deep affection during the entire period of my study. I owe them what I am today.

Finally, I express my heartiest gratitude to almighty GOD for giving me patience and strength to overcome the difficulties that came in my way in accomplishment of this endeavour.

All may not have been mentioned but none has been forgotten.

Navin Kumar

Date : 15.06.07.

(Navin Kumar)

Place : B.V.C., Patna-14

CONTENTS

****

LIST OF TABLES

****

LIST OF FIGURES

****

CHAPTER - I

INTRODUCTION

INTRODUCTION

Haemoprotozoan diseases have been known to exist since long in endemic form in Asian countries particularly in the Indian subcontinent, Middle East, Asia, USSR and African countries. Theileriosis attracts serious attention as a disease of major economic importance since its clinical manifestations in the indigenous breeds of animals are rarely recognized. Although these animals are comparatively resistant to this disease, yet they cause a threat to exotic animals and their crosses by acting as carriers. With the import of European breeds of cattle for upgrading the indigenous stock to improve their milk yield, the occurrence of the disease has increased. The *Bos taurus* cattle are highly susceptible and their cross-bred progeny are comparatively more susceptible than indigenous animals to the infection resulting in death of a large number of valuable animals. At present, theileriosis is a major hazard to the bovine industry in developing countries like India where exotic animals are being employed more and more for livestock development and upgradation through crossbreeding. A large cattle population has, thus, come up which is at a grave risk to the disease. The possible economic losses originating from them are too great to be visualized and fully appreciated. The disease is a major constraint to livestock improvement programmes in many parts of the Middle East

and Asia (Hashemi-Fesharki, R., 1988) and about 200 million cattle are at risk (Hall, F.R., 1988).

Theileriosis is a parasitic disease which affects cattle, buffaloes, sheep and goats. It is a tick-borne hemoprotozoan disease caused by the parasite of the genus *Theileria.* By far the most important species are *Theileria parva* causing East Coast Fever in Africa, *T. annulata* causing bovine tropical theileriosis in Asia, Middle East, North Africa & the Southern Europe. Other species are *T. mutans, T. lawrencei* and *T. sergenti,* the first two are prevalent in Africa, Europe, Middle and the Far East and the third one is distributed in Japan, Korea, USSR & China (Kreier, 1977). There are no estimates of losses due to tick-borne diseases for the whole world but it would be a whopping figure when compared to estimated losses of over 40 million dollars every year in USA where ticks have been eradicated at present (Barne, 1961).

For the first time the disease was recorded in India by Lingard (1905) in a young hill bull. Our knowledge largely came through the observations of Edwards (1925) and Cooper (1926), followed by a number of later workers (Ajwani and Subbarayalu, 1934; Sen and Srinivasan, 1937; Raghavchari, 1944; Rao, 1954; Kathuria, 1963). However, its importance was known when Gautam *et al.* (1970) recorded several cases of theileriosis in exotic animals and a Sahiwal calf.

Edwards (1925) and Cooper (1926) recognized two theilerial species affecting cattle in India namely *T. annulata*

and *T. mutans*. Dhar and Gautam (1977) performed complement fixation test on sera samples collected from Hissar region for species differentiation and found existence of these two species.

A number of drugs like sulphadrugs, diminazine, quinine compounds and the tetracycline group of antibiotics were tried either alone or in combination but none of them gave satisfactory results against theileriosis. As the schigonic stages and erythrocytic stages responded to different drugs (Weinman & Ristic, 1968), a suitable drug which affects both the forms of *Theileria* was very much desirable. Of late, parvaquone (Clexon, Wellcome) and buparvaquone (Butalex) have been developed and tried against experimentally & naturally induced infection of *T. annulata* and have yielded very good results. But the biggest drawback lies in the fact that they are very expensive and are almost beyond the reach of the common Indian farmers. Hence, an attempt has been made to look for other effective and affordable combinations.

Objectives:

The present investigation was designed keeping in view the following objectives:

- Close observation of clinical manifestations (Temperature, Pulse and Respiration rates) in ailing animals
- Studies on haematological and biochemical parameters and
- Treatment with different chemotherapeutic agents namely Diaminazine aceturate, Oxytetracycline and Levamisole in various combinations.

****

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The literature on bovine tropical theileriosis has been reviewed under the following sub-headings :

(1) Symptomatology

(2) Haematological changes

(3) Biochemical changes

(4) Chemotherapy

- (i) Berenil
- (ii) Oxytetracycline
- (iii) Levamisole
- (iv) Miscellaneous drugs

Symptomatology :

Sen and Srinivasan (1937) produced bovine theileriosis by inoculating infective blood and important symptoms noted by them were fever, enlargement of lymph nodes, anaemia, icterus and petechiae on visible mucous membrane.

Ramaiah (1946) observed corneal opacity and photophobia in some cases of theileriosis.

Khalifa and Kadim (1967) recorded petechial haemorrhage and ulceration of conjunctiva in *T. annulata* infection.

Narsimhamurthy *et al.* (1968) observed hyperpyrexia and haemoglobinuria in a high yielding cross-bred cow.

Gautam *et al.* (1970) recorded fever, swelling of superficial lymph nodes, anaemia, high coloured urine in nine

clinical cases of theileriosis. They also found haemoglobinuria in two cases.

Sharma and Gautam (1971) observed fever, enlargement of lymph nodes and anaemia in three indigenous calves. They also noted haemoglobinuria and severe jaundice in one calf.

Erturk *et al.* (1976) observed the symptoms of pyrexia, increased heart and respiration rates and greatly swollen lymph nodes in calves experimentally infected with *T. annulata.*

Srivastava *et al.* (1976) observed cerebral symptoms in 2 of 33 calves experimentally infected with *T. annulata* by infected *Hyalomma anatolicum* and dying on the 16th and 19th days.

Sharma and Gautam (1977) recorded petechial haemorrhages, haemorrhagic blotching of the conjunctiva and haemorrhagic spots in the perineal region. They also observed abortion in pregnant animals.

Gill *et al.* (1977) experimentally produced the disease in calves and observed swelling of lymph nodes, fever, accelerated pulse and respiration rates, swollen eyelids and icteric conjunctiva, nasal discharge and progressive weakness though appetite was normal.

Thandaveswar *et al.* (1978) observed a cow with pica to have hypoglycemia associated with lymphocytosis and found *T.annulata* in the blood.

Bulman *et al.* (1979) observed signs of pyrexia (42°C) anorexia, watery discharge from both eyes, slight constipation, and congested conjunctivae in 4 bulls diagnosed of *T. annulata* infection.

Srivastava and Sharma (1981) observed that the disease, clinically characterized by hyperpyrexia (106°F) and enlargement of prescapular and prefemoral lymph nodes, was encountered only in 18 cross-bred calves (29.5%) and in none of the indigenous zebu calves and buffalo calves.

Khanna *et al.* (1982) observed abrupt development of cerebral theileriosis with muscular twitching, high stepping gait, head pressing against fixed objects, paddling movements of legs in 4 out of 20 calves experimentally infected with *T. annulata.*

Shastry *et al.* (1982) found small papular skin eruptions over the back, sides of the neck and shoulders of two calves affected with acute fatal theileriosis.

Randhawa *et al.* (1983) recorded ocular lesion in cross-bred calves less than 3 months of age. These calves showed bilateral oedematous swelling of the eyelids and keratitis with necrotic changes in sclera and cornea leading to marked protrusion of eyeball from the socket.

Anantwar *et al.* (1986) studied symptoms of the disease and its treatment in 5 cross-bred cows in India. The symptoms observed were high fever, anaemia, loss of appetite, enlarged superficial lymph nodes and a marked reduction in the milk

yield. Rothra's test performed on urine and milk detected ketone bodies.

Amer *et al.* (1987) screened 46 cases of bovine theileriosis in Friesian cattle in Egypt and observed signs of weakness, increased body temperature, tarry faeces, teeth grinding, salivation, laboured respiration, enlarged lymph nodes and increased heart rate.

Sharma *et al.* (1987) infected twenty 3 to 4 month old cross-bred male calves with *T. annulata* and splenectomized 15 days later. The prescapular, parotid and prefemoral lymph glands were enlarged and the pulse and respiratory rates of the 11 surviving calves were significantly raised. Dulness, coughing, respiratory distress, nasal discharge, lachrymation and diarrhoea were also observed in infected animals.

Mehta *et al.* (1988) observed enlargement of lymph nodes as the first sign in experimentally induced cases of bovine tropical theileriosis. The first appearance of Koch's blue bodies was concurrent with a rise in body temperature. In all calves, there were nasal and lachrymal secretions. Initially, the animals were constipated and had mucus-covered faeces; this was followed by diarrhoea which resulted in emaciation and weakness. In the last stage of the disease, calves showed laboured respiration, recumbency and depression followed by death of all affected animals.

Venkatraman and Manickam (1992) diagnosed *T. annulata* infection in 8 (24.24%) of 33 sick young calves

brought to the Madras Veterinary College clinic between December 1982 to April 1983. Their clinical findings included enlargement of superficial (particularly prescapular) lymph glands.

Omer *et al.* (2003) studied clinico-pathological profiles in 62 Friesian cattle naturally infected with *T. annulata* in Saudi Arabia. Symptoms observed were marked fever, swelling of superficial lymph nodes, inappetance, tachycardia, dyspnoea and weakness.

Haematological changes :

Sharma and Gautam (1975) observed anisocytosis and polychromasia with the presence of immature erythrocytes.

Hooshmand (1976) reported severe anaemia in calves infected with a field strain of *T. annulata.* He also observed anisocytosis.

Laiblin (1978) experimentally infected ten steers with *T. annulata* stabilate and observed erythropenia, thrombopenia, and leucopenia before the appearance of erythrocytic form. He could not demonstrate reticulocytes and concluded that the animals had aplastic anaemia due to a toxin-mediated lesion of the bone marrow.

Dhar and Gautam (1979a) observed gradual fall in total erythrocyte count, packed cell volume and haemoglobin concentration with the progression of disease in experimentally infected calves. They also noticed that maximum fall in TEC, PCV and Hb values occurred after peak parasitaemia. They

concluded that a factor other than parasitic destruction of RBC, probably an auto-immune mechanism causing increased erythrophagocytosis was responsible for anaemia. They observed many reticulocytes and confirmed the existence of a macrocytic hypochromic anaemia.

Sinha and Gunay (1981) recorded severe anaemia in animals experimentally infected with virulent *T. annulata* schizonts.

Srivastava and Sharma (1981) studied the clinico-pathological aspects of natural theileriosis in calves. Haematological results indicated anaemia and leucopenia with neutropenia.

Lal and Soni (1983) observed gradual decrease in Hb concentration, erythrocytic count and became almost half as compared to control calves within 15 days after experimental *T. annulata* infection.

Kanaya (1985) observed that out of 643 natural *T. sergenti* infection in cattle, 109 had reticulocytes in the blood and most of these were severely anaemic whereas no reticulocytes were seen in uninfected cattle. They further observed that when infected cattle with reticulocytes were treated for the infection, 68 percent became reticulocyte-negative and hemotocrit values improved. On the other hand, when infected cattle with reticulocytes were left untreated, 67 per cent developed severe anaemia and required immediate

treatment. He concluded that infected cattle with reticulocytes need immediate treatment.

Lal and Soni (1985) recorded maximum loss of erythrocytes (58%), haemoglobin per cent (47%) and PCV (53%) between 14 and 15 days after experimental infection of *T. annulata* in cross-bred calves.

Dumali *et al.* (1987) recorded reduction in Hb and hematocrit values and the leucocyte count. They also noted that the percentage of lymphocytes increased, and that of neutrophils decreased and there was little change in per cent of monocytes, eosinophils or basophils.

Sharma *et al.* (1987) infected twenty 3-4 month old cross-bred male cow calves with *T. annulata* and splenectomized 15 days later. Before splenectomy, parasitaemia was 10%; 10 days after, it had increased to 25-35%. The packed cell volumes, haemoglobin levels, total leukocyte and erythrocyte counts and cholesterol levels were significantly lower than in uninfected animals.

Mehta *et al.* (1988) noticed marked anaemia of varying intensity with anisocytosis, poikilocytosis and polychromatia in experimental cases of theileriosis in bovines.

Sudhan *et al.* (1988) recorded haematological changes in six cross-bred calves infected experimentally with *T. annulata.* The haematological changes showed a significant fall in Hb, PCV and TEC values. The values of MCV, MCH and MCHC showed a gradual decline. The overall haematological

alterations revealed microcytic normochromic anaemia in chronic infection.

Rayalu *et al.* (1995) recorded significant changes in the haematological values in cattle infected with *T. annulata.* The mean values of TEC, Hb and PCV were significantly lower and were indicative of anaemia. The MCV and MCHC values were significantly ($P<0.01$) altered whereas the MCH values were significant ($P<0.05$). These values were indicative of macrocytic normochromic anaemia. The percentage of neutrophils decreased significantly whereas lymphocytes increased significantly. There was no significant change in basophils, eosinophils and monocytes.

Sahu *et al.* (1996) determined the haematological values in cross-bred cattle naturally infected with *T. annulata* under the warm and humid climatic conditions of Orissa. They recorded significant decline in Hb, PCV, TEC, TLC and non-significant increase in ESR values in infected animals compared to non-infected animals, reflecting anaemia.

Aulakh *et al.* (1998) compared haematological values of 7 *T. annulata* infected cross-bred cattle with those of 5 non-infected healthy cattle at a farm in Ludhiana district, Punjab. There were significant decreases in haemoglobin, packed cell volume, total erythrocyte counts and total leuckocytic counts and non-significant increases in erythrocyte sedimentation rate values in infected animals. There was significant elevation in percentage of lymphocytes and eosinophils, and a

significant decrease in percentage of neutrophils and monocytes.

Sandhu *et al.* (1998) studied haematological changes in experimental *T. annulata* infection in cross-bred calves. There was a significant progressive decrease in haemoglobin concentration, packed cell volume and red blood cell count. Total leukocyte count showed an initial non-significant leukocytosis followed by a significant leukopenia.

Farah *et al.* (1999) studied haematological changes in 10 Friesian calves after challenge with virulent strain. 21 naturally infected animals were controls. No significant changes were observed in vaccinated after challenge. However in naturally infected and non-vaccinated animals, haemoglobin concentration, packed cell volume and total erythrocyte count significantly decreased after infection.

Singh *et al.* (2001) conducted studies on some blood parameters of cross-bred calves with experimental *T. annulata* infections. Subcutaneous inoculation of 1 ml. of ground *T. annulata* tick tissue stabilate (0.75 tick equivalent) into cross-bred calves (n=6, average age 53 days) resulted in the development of acute theileriosis. The percentage parasitemia was 71.7±3.3% on day 20 after inoculation. Macroschizonts were observed in lymphocytes and monocytes. Phagocytosed schizonts were observed in neutrophils, along with cytoplasmic vacuolation in monocytes and neutrophils. There was

progressive decrease ($P<0.05$) in the haemoglobin and packed cell volume, along with a marked reticulocytosis.

Omer *et al.* (2002) observed haematological profiles in pure-bred cattle naturally infected with *T. annulata* in Saudi Arabia. Changes in blood parameters in *T. annulata* infected cattle indicated severe macrocytic hypochromic anaemia, panleukopenia, lymphocytopenia, eosinopenia, neutropenia and thrombocytopenia but no reticulocytosis.

Prem *et al.* (2002) experimentally infected eight apparently healthy cross-bred bovine male calves (2 months old) with *T. annulata* by releasing 25 infected *Hyalomma anatolicum anatolicum* ticks. Erythrocyte-associated haemato-biochemical changes in red cell membrane proteins and phospholipids were recorded at 1-5, 5-10, 10-15,15-20 and >20% parasitaemia. The mean red cell membrane protein in *T. annulata* infected cross-bred bovine calves was found to be significantly higher (41.75-71.72%) at and beyond 10-15% parasitaemia. Similarly, there was a significant increase from 42.85% to 56.68% in the levels of total phospholipids of red cell membrane in the infected animals at and beyond 10-15% parasitaemia.

Ceylan *et al.* (2004) conducted study to investigate whether the erythropoietin (Epo) level and some blood parameters were affected in cattle suffering from theileriosis. Blood samples were collected from 12 cattle with tropical theileriosis and 6 healthy cattle. Epo level increased in cattle

with tropical theileriosis. The erythrocyte count, packed cell volume and haemoglobin decreased in cattle with theileriosis. It was concluded that Epo level increased as a result of anaemia that developed in cattle with tropical theileriosis.

Muraleedharan *et al.* (2005) observed haematological changes in cattle (90% cross-bred) with natural infection of *T. annulata*. The haemogram indicated that the total erythrocyte counts and the Hb levels were low in 31.39% of cattle. The severity of anaemia was not often proportional to the degree of parasitemia. The total leukocyte counts showed leukocytosis or an inclination towards leukopenia and differential leukocyte counts indicated lymphocytosis and neutrophilia. Local cattle had marked leukocytosis and buffaloes showed leukocytosis with neutrophilia.

Biochemical Changes :

Bansal and Gaur (1977) experimentally infected calves with *T. annulata* and collected serum samples on 10, 20, 30 and 40 days after infection for biochemical estimation. They noticed reduction in blood glucose throughout the study. Bilirubin values were increased on day 10 and 20 but became normal on day 30 and 40. Sodium and potassium values decreased upto 20 and 30 days respectively and then increased. Calcium values reduced with lowest at day 40.

Jagdish (1977) observed increase in SGOT, SGPT and alkaline phosphatase during the acute phase of disease.

Laiblin *et al.* (1978) recorded an increase in serum bilirubin, AST, SDH and aldolase values in experimentally infected calves which indicated severe liver damage.

Dhar and Gautam (1979b) estimated total serum protein and protein fractions in experimentally *T. annulata* infected cattle. They observed hypoproteinemia with increase in α and β globulin fractions in acute phase but in chronic phase these fractions became almost normal but γ-globulin increased significantly.

Sinha and Gunay (1981) recorded increase in blood bilirubin in splenectomised calves.

Srivastava and Sharma (1981) studied the clinicopathological aspects of theileriosis in calves. Serum analysis revealed hypoproteinemia and hyperbilirubinaemia (icterus) with normal values of gamma-globulin and calcium concentration.

Yadav and Sharma (1986) observed decrease in level of glucose, calcium, proteins, phosphorus, magnesium and potassium and increase in bilirubin, cholesterol and alkaline phosphatase with no changes in sodium and acid phosphatase levels.

Amer *et al.* (1987) reported increased levels of aspartate aminotransferase, alanine aminotransferase and bilirubin.

Dumali *et al.* (1987) observed increase in blood concentration of potassium and total bilirubin but no significant alteration in serum sodium and blood urea values.

Sudhan *et al.* (1988) recorded biochemical changes in six cross-bred calves infected experimentally with *T. annulata.* The blood glucose and total serum protein contents decreased from day 0 to 28th day but the cholesterol and bilirubin contents increased.

Sahu *et al.* (1996) determined the biochemical values in cross-bred cattle naturally infected with *T. annulata* under the warm and humid climatic conditions of Orissa. There was no significant decline in serum magnesium and phosphorus values in infected animals. A significant rise in total cholesterol value was also noted.

Sandhu *et al.* (1998) studied biochemical changes on experimental *T. annulata* infection in cross-bred calves. There was a significant increase in concentrations of alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, creatine kinase, gamma-glutamyltransferase, uric acid, blood urea nitrogen and bilirubin. The concentrations of total protein, albumin, glucose, cholesterol and calcium showed non-significant decrease, while phosphorus decreased significantly during the terminal stages of the disease.

Farah *et al.* (1999) studied clinical changes in the blood of cattle vaccinated and infected with *Theileria annulata.* Concentrations of total serum protein, albumin, calcium, phosphorus, magnesium, sodium and potassium decreased and those of globulins, alanine aminotransferase, aspartate

aminotransferase and bilirubin increased with no changes in kidney functions.

Omer *et al.* (2003) studied the biochemical parameters in adult and young Friesian cattle naturally infected with *T. annulata* in the Quassim Region, Saudi Arabia. Forty-three clinical cases of tropical theileriosis were studied, together with 40 clinically healthy Friesian cattle. Cattle clinically infected with *T. annulata* had significantly lower serum total protein, albumin, globulin, creatinine, calcium, phosphorus, magnesium, potassium, iron and copper concentration and significantly higher AST activity and bilirubin concentration than the healthy cattle.

Fujimoto *et al.* (2004) studied the quantitative changes in serum concentration of bovine gut chitinase in *Theileria* infection. Its serum levels from 1 week to 1 year of age showed a significant increase only in 3-4 month old group. The plasma concentration of the gut chitinase was not changed during acute inflammation caused by lipopolysaccharide but increased gradually after a *Theileria* injection and peaked at 52 days post-infection. They concluded that the increase in the blood chitinase levels might be a defensive response in cattle against protozoan infection.

CHEMOTHERAPY :

Berenil :

Maisuradze (1975) conducted field trials of the chemotherapy and prophylaxis of theileriosis in cattle. Trials in

Georgia of a number of schemes for chemotherapy of *Theileria annulata* infection showed that the most effective treatment was the administration of Berenil, caffeine, vitamin B_{12} and monomycin, followed on the next day by the i/v administration of sodium chloride and then by the i/m administration of a mixture of Berenil, Haemosporidin, Azidin, Acaprin, Terramycin (or chlortetracycline) and procaine over 3-5 days. This treatment produced recovery in 335 out of 360 animals. Berenil given to 3654 cattle, did not effectively prevent theileriosis, although it did reduce the severity of the disease.

Bulman *et al.* (1979) investigated an outbreak of tropical theileriosis in cattle in Afghanistan. Of 7 bulls shipped from a breeding farm in sub-tropical Jalalabad to Kabul (150km. west), four bulls became ill with signs of pyrexia (42°C), anorexia, watery discharge from both eyes, slight constipation, and congested conjunctivae; one bull died. A presumptive diagnosis of *Theileria annulata* infection made from blood smears was confirmed by a fluorescent antibody test using antigens of the S3 and S19 strains of *T. annulata.* All three bulls responded to treatment with diminazine (7 mg/kg), dexamethasone and antibiotics within 2 days.

Mishra *et al.* (1983) studied the efficacy of some chemotherapeutic agents against clinical *Theileria annulata* infection in exotic cattle. In Sikkim, 52 Jersey cattle aged 1.5 to 2.5 years naturally infected with *T. annulata* infection were treated in 8 different groups and the responses were judged by

temperature, haemoglobin level, parasitaemia, relapse and course of the disease. The best results (10 animals) were achieved with 3 injections of Berenil (diminazine) at 1.2g/100kg. body weight on alternate days plus one daily injection of 500 mg/100kg. Achromycin (tetracycline) for 7 days, along with supportive administration of Belamyl, Novalgin, Mifex and Tonophosphan. Berenil (3 injections) and Oxysteclin (Oxytetracycline) for 6 days (doses as above) plus Novalgin, Tonophosphan and Belamyl also were effective (6 animals). The administration of Berenil alone or with supportive therapy provided some initial relief but the clinical symptoms recurred after 3-7 days.

Dwivedi *et al.* (1984) evaluated some chemotherapeutic agents against bovine theileriosis in Iraq. Cattle (2-3 years of age) naturally infected with *Theileria annulata* were injected i/m with Berenil (diminazine) at 0.8g/100 kg. body weight (2 injections at 24 hr. interval), with or without oxytetracycline 15 mg/kg i/m (3 injections at 24 hr. intervals), or injected 3 times at 24 hr. intervals with oxytetraycline 15 mg/kg or chloramphenicol 15 mg/kg. Based on clinical recovery, changes in parasitaemia, improvement in the condition of animals, and haematological changes, best results were obtained with diminazine + oxytetracycline, followed by diminazine alone and then oxytetracycline. The chloramphenicol treatment did not completely eliminate the erythrocytic stage of the infection.

Tanwar *et al.* (1984) discovered *T. annulata* infection in 18 of 42 sick indigenous Rathi calves aged 10 days to 3 months, brought to a college clinic during the year 1979-80, by microscopic examination of smears of blood or fluid from enlarged lymph nodes. 15 of the calves recovered after treatment with diminazine and oxytetracycline combined.

Sudhan *et al.* (1987) treated seven cross-bred calves heavily infested with *Hyalomma anatolicum anatolicum.* The animals had raised body temperature (mean 41.6^{0}C), pulse rate (99.9/min) and respiratory rate (32.7/min) and enlarged prescapular and prefemoral lymph glands. 4 of the 7 calves responded to treatment with 2 doses of Berenil at 0.8-1.6g/100kg bwt. i/m in combination with rolitetracycline and liver and iron tonics.

Sudhan and Sinha (1991) evaluated the therapeutic efficacy of Berenil at 15 mg/kg bwt. in combination with Reverin at 4 mg/kg bwt. along with supportive therapy in 18 clinical cases of *T. annulata* infection in cross-bred cattle. The drug cured 12 out of 18 animals. Significant increases were recorded in the haematological parameters. Hb, PCV and TEC of blood decreased in cured animals. However, the effect on serum bilirubin was non-significant during pre- and post-treatment observation.

Al-Khafaji (1996) evaluated the efficacy of diminazine aceturate, oxytetracycline and chloramphenicol, used alone or in combination, against clinical cases of bovine theileriosis on

the basis of the clinical signs, parasitemia and haematological changes. Combined treatment with diminazine (0.8g/kg. i/m twice with an interval of 24 hr) and oxytetracycline (15mg/kg. i.m. 3 times at 23 hr. intervals) was the most effective, followed by diminazine alone then oxytetracycline alone. Chloramphenicol (15mg/kg. i.m. 3 times at 24 hr. intervals) was not found to be effective.

Al Abdaly *et al.* (2000) conducted a study on 15 local breed cows naturally infected with *Theileria annulata* to evaluate the efficacy of diminazine at a dose rate of 3.5 mg/kg body weight and oxytetracycline at a dose rate of 20 mg/kg b.wt. alone or in combination. The study revealed that cows naturally infected with *T. annulata* and treated with diminazine plus oxytetracycline or oxytetracycline alone showed a decrease in body temperature, respiratory rate and heart rate. Treatment with diminazine alone led to a decrease in body temperature, while treatment with both drugs led to increases in Hb concentration and PCV but the treatment with diminazine alone led to decreases of PCV and Hb concentration, meanwhile treatment with oxytetracycline alone led to increase in Hb concentration.

Srivastava *et al.* (2001) randomly selected 30 large ruminants suspected to be suffering from blood parasitism at the Ghazipur Government Hospital, New Delhi. Of these, theileriosis was confirmed in 9 cases which responded well to treatment with diminazine (Berenil vet 7% Ready to Use)

administered i.m. @ 1 ml/20 kg. body weight in combination with oxytetracycline administered i.v. @ 25 mg/kg. body wt.

Avapal and Kumar (2003) observed theileriosis in calves of 1 month age precipitated by disbudding. They treated the affected calves with two doses of Berenil @ 5mg/kg, deep intramuscular, along with symptomatic therapy of Diarroak® (Dabur Ayurvet Limited) and 3D-Vet-Plus® (Intas Pharmaceutical Limited). Improvement in condition was observed within 24 hours and complete recovery occurred within 3 days. They also observed that oxytetracycline usually is ineffective after the establishment of infection.

Oxytetracycline :

Jones (1971) treated 97 cattle with oxytetracycline orally or parenterally but 24 of them relapsed within 6-18 days. 14 cattle were treated with oxytetracycline in combination with chloroquine phosphate of which 13 survived and there was no relapse.

Hashami and Shad (1975) studied the therapeutic value of oxytetracycline hydrochloride (Terramycin) in bovine calves experimentally infected with *T. annulata.* Their study revealed that treated groups and controls did not differ at any stage in clinical reactions and levels of parasitism. They concluded that Terramycin was ineffective.

Gill *et al.* (1978) studied the chemoprophylactic effect of long acting oxytetracycline (1 or 2 doses at 20 mg/kg s/c injection) or oral tetracycline (16 mg/kg for 8 days)

commencing on the day of experimental infection of calves with *T. annulata.* They noticed that the calves either failed to react to infection or developed a mild infection. These calves also resisted a virulent challenge.

Samish and Pipano (1978) used oxytetracycline in the immunization of cattle against *Theileria annulata* infection. Calves were given oxytetracycline @ 10 to 20 mg/kg. simultaneously with, and for 2 to 12 consecutive days after, inoculation with suspensions from triturated ticks infected with *Theileria annulata.* All 11 calves receiving 4 or more treatments survived and became resistant to an otherwise lethal challenge.

Singh *et al.* (1980) studied the chemotherapeutic activity of oxytetracycline against clinical cases of *Theileria annulata* infection in exotic and cross-bred cattle. Nineteen cattle infected with *T. annulata* were treated at Parbhani, Maharashtra, India with oxytetracycline plus supportive measures. 17 animals given oxytetracycline @ 10 to 15 mg/kg. body weight daily for 4 to 6 days were cured whereas 2 cross-breds given only 4 to 7mg/kg/day for 4 to 6 days died after showing high parasitemia (43 and 63%).

Pipano *et al.* (1981) experimentally infected Friesian calves with *T. annulata* and treated them with oxytetracycline @ 10-20 mg/kg beginning from the day of infection. They observed all infected treated calves to survive while untreated controls died.

Tripathy (1981) made observations on treatment of bovine theileriosis. Four groups each of 10 two to six year old cattle with early infections of *Theileria* were treated with oxytetracycline according to 4 dose schedules (i) 5 mg/kg body weight intramuscularly daily for 5 days; (ii) 10 mg/kg intravenously daily for 5 days; (iii) like (i) plus diminazine 15 mg/kg intramuscularly repeated after 3 days; (iv) like (ii) plus diminazine as in (iii). The best therapeutic results were obtained in group (iv) and almost as good in group (ii) On the 5^{th} day of treatment the mean parasitaemia was reduced by 76 and 60% respectively and Koch's blue bodies in lymph node smears were reduced by 50 and 50% respectively. The temperatures fell earlier in these 2 groups. Group (i) animals showed little improvement.

Anantwar *et al.* (1986) treated 5 ketotic cross-bred cows affected with theileriosis with oxytetracycline at 10-15 mg/kg i/v plus chloroquine at 2 mg/kg i/m and the treatment was found to be very effective.

Mohapatra and Tripathy (1986) studied the therapeutic efficacy of oxytetracycline hydrochloride in natural bovine theileriosis in India. The affected cows were treated with oxytetracycline at 15 or 20 mg/kg body weight daily for 3 days. At both doses, oxytetracycline reduced temperature to normal within 3 days of start of treatment. On day 3, erythrocytes were free of piroplasm in 80% of cases, and the remaining 20% were found free when examined on day 7. One i.m. injection of

diminazine did not improve treatment results. Schizonts were not detected in lymph node smears taken 72 hr after initiation of treatment.

Abdel Rahman *et al.* (1987) treated 3 splenectomized experimentally *T. annulata* infected calves with a single injection of imidocarb and oxytetracycline (15mg/kg) daily for 5 days and noticed reduction in parasitemia to 2-6 per cent and the body temperature and haematological values returned to normal 45 days after treatment.

El-Magd *et al.* (1987) observed that oxytetracycline was completely effective against *T. annulata* schizonts when given intravenously to naturally infected cattle @ 50 ml. daily for 3 days or 30 ml. daily for 5 days.

Mallick *et al.* (1987) infected 10 cross-bred male calves with *T. annulata* and treated them with oxytetracycline @ 20 mg/kg. simultaneously. They found that 8 of the 10 calves survived.

Bagherwal (1989) employed oxytetracycline (Telon LA) as a chemotherapeutic agent against bovine tropical theileriosis in 16 crosbred cattle. Of these, all the 14 clinical cases treated with oxytetracycline @ 20mg/kg. with 2-3 intramuscular injections 48 hours apart, were cured, while 2 cross-breds treated at 5-10 mg/kg succumbed to infection.

Nayak and Dey (1991) successfully treated acute clinical theileriosis in a pure-bred Jersey cow in Orissa by a

combination of oxytetracycline, Berenil (diminazine), single blood transfusion, haematinics and antipyretics.

Bandopadhyay *et al.* (1994) studied efficacy of some drugs against bovine theileriosis in field condition at Bethuadahari, Nadia, West Bengal. A total of 108 cattle with clinical theileriosis were treated using 6 different drug protocols. The drug combinations and their efficacies were as follows : metakalfin, oxytetracycline LA and sterodin (92%), oxytetracycline and levamisole (83%), oxytetracycline and sterodin (44%), oxytetracycline and berenil (33%), oxytetracycline (17%) and oxytetracycline LA (25%). In animals treated with oxytetracycline alone or in combination with berenil there was an initial cure followed by a relapse after 15-30 days.

Patel *et al.* (2001) assessed the efficacy of artesunate in combination with oxytetracycline in order to evolve an alternative to standard chemotherapeutic agents against bovine tropical theileriosis. They observed that the efficacy of this combination was 66.67% and suggested that this combination can be used in the treatment of bovine tropical theileriosis.

Levamisole :

Kumar *et al.* (1988) treated five cows with *T. annulata* parasitemias between 10 and 20% intramuscularly with a single dose of levamisole at 3 mg/kg along with oxytetracycline at 5 mg/kg/day for 5 days. Supportive therapy of hematinics

was also given. The body temperature of the animals had declined by 2^{0}C by day one after levamisole treatment. Parasitemia started declining on the 3rd day after levamisole treatment, and was zero in 4 cows after 5 days. Milk production had returned to normal by the 10th day post-treatment, and the condition of the animals improved during treatment.

Miscellaneous drugs :

Uzakov *et al.* (1971) obtained best result in *T. annulata* infection with simultaneous administration of progonil hydrochloride intravenously at 5 mg/kg. subcutaneously.

Hedge *et al.* (1973) treated natural cases of bovine theileriosis with intramuscular injection of chloroquine phosphate at 20 ml/day (gradually reduced to 10 ml/day) and reported complete recovery.

Shomein and Obeid (1973) used quinuronium sulphate, quinine, combinations of quinuronium with oxytetracycline in experimental theileriosis and opined that none of the drugs were effective.

Anjaria *et al.* (1976) observed that intramuscular injection of chloroquine phosphate and quinine hydrochloride had curative effect in natural cases of theileriosis.

Rafail and Michael (1976) reported that single dose of imidocarb dipropionate at 2.4 mg/kg resulted in disappearance of *T. annulata* from the peripheral blood 10 days after treatment.

Evplov (1977) studied the therapy of theileriosis of the various treatments tried in experimental bovine theileriosis. The most effective were trypanflavin given in conjunction with tetran (oxytetracycline), vitamins and camphor oil, and chinocide (quinocide) given with Bigumal (proguanil hydrochloride), vitamins, Ftalazol (phthalyl sulphathiazole) and caffeine. ABP, a preparation which includes acrichin and Bigumal, each at 5 mg/kg. body weight, and plasmocide at 1 mg/kg, was 92 to 100% effective, in combination with vitamins and camphor oil, against natural theileriosis in the USSR but slightly toxic if used for more than 10 days. A change in the proportions of the ingredients (acrichin 5mg/kg, plasmocide 1mg/kg and Bigumal 10mg/kg) rendered ABP more effective so that an 8-day course was sufficient even in severe infections.

Laiblin *et al.* (1978) treated experimental *T. annulata* infected cases with penicillin and streptomycin combination along with liver protecting preparations but observed no curative effect.

Singh *et al.* (1980) studied the chemo-immunoprophylactic activity of Rolitetracycline in calves by inoculating simultaneously with GUTS containing *T. annulata* and 4 mg/kg. intramuscular Rolitetracycline following 3 days and reported that the animals withstood lethal challenge 45 days after the initial infection.

Chandel (1982) studied the therapeutic value of garlic extract against *Theileria annulata* infection. Six experimentally infected calves were each injected i.v. with 10 ml. garlic extract (20%) and 48h later with 10ml. garlic extract (100%). There were significant differences between the percentage parasitemia and temperature of the garlic-treated and control groups at 24, 48, 72 and 96 h after treatment. At 96 h post-treatment, the parasitemia was only 0.193% in treated calves and their temperature was normal. All 3 control calves died of infection. The treated calves were resistant to a second infestation with *Theileria* infected ticks.

Guler (1982) studied the effect of halofuginone treatment on *Theileria annulata* infection in cattle. When 75 cattle naturally infected with *T. annulata* were treated with two doses of halofuginone at 2 mg/kg. body weight 1-13 days after the first signs of fever, all recovered in 24-48 hrs. Another 15 naturally infected animals were treated 15-16 days after the first signs of fever; twelve recovered and three died.

Morgan and McHardy (1982) compared the efficacy of Welcome 993C and halofuginone in experimental cases of theileriosis. They observed that Welcome 993C compound cured all nine animals at a dose rate of 20 mg/kg. given intramuscularly and no major recrudescence of the infection occurred. Halofuginone at a dose rate of 1.2 mg/kg. given orally cured almost all cases of theileriosis but survivors developed moderate to severe resurgences of the infection.

Khanna *et al.* (1983) studied the chemotherapy of experimental *T. annulata* infection in bovine calves. Three groups (A, B and C) of 6 calves infected with *T. annulata* were treated intravenously with menoctone at 12.5 mg/kg. body weight in 4 divided doses on consecutive days when parasitaemia was >10%. Group B calves were also given oxytetracycline intramuscularly, single 20 mg/kg. dose. Group C calves were given rolitetracycline 4 mg/kg. intramuscularly and Avil 2 to 3 ml. intramuscularly for 4 days. All control, untreated calves died of severe theileriosis while 3, 4 and 5 calves in groups A, B and C respectively recovered. Animals in groups B and C had a shorter duration of fever and a quicker reduction in parasitemia compared with group A animals.

Mohanty *et al.* (1983) administered 10 cattle with *Theileria annulata* infection with an intravenous injection of 1.5g tetracycline [Achromycin] in 7.5 ml., once daily for 4-7 days, together with a single dose of diminazine on the first day. All responded well to treatment, with parasitemia falling to <15% on the 3rd day. Another 10 were treated with oxytetracycline plus diminazine, and 8 recovered, though the response was slower.

Gill *et al.* (1984) treated seven groups of calves with parvaquone (20 mg/kg intramuscularly) or halofuginone lactate (1.2mg/kg. orally) on the first, third or sixth day of significant pyrexia following artificial infection with the Hissar strain of *T. annulata.* Eight untreated control animals

developed severe theileriosis and five died. All animals treated with parvaquone or halofuginone lactate on the first or third day of fever underwent relatively mild theileriosis and all of them recovered. One of five animals treated with parvaquone and three of six treated with halofuginone on the sixth day of fever died of theileriosis.

Guralp (1985) studied the efficacy of napthaquinone against theileriosis and reported that parvaquone (Clexon) was effective against all stages of *T. annulata* infection whereas halofuginone was only effective against shizonts.

McHardy and Morgan (1985) used parvaquone in experimental *T. annulata* infection and found that better rate of recovery was observed when parvaquone was given @ 10 mg/kg. on 10^{th} day of infection in 2 doses repeated at 24 hr or 48 hr interval as compared to 20 mg/kg given as a single dose.

McHardy *et al.* (1985) treated a series of hydroxynaphthaquinone *in vitro* and observed that all compounds were more active against *T. parva* (Muguga strain) than against *T. annulata* (Ankara strain). They also reported that the most potent compound against both parasites was BW 720C (Buparvaquone). Buparvaquone cured all 13 cattle infected with *T. parva* and all 6 cases infected *with T. annulata* @ 2.5 mg/kg body weight when tested *in vivo.*

Musisi *et al.* (1985) treated 126 clinical cases of theileriosis with parvaquone and reported recovery of 115 cattle. These recovered animals did not develop clinical signs of

theileriosis during subsequent rainy season but they remained carrier up to 14 months post-infection.

Banerjee *et al.* (1986) studied the efficacy of halofuginone, diminazine plus oxytetracycline and diminazine alone in three groups of naturally *T. annulata* infected cattle and observed a success of 100%, 62.5% and 36.3% respectively. They concluded that halofuginone lactate was suitable for treating *T. annulata* infection in cattle.

Bansal and Sharma (1986) experimentally infected calves with *T. annulata* and observed that calves treated with single dose of parvaquone (20mg/kg) or long acting oxytetracycline (20mg/kg) underwent mild clinical reactions and recovered. They further observed that parvaquone (10mg/kg) given intramuscularly on the first and second days of fever protected 4 out of 5 calves.

Dhar *et al.* (1986) experimentally infected 20 cross-bred calves with *T. annulata* and divided them into 3 groups. One group received only buparvaquone, the second group received the drug with liver extract and B vitamins and the third group served as infected control. They noticed that buparvaquone along with supportive drugs gave very good results.

Morgan and McHardy (1986) observed that buparvaquone was much more effective against *T. parva* than parvaquone. They also cured all experimentally *T. annulata* and *T. parva* infected cattle with buparvaquone @ 2.5 mg/kg body weight intramuscularly.

Shastri and Deshpande (1986) tried parvaquone in seven *T. annulata* infected cross-bred calves in single intramuscular dose of 20 mg/kg and concluded that piroplasms were reduced 3 to 16 days after treatment though they persisted up to 2 per cent till 30 days after treatment in 6 out of 7 calves.

Abdel Rahman *et al.* (1987) treated two six-month old Friesian bulls with a single injection of imidocarb dipropionate (s/c, 2.4 mg/kg) and oxytetracycline (15mg/kg) daily for 5 days. Following treatment, parasitaemia fell to 2-6%, and haematology and body temperature returned to normal 45 days after treatment.

Can *et al.* (1987) studied treatment of theileriosis by administration of halofuginone and tranexamic acid. Of 60 cattle with clinical *T. annulata* infections, four controls were treated with halofuginone alone at 2 mg/kg orally over two days. The other 56 were treated with the same dosage of halofuginone, but with the antifibrinolytic agent tranexamic acid i.m. at 10mg/kg, followed four days later with diminazine i.m. at 3.5 mg/kg, then, 1-2 days after this, oxytetracycline i.m. at 10 mg/kg. The four controls died 7-8 days after treatment and had mucosal and conjunctival haemorrhages. Of the other 56, 54 recovered and only two died.

Dhar *et al.* (1987a) successfully treated 19 cross-bred cattle with clinical bovine theileriosis with a single intramuscular injection of buparvaquone (BW 720C) at 2.5mg/kg body weight. They observed that body temperaure

returned to normal in the majority of animals within 3 days after treatment and theilerial schizonts and piroplasms could not be detected in blood smears and lymph node biopsy smears 6-15 days after treatment.

Dhar *et al.* (1987b) studied the chemo-immunoprophylactic activity of buparvaquone in cross-bred calves by inoculating simultaneously with GUTS containing *T. annulata* and 2.5 mg/kg intramuscular buparvaquone and observed that animals remained clinically normal and withstood lethal challenge 30 days later.

Hang (1987) used primaquine, sulphamethoxypyrazine, Trimethoprim, Suramin and Quinuronium sulphate in various combinations in experimentally *T. annulata* infected calves and concluded that gametocytes were completely eliminated by treatment with primaquine.

Mehta *et al.* (1987) studied the efficacy of clexon (parvaquone) in 16 cross-bred cattle naturally infected with *Theileria annulata.* They administered clexon @ 10 mg/kg b.wt. i.m., with 2 doses at an interval of 48h. They observed that lymph node biopsy smears were negative on the fourth day, while blood smears showed no piroplasms between days 4 and 7 post-treatment.

Srivastava *et al.* (1987) investigated the chemotherapeutic use of two indigenous drugs in infection of *Theileria annulata* in cattle. Groups of 4 native cross-bred calves aged 1 to 2 months and experimentally infected with *T. annulata* were

treated with 10 ml. of a 1 % garlic extract solution i.v. on the day of infection (Group 1) or on day 7 pi (group 2). Groups 3 and 4 received similar regimens of 10 ml. of neem seed extract (oil) intramuscularly. In all 4 groups the treatment was repeated after 48h. Neither extract was effective. Groups 5 and 6 received i.m. injections of oxytetracycline at 15 mg/kg b.wt. on 5 consecutive days starting on day 0 and day 7 pi respectively. Oxytetracycline, when started on day 0 pi, suppressed schizogony; group 5 calves survived after mild or sub-clinical symptoms. Group 6 calves suffered clinical disease and 50% died.

Banerjee *et al.* (1988) treated 15 clinical cases of theileriosis with buparvaquone at 2.5mg/kg body weight. Out of 15 animals, 10 received single injection and 5 animals were given 2 injections 6 days apart. All the animals recovered.

Dhar *et al.* (1988) experimentally infected twenty 7-21 day old cross-bred calves with *T. annulata.* Six calves served as untreated controls and all of them died. The remaining 14 calves were equally divided into groups A and B and were treated intramuscularly with buparvaquone at 2.5 mg/kg. Every calf of group B also received haematinics daily for 12 days. In group A, five calves were cured and two of them died due to cerebral theileriosis, all the calves of group B were clinically cured. The initial declines of haemoglobin level and PCV were halted and preinfection values were soon restored.

Unsuren *et al.* (1988) evaluated the effectiveness of parvaquone in 13 dairy cattle naturally infected with *Theileria annulata* in Turkey. Two doses of parvaquone were injected into the neck intramuscularly at 10 mg/kg body weight at 48 h interval. They observed that most piroplasms became pyknotic within 5 days of the first injection and schizonts were extensively damaged following treatment. Of the 13 cattle treated, 2 died of tropical theileriosis 6 days after the first treatment. Six months after the cessation of treatment all surviving adults were in good condition and daily milk production had increased.

Shastri (1989) performed chemotherapeutic and chemoprophylactic trial of buparvaquone in field conditions and found 58.8 per cent efficacy in clinical cases. In another group, 10 young calves received buparvaquone as a preventive measure and showed 100 per cent protection against the disease.

Dhar *et al.* (1990) used buparvaquone against different stages of experimentally induced tropical bovine theileriosis and opined that this drug was found effective in treating all clinical stages at 2.5 mg/kg body weight i.m. as a single dose.

Sharma and Mishra (1990) investigated the efficacy of buparvaquone against the Izatnagar isolate of *Theileria annulata.* They suggested that at a dose rate of 2.5mg/kg b.wt. i.m., buparvaquone does not interfere with the development of protective immunity against *T. annulata.*

Hashemi (1991) evaluated parvaquone and buparvaquone to determine their chemotherapeutic efficacy in the treatment of theileriosis caused by *T. annulata* infection in cattle in Iran. The recovery rate of animals treated with parvaquone was found to be 60.7% while that with buparvaquone it was 88.7%. He concluded that buparvaquone at a dose of 2.5mg/kg had a satisfactory therapeutic index and was a more effective treatment of *T. annulata* infection than parvaquone.

Rana and Dhar (1993) experimentally infected 23 cross-bred calves with GUTS containing *T. annulata* and simultaneously treated them with buparvaquone @ 2.5 mg/kg. bwt. Later these calves were challenged with 50 *known T. annulata* infected ticks (about 750 infected acini) on day 1, 4, 7, 10, 13 and 16 respectively. All the immunized calves withstood the lethal challenge infection indicating that this method of immunization may be used successfully in endemic areas.

Singh *et al.* (1993a) conducted chemotherapeutic trials with four drugs in cross-bred calves experimentally infected with *Theileria annulata.* Treatment with long-acting oxytetracycline, at 20 mg/kg injected intramuscularly had no effect against severe *Theileria annulata* infection when administered either as a single injection on the day of infection or as three injections given on days 8, 10 and 12 after infection. Halofuginone lactate, given orally at 1.2 mg/kg, was effective but caused anorexia, diarrhoea and debility.

Parvaquone at 20 mg/kg intramuscularly given on day 11 after infection, had a marked suppressive effect, while buparvaquone was highly effective. A single treatment with buparvaquone, either at 5 mg/kg or 2.5 mg/kg intramuscularly, rapidly eliminated schizonts and piroplasms of *T. annulata.*

Singh *et al.* (1993b) suggested that the most economical way to control theileriosis in India would be to immunize cattle with sporozoite stabilate and simultaneous treatment with tetracycline, while reserving buparvaquone for clinical cases of theileriosis.

Patil *et al.* (1995) conducted a clinical trial to test Butalex (buparvaquone) in the treatment of *Theileria annulata* infection in 10 Holstein Friesian cows. Eight cows required a single injection of Butalex @ 1ml/20 kg. body weight (Buparvaquone 2.5 mg/kg) and 2 cows required 2 injections of the drug 4 days apart. The clinical symptoms in all the cows disappeared and they regained their milk yield within 10-15 days of treatment.

Ashok Kumar *et al.* (1998) investigated the chemotherapeutic efficacy of buparvaquone against various stages (Schizonts, piroplasms and parasites as a whole) of *Theileria annulata* infection in cattle and found the drug to be effective against all the three stages of the parasite.

Nirmal and Sangwan (1999) studied thiamine, riboflavin and ascorbic acid in relation to tropical theileriosis in cattle. They opined that it was likely that vitamin deficiency

contributed to the pathogenesis of theileriosis and therefore suggested that vitamin supplements might help in the treatment of the disease.

Dinesh *et al.* (2001) evaluated the potential of artemether, a neoteric antimalarial drug, in induced bovine tropical theileriosis in cross-bred calves. They divided 12 calves into two groups. Group A was treated with artemether i/m @ 1.6 mg/kg b.i.d on the first day followed by 1.6 mg/kg until day 4. Group B served as the control. From the results obtained, they concluded that artemether was effective in reversing the clinico-haemato-biochemical alterations in bovine tropical theileriosis.

****

CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

Site of present investigation :

The present study was conducted in Bihar Veterinary College Hospital, Patna, under Rajendra Agricultural University, Pusa, Samastipur (Bihar).

Clinical cases :

A total of 130 blood films from febrile cases of cattle showing persistent febrile reactions and with partial to complete loss of appetite were screened for the presence of *Theileria annulata* infection. Out of the positive cases confirmed on the basis of microscopical examination of the blood films and biopsy of the lymph node, 27 cases of theileriosis were taken up for detailed clinical, haematological and biochemical investigations. The samples were collected before treatment and examined in the Department of Veterinary Medicine, Bihar Veterinary College, Patna.

Healthy Control :

A group of nine healthy animals (Control group) of different age groups were selected for normal physiological observations like temperature, respiration rate and pulse rate, haemogram and biochemical parameters. These animals were kept separately. They were not allowed to come in contact with the infected animals. These animals were regularly examined for the presence of ticks or any other infections. They were further observed for other abnormal clinical manifestations.

Temperature, pulse and respiration rates were recorded daily. Blood samples were collected for haematological examination and serum was separated for biochemical analyses.

Examination of the blood film and lymph node biopsy :

Thin blood films were made, fixed in methyl alcohol for 2-3 minutes and stained with Giemsa's stain and examined under oil immersion lens for the presence of theilerial organisms.

Biopsy of the prescapular lymph node was done by injecting 1 ml. of sterile normal saline solution and aspirating the fluid with the help of 18 gauge sterile hypodermic needle fitted to a 2 ml. glass syringe. Smear was made on a clean glass slide, fixed with methanol for 3 minutes and then stained with Giemsa's stain for the detection of Koch's blue bodies.

Symptomatology :

All the symptoms including history were noted individually before taking up the cases for chemotherapeutic trials. Clinical manifestations such as body temperature, pulse rate, respiration rate, palpation of superficial lymph nodes, examination of visible mucosa and presence of ticks on the body of animals were recorded.

Haematological Examination :

For haematological examination, 5 ml. of blood was collected from the jugular vein in a clean empty glass vial containing 5 mg. EDTA (Disodium ethylene diamine tetra-acetic acid). All the haematological studies were carried out

within 4 hrs. of collection of blood samples as per the method described by Schalm *et al.* (1975).

Hemoglobin (Hb) concentration : The hemoglobin level was estimated by Sahli's hemoglobinometer.

Packed cell volume (PCV) : Packed cell volume was determined by using Wintrobe's haematocrit tubes. Approximately, 1 ml. of blood was taken in each tube which was centrifuged at 4000 rpm for 60 minutes, before taking the reading.

Total erythrocyte count (TEC) : It was done with the help of a haemocytometer. For erythrocyte count, Hayme's solution with following composition was used as diluent.

Hayme's solution :

Mercuric Chloride	: 0.5g
Sodium Chloride	: 1.0g
Sodium Sulfate	: 5.0g
Distilled water	: 200ml.

Blood samples were diluted 1 : 200 times with the diluents in RBC diluting pipette.

Erythrocyte Sedimentation Rate (ESR) : The blood was filled with a Pasteur pipette in the Wintrobe ESR haematocrit tube from bottom upward up to zero mark and then the tube was kept in a special ESR stand vertically and level of sedimentation was recorded after 1 hour. The average sedimentation rate per hour was calculated as per the method described by Schalm *et al.* (1975).

Total Leucocyte Count (TLC) :

Blood was taken up to 0.5 mark in WBC diluting pipette and was diluted with the WBC diluting fluid up to 11 mark taking care that no air bubble was included. The contents were mixed by rotating the pipette, the Neubauer's counting chamber was then charged with 1-2 drops of the mixed fluid. The white cells were counted in the four large corner squares of the chamber and the total number of leucocyte count per cubic mm. was calculated.

Differential Leucocyte Count (DLC) :

For DLC, a thin and uniform smear of blood was prepared on a clean grease-free slide and dried in the air. The smear was stained with Leishman's stain. The stained blood film was seen under low power objective of the microscope to see whether the film was homogeneously stained or not and then examined under oil immersion objective lens of microscope by placing a drop of cedar wood oil in well separated film. After that at least 100 leucocytes were counted and the percentage of different leucocytic cells was recorded (Schalm *et al.*, 1975).

Erythrocytic indices

a. Mean corpuscular volume (MCV)

b. Mean corpuscular hemoglobin (MCH)

c. Mean corpuscular hemoglobin concentration (MCHC)

The erythrocytic indices were calculated by the following formulae :

$$MCV(fl) = \frac{\text{PCV in per cent}}{\text{TEC in millions}} \times 10$$

$$MCH\ (pg) = \frac{\text{Hb in gm per cent}}{\text{TEC in millions}} \times 10$$

$$MCHC\ (g/dl) = \frac{\text{Hb in gm per cent}}{\text{PCV in per cent}} \times 100$$

Biochemical Analysis :

Ten ml. of blood was collected separately into another sterilized screw-capped tube and allowed to coagulate. These tubes were carried to the laboratory and serum samples were separated by centrifugation, drawn by pipette and transferred into sterilized screw-capped serum vials and kept in the refrigerator for further study.

Total serum protein (TSP) : It was determined by the method of Reinhold as described by Oser (1965).

Total serum bilirubin (TSB) : It was analyzed as per the method described by Wooton (1964).

Serum Iron (Fe) and Copper (Cu) : These were estimated using atomic absorption spectrophotometer.

Therapeutic trials :

27 cases suffering from tropical bovine theileriosis were undertaken for the study of therapeutic trials. They were divided into three groups for the following treatment regime.

Treatment Group 1(T_1) :

Berenil[1] + Intamycin LA[2] + Helmonil Inj.[3]

(Diminazine aceturate) (Oxytetracycline) (Levamisole)

Treatment Group 2 (T_2) : Berenil + Helmonil Inj.

Treatment Group 3 (T_3) : Intamycin LA + Helmonil Inj.

The dose rates and routes of administration employed for the above treatment regime was as follows :

Berenil @ 800 mg/100 kg. b.wt. i.m. (Single dose).

Intamycin LA @ 20 mg/kg b.wt. i.v. for 5 days at 72 hr interval.

Helmonil Inj. @ 3 mg/kg b.wt. subcutaneously (Single dose).

This schedule was followed to note the efficacy of the agents through clinical examination of cases.

In all the cases, supportive therapy was followed as per the haemogram and biochemical observations.

Statistical Analysis of Data :

Statistical analyses were done by 't' test and two way ANOVA (Analysis of Variance) as per the method described by Snedecor and Cochran (1967).

---

1. Berenil – Intervet (India) Ltd.
2. Intamycin LA – Intas Pharmaceuticals Ltd.
3. Helmonil Inj. – Alved Pharma & Foods Pvt. Ltd.

CHAPTER - IV

RESULTS

RESULTS

Symptomatology :

All the 9 healthy control animals were active with normal physiological functions. They had good appetite and their skin had normal lustre. The urine and faeces were normally excreted.

Of the 27 clinical cases suffering from theileriosis, most of them had rectal temperatures ranging from 105-106^{0}F. In almost all the cases, the prescapular and prefemoral lymph nodes were swollen and enlarged. All the affected animals were suffering from partial to complete loss of appetite. The animals preferred drinking water instead of taking feed. Three animals were observed to be icteretic with yellow to deep yellow conjunctiva. The other clinical findings observed in clinical cases were haemolytic anaemia, anorexia, weakness and decreased milk yield.

Clinical Parameters :

Body Temperature (^{0}F): Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of body temperature of different treatment groups have been given in Table-1 (Fig.-1).

The critical difference studies showed highly significant ($P<0.01$) difference between pre-and post-treatment values of all the three treatment groups. However, there was no significant difference in the pre-treatment and 3rd day post-

treatment value of temperature in animals of treatment group 3 and also the 15th day post-treatment value of T_3 differed significantly ($P<0.01$) with that of the 15th day post-treatment values of treatment groups 1 and 2 which differed non-significantly with that of the healthy controls. The mean value of body temperature of healthy controls differed non-significantly during the entire period of observation.

Best results of temperature decline and its return to normal values were seen to be present in treatment group 1 followed by treatment group 2 while the temperatures remained higher than normal in treatment group 3.

Analysis of variance (Table-3) showed highly significant ($P<0.01$) difference in body temperature both between different treatment groups and between periods.

Pulse Rate(per minute) : Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of pulse rate (per minute) of different treatment groups have been given in Table-2 (Fig.-2).

The mean values of pulse rate in cattle in different treatment groups viz. healthy control (0 day and 15th day), T_1-pre and post, T_2-pre and post and T_3-pre and post were recorded to be 66.22 ± 0.36, 66.00 ± 0.37, 87.78 ± 0.49, 66.00 ± 0.62, 88.00 ± 0.60, 69.56 ± 0.65, 88.11 ± 0.56 and 79.56 ± 0.78 per minute respectively. The critical difference studies showed highly significant difference between pre and post-treatment values in all the three treatment groups. The pre-

treatment mean values differed significantly (P<0.01) with that of the healthy control while the post-treatment value of only the first treatment group (T_1) differed non-significantly with that of the healthy control. There was also no significant difference in the mean value of healthy controls between 0 day and 15th day.

Analysis of variance (Table-3) showed highly significant (P<0.01) difference between different treatment groups under investigation.

Respiration rate (per minute) : Mean along with S.E. and C.V.% of respiration rate (per minute) of clinical cases under different treatment groups have been given in Table-2 (Fig.-2).

The mean value of respiration rate in cattle in different treatment groups viz. healthy control-0 day and 15th day, treatment group T_1-pre and post, treatment group T_2-pre and post and treatment group T_3-pre and post were observed to be 22.56 ± 0.50, 22.44 ± 0.53, 33.67 ± 0.47, 22.67 ± 0.44, 33.89 ± 0.70, 27.11 ± 0.48, 33.78 ± 0.36 and 31.11 ± 0.92 per minute respectively. The pre-treatment values in all the three treatment groups under study differed highly significantly (P<0.01) with that of the healthy control although the pre-treatment values in each of the three treatment groups did not show any significant difference between themselves. The post-treatment mean value of treatment group T_1 differed non-significantly with the 15th day mean value of healthy control. The post-treatment mean value of the other two treatment

groups (T_2 and T_3) differed significantly with that of the healthy control but tended to decline gradually towards normal.

Analysis of variance (Table-3) showed highly significant ($P<0.01$) difference between different treatment groups under investigation.

HAEMATOLOGICAL CHANGES :

Haemoglobin (g%): Mean along with S.E. and C.V.% of haemoglobin of different treatment groups of animals have been given in Table-4 (Fig. – 3).

The mean haemoglobin values in cattle were found to be 10.94 ± 0.55, 11.00 ± 0.37, 6.06 ± 0.15, 10.83 ± 0.14, 0.33 ± 0.17, 9.89 ± 0.14, 6.06 ± 0.18 and 8.89 ± 0.16 g% in different treatment groups viz. healthy control-0 day and 15th day, treatment group 1 (T_1)-pre and post, treatment group 2 (T_2)-pre and post and treatment group 3 (T_3)-pre and post respectively. The critical difference studies showed highly significant ($P<0.01$) difference between pre and post-treatment values of all the three treatment groups. The pre-treatment values of all the three treatment groups differed significantly with that of the healthy control. Only the post-treatment mean value of treatment group T_1 differed non-significantly with its corresponding value of healthy control showing that the Hb values returned to normal while the post-treatment mean values of T_2 and T_3 differed significantly ($P<0.01$) with that of the control. However, the post-treatment values of T_2 and T_3 showed gradual rise in their Hb levels with the treatment

group T_2 showing better improvement as compared to the treatment group T_3.

Analysis of variance (Table-5) showed highly significant ($P<0.01$) difference between the various treatment groups under investigation.

Packed Cell Volume (%): Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of packed cell volume (PCV) of different treatment groups have been depicted in Table-4 (Fig.-3).

The mean values of PCV in infected animals under-different treatment groups viz. healthy control-0 day and 15th day, Berenil along with Intamycin LA and Helmonil Inj. treated group (T_1)-pre and post, Berenil plus Helmonil Inj. treated group (T_2)-pre and post and Intamycin LA plus Helmonil Inj. treated group (T_3)-pre and post were recorded to be 33.89 ± 0.45, 33.67 ± 0.69, 18.72 ± 0.12, 33.78 ± 0.28, 18.83 ± 0.08, 31.33 ± 0.67, 18.94 ± 0.13 and 25.89 ± 0.54 % respectively. The mean values of PCV% were found to differ non-significantly between control on 0 day and 15th day while the pre-treatment and post-treatment values of all the three treatment groups were found to differ significantly ($P<0.01$). Also, the pre-treatment values of all the three drug treated groups differed highly significantly from that of the healthy control. The post-treatment values of only the treatment group T_1 were found to be non-significant with respect to the healthy control values. Though there was a gradual increase in the

post-treatment PCV% values of the other two treatment groups (T_2 and T_3), studies on critical difference showed them to differ significantly ($P<0.01$) with that of the healthy control values recorded on the same day of treatment.

Highly significant ($P<0.01$) difference in packed cell volume per cent values between different treatment groups was revealed in analysis of variance (Table-5).

Total erythrocyte count (10^6/mm^3): Mean ± S.E. along with their coefficient of variation of total erythrocyte count observed in animals under different treatment groups have been shown in Table-4 (Fig.-3).

The mean values of total erythrocyte count (TEC) in animals under various treatment groups viz. healthy control-0 day and 15th day, treatment group T_1-pre and post, treatment group T_2-pre and post and treatment group T_3-pre and post were determined to be 7.33 ± 0.44, 7.11 ± 0.39, 4.11 ± 0.25, 7.11 ± 0.26, 4.17 ± 0.17, 6.81 ± 0.22, 4.11 ± 0.16, 5.39 ± 0.22 million/mm^3 respectively. The critical difference studies showed non-significant difference in values of healthy control between 0 day and 15th day while the pre and post-treatment values of all the three treatment groups differed highly significantly ($P<0.01$). There was also significant difference ($P<0.01$) between the pre-treatment values of all the three treatment groups and that of the healthy control animals. The post-treatment values of treatment groups T_1 and T_2 showed non-significant difference with that of control while there was

post-treatment PCV% values of the other two treatment groups (T_2 and T_3), studies on critical difference showed them to differ significantly ($P<0.01$) with that of the healthy control values recorded on the same day of treatment.

Highly significant ($P<0.01$) difference in packed cell volume per cent values between different treatment groups was revealed in analysis of variance (Table-5).

Total erythrocyte count (10^6/mm^3): Mean ± S.E. along with their coefficient of variation of total erythrocyte count observed in animals under different treatment groups have been shown in Table-4 (Fig.-3).

The mean values of total erythrocyte count (TEC) in animals under various treatment groups viz. healthy control-0 day and 15th day, treatment group T_1-pre and post, treatment group T_2-pre and post and treatment group T_3-pre and post were determined to be 7.33 ± 0.44, 7.11 ± 0.39, 4.11 ± 0.25, 7.11 ± 0.26, 4.17 ± 0.17, 6.81 ± 0.22, 4.11 ± 0.16, 5.39 ± 0.22 million/mm^3 respectively. The critical difference studies showed non-significant difference in values of healthy control between 0 day and 15th day while the pre and post-treatment values of all the three treatment groups differed highly significantly ($P<0.01$). There was also significant difference ($P<0.01$) between the pre-treatment values of all the three treatment groups and that of the healthy control animals. The post-treatment values of treatment groups T_1 and T_2 showed non-significant difference with that of control while there was

only a little increase in the post-treatment value of the last treatment group (T_3) from its pre-treatment value and therefore showed significant difference ($P<0.01$) with that of the healthy control mean value of TEC.

Analysis of variance showed highly significant ($P<0.01$) difference between different treatment groups under study (Table-5).

Erythrocyte sedimentation rate (per hour) : Mean along with S.E. and C.V.% of ESR of different treatment groups of cattle have been given in Table-6.

The mean erythrocyte sedimentation rate values in cattle were found to be 0.77 ± 0.04, 0.78 ± 0.03, 0.86 ± 0.01, 0.78 ± 0.01, 0.86 ± 0.01, 0.80 ± 0.01, 0.86 ± 0.01 and 0.75 ± 0.01 per hour in various treatment groups viz. healthy control-0 day and 15th day, T_1 – pre and post, T_2 – pre and post and T_3 – pre and post respectively. The mean values between different treatment groups and healthy control differed non-significantly. Also, there was no significant difference between the pre and post-treatment values under various treatment groups. However the pre-treatment mean values of all the three treatment groups were observed to be higher as compared to that of the animals of the healthy control group but the post-treatment values of treatment group 1 tended to be closest to the normal values followed by treatment group T_2 and then treatment group T_3.

Analysis of variance (Table-7) showed non-significant difference between different treatment groups under investigation.

Total leukocyte count ($10^3/mm^3$): Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of total leukocyte count (TLC) of different treatment groups have been given in Table-6 (Fig.-3). The mean values of TLC in infected animals under different treatment groups viz. healthy control-0 day and 15th day, treatment group T_1-pre and post, treatment group T_2-pre and post and treatment group T_3-pre and post were recorded to be 9.11 ± 0.79, 9.11 ± 0.63, 7.11 ± 0.29, 9.00 ± 0.31, 7.17 ± 0.29, 8.89 ± 0.26, 7.00 ± 0.31 and 7.50 ± 0.31 thousand/mm^3 respectively. The 0 day and 15th day healthy control values and the pre and post-treatment values of T_3 showed no significant difference while the pre and post-treatment values differed significantly ($P<0.01$) in the first two treatment groups T_1 and T_2. The pre-treatment values of all the three drug-treated groups varied significantly with that of the healthy control whereas the post-treatment values of the treatment groups T_1 and T_2 were close to normal healthy control values thereby showing no significant difference with that of the healthy control. However, the post-treatment value of treatment group T_3 differed non-significantly with its corresponding pre-treatment value thereby indicating little improvement in the mean value of treatment group T_3 after treatment with Intamycin LA and Helmonil Inj..

Analysis of variance showed highly significant (P<0.01) difference between different treatment groups under investigation (Table-7).

Differential leukocyte count: Because the basophil count in cattle mostly was determined to be 0 per cent in most of the counts, only the neutrophil, lymphocyte, monocyte and eosinophil counts were considered for analysis considering basophil count to be zero. Also the differential leukocyte count (DLC) values determined being in percentage were converted to their arcsin values for analysis of variance and critical difference studies.

Neutrophil count: The mean along with the S.E. and CV% values of neutrophil count recorded in different treatment groups have been shown in Table-8 (Fig.-4).

The mean values of neutrophil count in theileriosis affected animals under different treatment groups viz. healthy control-0 day and 15th day, Berenil along with Intamycin LA plus Helmonil Inj. treated group T_1-pre and post, Berenil plus Helmonil Inj. treated group T_2-pre and post, Intamycin LA plus Helmonil Inj. treated group T_3-pre and post were recorded to be 39.23 ± 0.36, 39.23 ± 0.36, 26.86 ± 0.38, 39.30 ± 0.33, 27.03 ± 0.36, 36.33 ± 0.31, 29.10 ± 0.34 and 32.29 ± 0.28 respectively. The critical difference studies showed non-significant difference between 0 day and 15th day values of healthy control whereas the pre and post-treatment values in all the three treatment groups revealed highly significant

difference (P<0.01) between them. The post-treatment mean value of neutrophil count in treatment group T_1 was found to differ significantly with that of the healthy control group showing significant improvement with the treatment adopted. However, though the post-treatment values in treatment groups T_2 and T_3 showed an increase with respect to their mean pre-treatment values, they failed to attain resemblance to the normal healthy control values and therefore were found to differ significantly with that of the healthy control values.

The analysis of variance (Table-9) showed highly significant (P<0.01) difference both between treatment and between period.

Lymphocyte Count: The mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of lymphocyte count of different treatment groups have been shown in Table-8 (Fig.-4).

The mean values of lymphocyte count in theileriosis affected animals of different treatment groups viz. healthy control-0 day and 15th day, T_1-pre and post, T_2-pre and post and T_3-pre and post as determined were 45.00 ± 0.36, 45.00 ± 0.36, 54.47 ± 0.32, 45.26 ± 0.25, 54.07 ± 0.27, 45.76 ± 0.25, 54.47 ± 0.32 and 51.09 ± 0.29 respectively. Studies on critical difference revealed significant difference between healthy control (0 day) value and the pre-treatment mean values of all the three treatment groups. However, the post-treatment mean values of T_1 and T_2 were both close to normal and differed non-

significantly with that of the healthy control. There was only a slight improvement in the post-treatment values of treatment group T_3.

The analysis of variance (Table-9) showed highly significant ($P<0.01$) difference both between treatment and between period.

Monocyte count : The mean values of monocyte count along with the standard error (S.E.) and coefficient of variation (C.V.%) observed in different treatment groups have been shown in Table-8 (Fig.-4).

The mean values of monocyte count in animals under various treatment groups viz. healthy control-0 day and 15th day, T_1-pre and post-treatment, T_2-pre and post-treatment and T_3-pre and post-treatment were recorded to be 12.15 ± 0.24, 12.31 ± 0.24, 8.93 ± 1.86, 10.69 ± 2.08, 11.50 ± 2.02, 13.14 ± 2.04, 10.54 ± 2.19 and 12.88 ± 1.90 respectively. The pre and post-treatment values in all the treatment groups were found to differ non-significantly. However, a slight increase was observed in the post-treatment values of all the treatment groups under study from their corresponding mean pre-treatment values.

The analysis of variance (Table-9) showed no significant difference between different treatment groups under study.

Eosinophil Count: The mean values of eosinophil count along with the standard error (SE) and coefficient of variation (CV%)

observed in different treatment groups have been shown in Table-8 (Fig.-4).

The mean value of eosinophil count in animals under various treatment groups viz. healthy control-0day and 15th day, T_1-pre and post, T_2-pre and post and T_3-pre and post-treatment were recorded to be 13.62 ± 0.22, 13.48 ± 0.22, 18.49 ± 0.53, 12.37 ± 0.60, 17.28 ± 0.58, 15.66 ± 0.47, 14.89 ± 0.65 and 14.75 ± 0.53 respectively. The mean pre-treatment values of the three treatment groups were found to differ significantly ($P<0.01$) with that of the corresponding healthy control values. The mean post-treatment value of only the first treatment group (T_1) differed non-significantly whereas that of the other two treatment groups (T_2 and T_3) differed significantly with the healthy control group. The post-treatment eosinophil count in treatment group T_1 decreased considerably and was close to normal. Although the post-treatment values of the other two treatment groups (T_2 and T_3) differed significantly with that of the normal, there was a slow but gradual decrease in their eosinophil counts too.

The analysis of variance (Table-9) showed significant difference ($P<0.01$) between the different treatment groups under investigation.

Mean corpuscular volume (fl) : Mean along with standard error (S.E.) and coefficient of variation (CV%) of mean corpuscular volume (MCV) of different treatment groups have been given in Table-10 (Fig.-5).

The mean values of MCV in animals under different eatment groups viz. healthy control-0 day and 15th day, erenil plus Intamycin LA and Helmonil Inj. treated group (T_1) pre and post, Berenil plus Helmonil Inj. treated group (T_2)-re and post and Intamycin LA plus Helmonil Inj. treated roup (T3)-pre and post were recorded to be 47.42 ± 2.58, 8.32 ± 2.33, 46.63 ± 2.29, 48.01 ± 1.75, 45.77 ± 1.81, 46.15 ± .69, 46.63 ± 1.79 and 48.36 ± 1.04 fl respectively. The mean re and post-treatment values of all the treatment groups howed no significant difference. However, the post-treatment alues of all the three treatment groups showed slight ncreases from their mean pre-treatment values.

The analysis of variance showed no significant difference etween the different treatment groups under study (Table-11).

Mean corpuscular haemoglobin (pg): Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of nean corpuscular haemoglobin (MCH) of different treatment groups have been given in Table-10 (Fig.-5).

The mean value of MCH in theileriosis affected animals nder different treatment groups viz. healthy control-0 day nd 15th day, treatment group T_1-pre and post, treatment roup T_2-pre and post and treatment group T_3-pre and post ere recorded to be 15.01 ± 0.36, 15.88 ± 1.09, 14.98 ± 0.55, 5.43 ± 0.69, 15.37 ± 0.64, 15.59 ± 0.32, 14.84 ± 0.51 and 6.62 ± 0.40 pg respectively. The mean pre-treatment and ost-treatment values of MCV showed no significant difference

veen any of the treatment groups. However, there was ht increase in the mean post-treatment values as compared he mean pre-treatment values in all the three treatment ups showing slow but gradual improvement.

The analysis of variance (Table-11) showed no significant erence between any of the treatment groups under study.

in corpuscular haemoglobin concentration (g/dl) : The in values of mean corpuscular haemoglobin concentration HC) along with the standard error (S.E.) and their ficient of variation (C.V.%) of different treatment groups e been given in Table-10 (Fig.-5). The mean values of HC of animals under different treatment groups viz. healthy trol-0 day and 15th day, treatment group T_1-pre and post, tment group T_2-pre and post and treatment group T_3-pre post were observed to be 32.40 ± 1.83, 32.91 ± 1.60, 32.33 71, 33.39 ± 0.53, 33.62 ± 0.82, 34.62 ± 0.43, 31.95 ± 0.85 34.36 ± 0.25 g/dl respectively. The mean pre and post-tment values of MCHC differed non-significantly in veen different treatment groups and also within individual tment groups. However, the post-treatment values showed it and gradual increase from their pre-treatment levels.

The analysis of variance (Table-11) showed no significant rence between treatments and between periods.

BIOCHEMICAL CHANGES :

Total serum protein (g/dl) : Means with S.E. and C.V.% of total serum protein (TSP) of various treatment groups have been given in Table-12 (Fig.-6).

The mean value of total serum protein in infected cattle under different treatment groups viz. healthy control – 0 day and 15th day, T_1-pre and post, T_2-pre and post and T_3-pre and post were observed to be 6.63 ± 0.06, 6.62 ± 0.05, 5.23 ± 0.01, 6.62 ± 0.00, 5.23 ± 0.01, 6.28 ± 0.01, 5.25 ± 0.01 and 5.97 ± 0.01 g/dl respectively. Studies on critical difference revealed significant difference between pre-treatment level of TSP in the three treatment groups and that of the healthy control. The post-treatment mean of both T_1 and T_2 differed non-significantly with that of the control. However, significant difference was observed between the post-treatment levels of T_1 and T_2 revealing better improvement in post-treatment mean value of T_1 as compared to that of the Berenil plus Helmonil Inj. treated group (T_2). There was very little increase in the post-treatment mean level of TSP in T_3 from its mean pre-treatment level and therefore differed significantly from the normal healthy control values.

The analysis of variance (Tabel-13) showed significant difference both between treatment and between period.

Total serum bilirubin (mg/dl): Mean along with the S.E. and C.V.% of total serum bilirubin (TSB) recorded in different treatment groups have been shown in Table-12 (Fig.-6).

The mean values of TSB in different treatment groups ler study viz. healthy control-0day and 15th day, T_1-pre and t, T_2-pre and post and T_3-pre and post as determined were 4 ± 0.01, 0.14 ± 0.01, 0.69 ± 0.01, 0.15 ± 0.01, 0.69 ± 0.01, 3 ± 0.01, 0.69 ± 0.00 and 0.49 ± 0.01 mg/dl respectively.

While the pre-treatment levels of the three treatment ups were found to be non-significant with each other, the t-treatment mean levels of TSB were found to differ nificantly ($P<0.01$) amongst themselves. The post-treatment an of only the treatment group T_1 was observed to be non-nificant with that of the healthy control. However, gradual reases in TSB levels were also recorded in T_2 and T_3 with former recording better improvement as compared to its -treatment mean TSB level.

The analysis of variance (Table-13) showed highly nificant ($P<0.01$) difference between treatment and between iod.

um Iron (µg/ml): Mean along with the S.E. and C.V.% of um iron (Fe) of different treatment groups have been icted in Table-12 (Fig.-6).

The mean values of serum iron in animals under various tment groups viz. healthy control-0 day and 15th day, T_1- and post, T_2-pre and post and T_3-pre and post were rded to be 3.80 ± 0.03, 3.80 ± 0.02, 3.52 ± 0.04, 3.80 ± , 3.43 ± 0.01, 3.76 ± 0.01, 3.48 ± 0.01 and 3.54 ± 0.02 nl. respectively. Studies on critical difference showed

highly significant difference between the pre-treatment mean of healthy control and that of the three treatment groups (T_1, T_2 and T_3). Whereas the mean pre and post-treatment values of healthy control showed non-significant difference, significant difference was recorded between the pre and post-treatment levels of the three treatment groups under trial. The post-treatment levels of treatment groups T_1 and T_2 differed non-significantly with that of the healthy control group. Though there was a slight increase in the post-treatment level of serum iron of treatment group T_3 from its mean pre-treatment level, it differed significantly with that of the healthy control group.

Analysis of variance (Table-13) showed highly significant difference ($P<0.01$) between different treatment groups and between periods.

Serum Copper (µg/ml): Mean along with the standard error (S.E.) and coefficient of variation (C.V.%) of serum copper of different treatment groups have been given in Table-12 (Fig.-6).

The mean value of serum copper in animals under different treatment groups viz. healthy control-0 day and 15th day, T_1-pre and post, T_2-pre and post and T_3-pre and post were recorded to be 0.86 ± 0.01, 0.86 ± 0.01, 0.79 ± 0.01, 0.86 ± 0.01, 0.78 ± 0.01, 0.83 ± 0.01, 0.78 ± 0.01 and 0.81 ± 0.01 µg/ml. respectively. Studies on critical difference did not show any significant difference between any of the treatment groups under study. However, the mean post-treatment value of all the three treatment groups improved with T_1 showing the best

improvement followed by T_2 and only a slight increase in the T_3 post-treatment level of serum copper.

The analysis of variance (Table–13) showed no significant difference between any of the treatment groups.

Therapeutic Trials in Clinical cases :

Treatment Group 1 (Berenil plus Intamycin LA plus Helmonil Inj.) : Animals of this group were treated with Berenil along with Intamycin LA plus Helmonil Inj. While Berenil and Helmonil Inj. were administered as a single dose @ 5ml./100kg. body weight intramuscularly and @ 3 mg/kg. body weight subcutaneously respectively, Intamycin LA was administered @ 20 mg/kg. body weight intravenously for 5 days at 72 hr. intervals. Out of the nine animals treated with this combination therapy, eight animals recovered from the disease while one animal reported death on the 20th day. Thus the efficacy of the treatment was found to be about 88.89% (Table-14 & Fig. 7).

Treatment Group 2 (Berenil plus Helmonil Inj.) : Animals of this group were treated with Berenil @ 5 ml/100kg. body weight intramuscularly and Helmonil Inj. @ 3 mg/kg body weight subcutaneously both given as a single dose. Out of the nine animals treated in this group, three animals reported death on 16th, 19th and 23rd day. The efficacy of this combination therapy turned out to be about 66.67% (Table-14 & Fig.-7).

improvement followed by T_2 and only a slight increase in the T_3 post-treatment level of serum copper.

The analysis of variance (Table–13) showed no significant difference between any of the treatment groups.

Therapeutic Trials in Clinical cases :

Treatment Group 1 (Berenil plus Intamycin LA plus Helmonil Inj.) : Animals of this group were treated with Berenil along with Intamycin LA plus Helmonil Inj. While Berenil and Helmonil Inj. were administered as a single dose @ 5ml./100kg. body weight intramuscularly and @ 3 mg/kg. body weight subcutaneously respectively, Intamycin LA was administered @ 20 mg/kg. body weight intravenously for 5 days at 72 hr. intervals. Out of the nine animals treated with this combination therapy, eight animals recovered from the disease while one animal reported death on the 20th day. Thus the efficacy of the treatment was found to be about 88.89% (Table-14 & Fig. 7).

Treatment Group 2 (Berenil plus Helmonil Inj.) : Animals of this group were treated with Berenil @ 5 ml/100kg. body weight intramuscularly and Helmonil Inj. @ 3 mg/kg body weight subcutaneously both given as a single dose. Out of the nine animals treated in this group, three animals reported death on 16th, 19th and 23rd day. The efficacy of this combination therapy turned out to be about 66.67% (Table-14 & Fig.-7).

Treatment group 3 (Intamycin LA plus Helmonil Inj.) : Animals under this group were treated with Helmonil Inj. given as a single dose @ 3 mg/kg body weight subcutaneously and Intamycin LA @ 20 mg/kg. body weight intravenously for five days at 72 hr interval. Out of the nine animals treated with this combination therapy, recovery was initially noted in four animals but in one animal relapse occurred and it later succumbed to infection. Only three animals survived while deaths were reported on 16th, 18th, 20th, 21st, 24th and 35th day. The overall efficacy of this combination therapy was recorded to be only 33.33% (Table-14 and Fig.-7).

Supportive Therapy : In cases where anaemia was of moderate to severe degree with icteric mucosa, treatment with iron dextran, liver extract and Vit. B complex was administered parenterally. The treatment was continued till the recovery of the animal in all cases.

****

Table – 1 : Mean ± S.E. along with the CV% of temperature (^{0}F) in the three treatment groups of cattle suffering from tropical theileriosis, including healthy control.

Treatment Groups	0 day/Pre-treatment		3rd day/Post-treatment		7th day/Post-treatment		11th day/Post-treatment		15th day/Post-treatment	
	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
Healthy Control	101.50^{aA} ± 0.11	0.32	101.39^{aA} ± 0.11	0.31	101.33^{aA} ± 0.17	0.46	101.67^{aA} ± 0.17	0.46	101.61^{aA} ± 0.20	0.56
T_1	105.89^{bA} ± 0.14	0.37	104.22^{bB} ± 0.15	0.40	102.94^{bC} ± 0.13	0.36	101.94^{abD} ± 0.13	0.36	101.56^{aD} ± 0.10	0.28
T_2	106.00^{bA} ± 0.14	0.39	104.61^{cB} ± 0.14	0.37	103.06^{bC} ± 0.13	0.36	102.06^{bD} ± 0.13	0.36	101.94^{aD} ± 0.13	0.36
T_3	105.50^{cA} ± 0.14	0.39	105.11^{dA} ± 0.14	0.37	105.00^{cB} ± 0.14	0.39	103.11^{cB} ± 0.14	0.38	102.06^{bB} ± 0.15	0.36

NB : Means with different superscripts differ significantly (P<0.01).
[Column-wise (small letter)], [Row-wise (capital letter)]

Fig. 1 : Line diagram showing the trend of febrile state in different treatment groups of cattle suffering from tropical theilerosis, including healthy control.

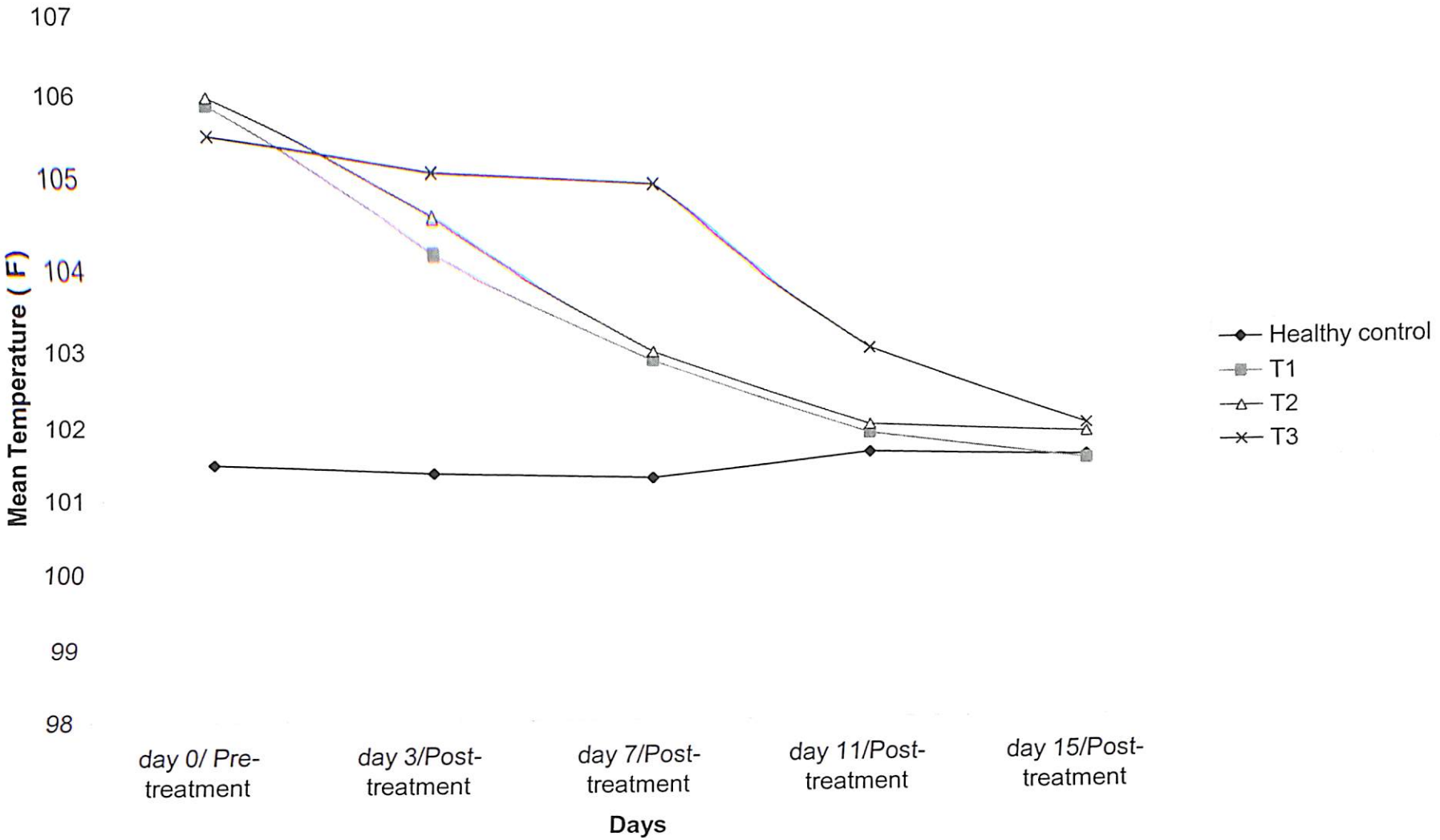


Table – 2 : Mean ± S.E. along with the ... treatment groups of cattle suffering from tropical theileriosis, including healthy ...

Treatment Groups	Pulse Rate (per minute)				Respiration Rate (per minute)			
	0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/post-treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %
Healthy Control	66.22^{aA} ± 0.36	1.56	66.00^{aA} ± 0.37	1.59	22.56^{aA} ± 0.50	6.29	22.44^{aA} ± 0.53	6.68
T_1	87.78^{bA} ± 0.49	1.59	66.00^{aB} ± 0.62	2.67	33.67^{bA} ± 0.47	3.95	22.67^{aB} ± 0.44	5.51
T_2	88.00^{bA} ± 0.60	1.93	69.56^{bB} ± 0.65	2.63	33.89^{bA} ± 0.70	5.81	27.11^{bB} ± 0.48	5.05
T_3	88.11^{bA} ± 0.56	1.80	79.56^{cB} ± 0.78	2.79	33.78^{bA} ± 0.36	3.05	31.11^{cB} ± 0.92	8.36

NB : Means with different superscripts differ significantly (P<0.01).

[Column-wise (small letter)], [Row-wise (capital letter)]

Table – 2 : Mean ± S.E. along with the [illegible] treatment groups of cattle suffering from tropical theileriosis, including healthy [illegible]

Treatment Groups	Pulse Rate (per minute)				Respiration Rate (per minute)			
	0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/post-treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %
Healthy Control	66.22^{aA} ± 0.36	1.56	66.00^{aA} ± 0.37	1.59	22.56^{aA} ± 0.50	6.29	22.44^{aA} ± 0.53	6.68
T_1	87.78^{bA} ± 0.49	1.59	66.00^{aB} ± 0.62	2.67	33.67^{bA} ± 0.47	3.95	22.67^{aB} ± 0.44	5.51
T_2	88.00^{bA} ± 0.60	1.93	69.56^{bB} ± 0.65	2.63	33.89^{bA} ± 0.70	5.81	27.11^{bB} ± 0.48	5.05
T_3	88.11^{bA} ± 0.56	1.80	79.56^{cB} ± 0.78	2.79	33.78^{bA} ± 0.36	3.05	31.11^{cB} ± 0.92	8.36

NB : Means with different superscripts differ significantly (P<0.01).

[Column-wise (small letter)], [Row-wise (capital letter)]

Table – 3 : Analysis of variance showing the effect of different treatments on different clinical parameters in cattle suffering from tropical theileriosis.

Source of variation	Temperature (°F)			Pulse Rate (per minute)			Respiration Rate (per minute)		
	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	58.56	79.14**	3	1002.05	45.30**	3	333.79	44.86**
Between period	3	51.29	69.31**	1	2701.13	122.11**	1	475.35	63.89**
Error	172	0.74		67	22.12		67	7.44	

NB : ** = Significant at P<0.01.

Fig. 2 : Histogram showing changes in pulse rate (per minute) and respiration rate (per minute) in healthy control and theileriosis infected cattle.

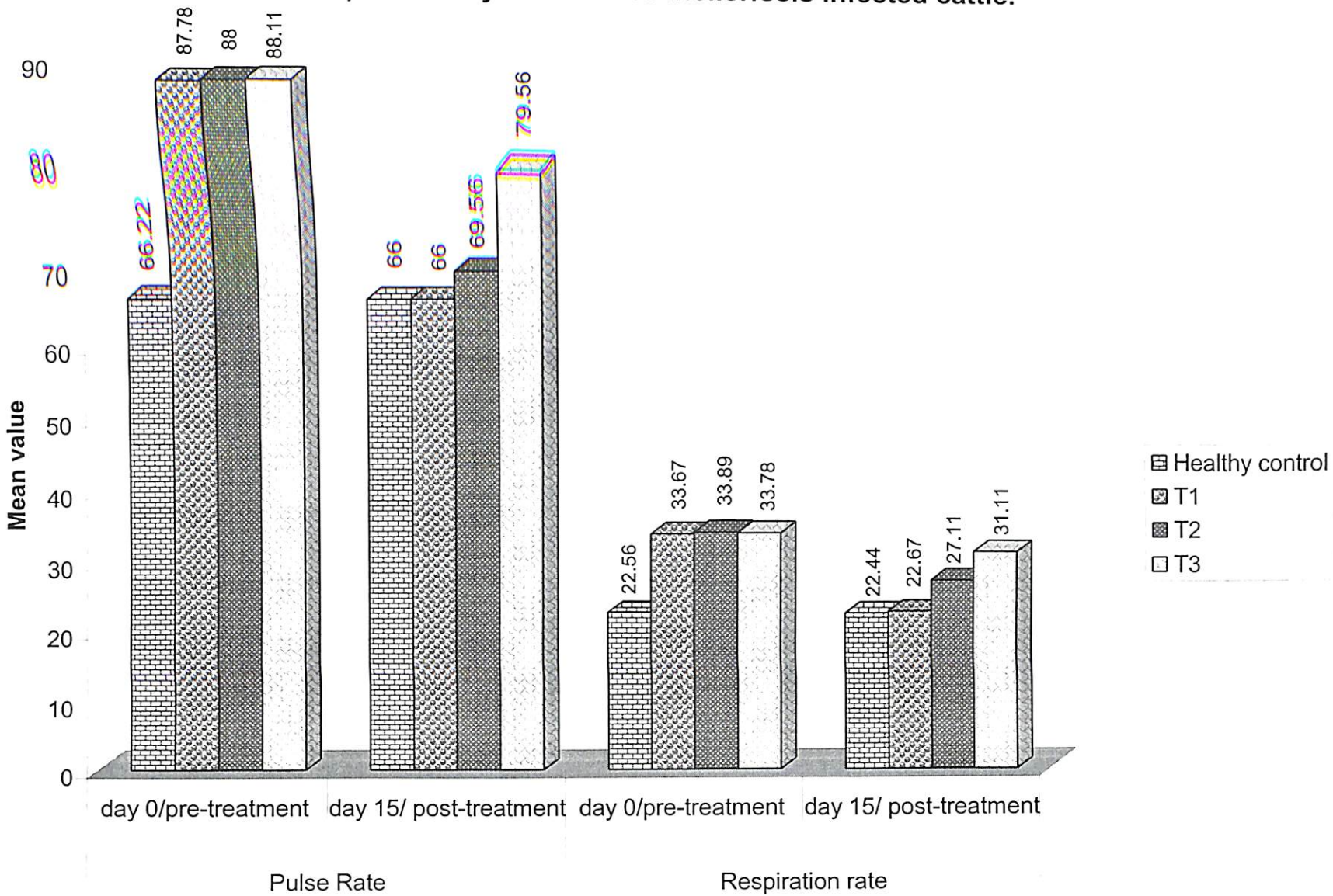


Table – 4 : Mean ± S.E. along with the CV% of Hb, PCV and TEC in the three treatment groups of cattle suffering from tropical theileriosis, including healthy control.

Treatment Groups	Hemoglobin (g%)				PCV (%)				TEC (10^6/mm^3)			
	0 day/ pre-treatment		15th day/ post-treatment		0 day/ pre-treatment		15th day/post-treatment		0 day/ pre-treatment		15th day/post-treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %
Healthy Control	10.94^{aA} ± 0.55	14.17	11.00^{aA} ± 0.37	9.55	33.89^{aA} ± 0.45	3.81	33.67^{aA} ± 0.69	5.76	7.33^{aA} ± 0.44	17.05	7.11^{aA} ± 0.39	15.47
T_1	6.06^{bA} ± 0.15	7.26	10.83^{aB} ± 0.14	3.79	18.72^{bA} ± 0.12	1.82	33.78^{aB} ± 0.28	2.34	4.11^{bA} ± 0.25	17.03	7.11^{aB} ± 0.26	10.41
T_2	6.33^{bA} ± 0.17	7.42	9.89^{bB} ± 0.14	3.94	18.83^{bA} ± 0.08	1.27	31.33^{bB} ± 0.67	6.03	4.17^{bA} ± 0.17	11.27	6.81^{aB} ± 0.22	9.10
T_3	6.06^{bA} ± 0.18	8.25	8.89^{cB} ± 0.16	5.17	18.94^{bA} ± 0.13	1.95	25.89^{cB} ± 0.54	5.87	4.11^{bA} ± 0.16	11.19	5.39^{bB} ± 0.22	11.32

NB : Means with different superscripts differ significantly (P<0.01).

[Column-wise (small letter)], [Row-wise (capital letter)]

Table – 5 : Analysis of variance showing the effect of different treatments on Hb, PCV and TEC in cattle suffering from tropical theileriosis.

Source of variation	Hemoglobin			Packed Cell Volume			Total Erythrocyte Count		
	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	42.44	29.47**	3	426.75	39.22**	3	19.52	17.75**
Between period	1	141.68	98.39**	1	1321.84	121.49**	1	50.50	45.91**
Error	67	1.44		67	10.88		67	1.10	

NB : ** = Significant at P<0.01.

Table – 6 : Mean ± S.E. along with the CV% of ESR and TLC in the three treatment groups of cattle suffering from tropical theileriosis, including healthy control.

Treatment Groups	ESR (per hour)				TLC (10^3/mm^3)			
	0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/post-treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %
Healthy Control	0.77^{NS} ± 0.04	15.58	0.78^{NS} ± 0.03	11.54	9.11^{aA} ± 0.79	24.48	9.11^{aA} ± 0.63	19.65
T_1	0.86^{NS} ± 0.01	2.33	0.78^{NS} ± 0.01	2.56	7.11^{bA} ± 0.29	11.39	9.00^{aB} ± 0.31	9.78
T_2	0.86^{NS} ± 0.01	2.33	0.80^{NS} ± 0.01	2.50	7.17^{bA} ± 0.29	11.44	8.89^{aB} ± 0.26	8.32
T_3	0.86^{NS} ± 0.01	2.33	0.75^{NS} ± 0.01	1.33	7.00^{bA} ± 0.31	12.57	7.50^{bA} ± 0.31	11.73

NB : Means with different superscripts differ significantly (P<0.01)

[Column-wise (small letter)], [Row-wise (capital letter)], NS = Non-significant

Table – 7 : Analysis of variance showing the effect of different treatments on ESR (per hour) and TLC ($10^3/mm^3$) in cattle suffering from tropical theileriosis.

Source of variation	Erythrocyte Sedimentation Rate			Total Leukocyte Count		
	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	0.01	0.00^{NS}	3	10.51	5.71**
Between period	1	0.06	0.00^{NS}	1	19.01	10.33**
Error	67	0.00		67	1.84	

NB : NS = Non-significant, ** = Significant at P<0.01.

Fig. 3 : **Histogram showing changes in Hemoglobin (g%), Packed cell volume (%), Total erythrocyte count (10 /mm) and Total leukocyte count (10 /mm) in healthy control and theileriosis infected cattle.**

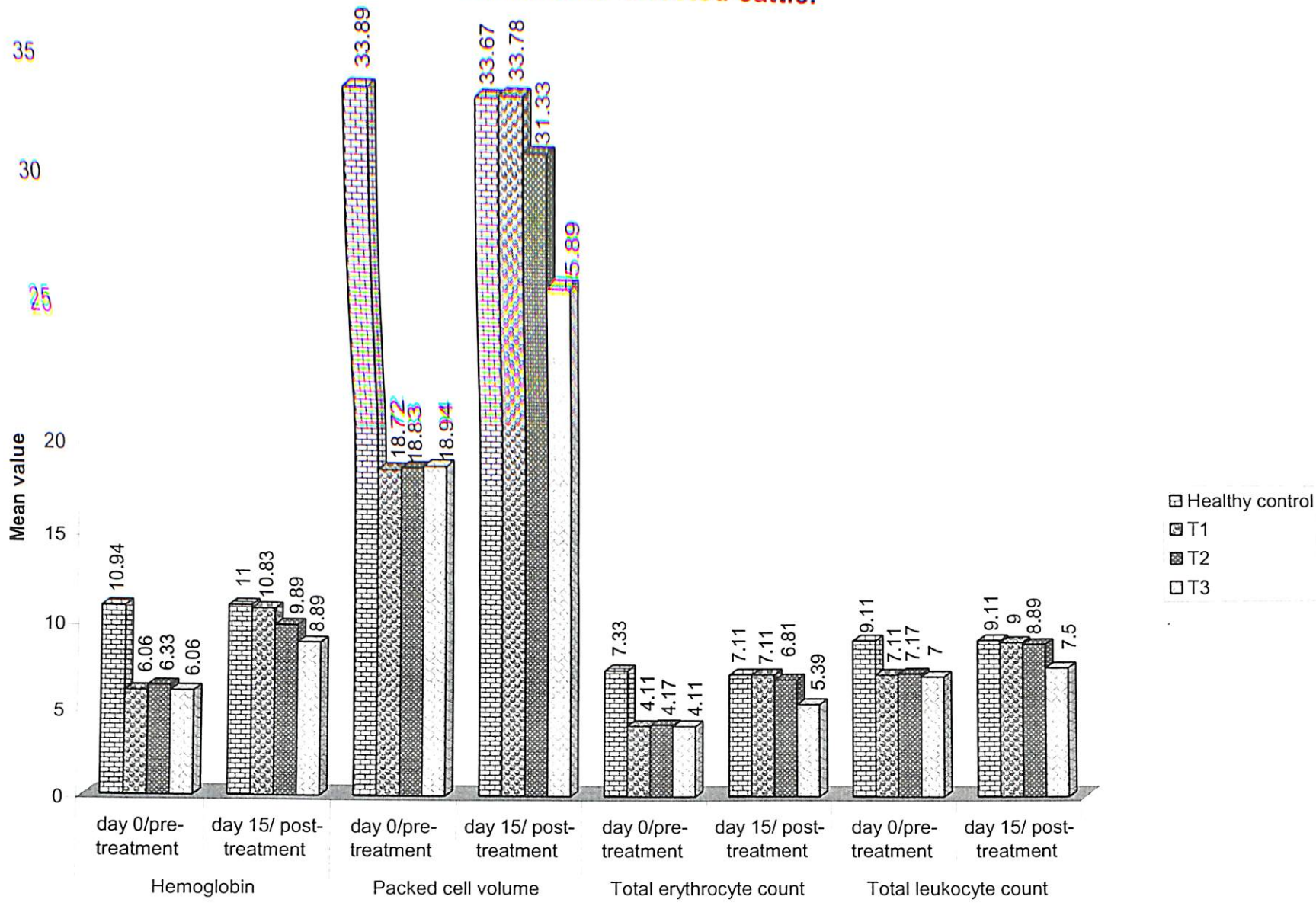


Table - 8 : Mean ± S.E. along with the CV% of differential leukocyte counts in the three treatment groups of cattle suffering from tropical theileriosis, including healthy control.

Treatment Groups	Neutrophil				Lymphocyte				Monocyte				Eosinophil			
	0 day/ pre-treatment		15th day/ post-treatment		0 day/ pre-treatment		15th day/ post-treatment		0 day/ pre-treatment		15th day/ post-treatment		0 day/ pre-treatment		15th day/ post-treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV
Healthy Control	39.23^{aA} ± 0.36 (40.00 ±0.62)	2.63	39.23^{aA} ± 0.36 (40.00 ± 0.62)	2.63	45.00^{aA} ± 0.36 (50.00 ± 0.62)	2.25	45.00^{aA} ± 0.36 (50.00 ± 0.62)	2.25	12.15^{NS} ± 0.24 (4.44 ± 0.18)	5.64	12.31^{NS} ± 0.24 (4.56 ± 0.18)	5.57	13.62^{aA} ± 0.22 (5.56 ± 0.18)	4.60	13.48^{aA} ± 0.22 (5.44 ± 0.18)	4.6
T_1	26.86^{bA} ± 0.38 (20.44 ± 0.56)	4.14	39.30^{aB} ± 0.33 (40.11 ± 0.56)	2.37	54.47^{bA} ± 0.32 (66.22 ± 0.52)	1.65	45.26^{aB} ± 0.25 (50.44 ± 0.44)	1.59	8.93^{NS} ± 1.86 (3.22 ± 0.76)	58.95	10.69^{NS} ± 2.08 (4.44 ± 0.93)	54.96	18.49^{bA} ± 0.53 (10.11 ± 0.56)	8.16	12.37^{aB} ± 0.60 (4.67 ± 0.44)	13.
T_2	27.03^{bA} ± 0.36 (20.67 ± 0.50)	3.73	36.33^{bB} ± 0.31 (35.11 ± 0.51)	2.39	54.07^{bA} ± 0.27 (65.56 ± 0.44)	1.40	45.76^{aB} ± 0.25 (51.33 ± 0.44)	1.56	11.50^{NS} ± 2.02 (4.89 ± 1.25)	49.59	13.14^{NS} ± 2.04 (6.11 ± 1.14)	43.98	17.28^{bA} ± 0.58 (8.89 ± 0.56)	9.50	15.66^{bB} ± 0.47 (7.33 ± 0.44)	8.4
T_3	29.10^{cA} ± 0.34 (23.67 ±0.50)	3.29	32.29^{cB} ± 0.28 (28.56 ± 0.44)	2.48	54.47^{bA} ± 0.32 (66.22 ± 0.52)	1.65	51.09^{bB} ± 0.29 (60.56 ± 0.50)	1.96	10.54^{NS} ± 2.19 (4.44 ± 1.12)	58.68	12.88^{NS} ± 1.90 (5.78 ± 1.14)	41.73	14.89^{bA} ± 0.65 (5.67 ± 0.50)	13.40	14.75^{bB} ± 0.53 (4.78 ± 0.40)	12.

NB : Means with different superscripts differ significantly (P<0.01).

[Column-wise (small letter)], [Row-wise (capital letter)].
Figures in Parenthesis indicate actual mean values.

Table – 9 : Analysis of variance showing the effect of different treatments on Differential Leukocyte Counts in cattle suffering from tropical theileriosis.

Source of variation	Neutrophil count			Lymphocyte count			Monocyte count			Eosinophil count		
	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	264.37	35.44**	3	187.67	41.06**	3	24.57	0.93^{NS}	3	45.19	12.66**
Between period	1	699.31	93.74**	1	491.26	107.50**	1	39.12	1.47^{NS}	1	91.02	25.50**
Error	67	7.46		67	4.57		67	26.54		67	3.57	

NB : NS = Non-significant, ** Significant at P<0.01.

Fig. 5 : Histogram showing changes in Mean corpuscular volume (fl), Mean corpuscular hemoglobin (pg) and Mean corpuscular hemoglobin concentration (g/dl) in healthy control and theileriosis infected cattle.

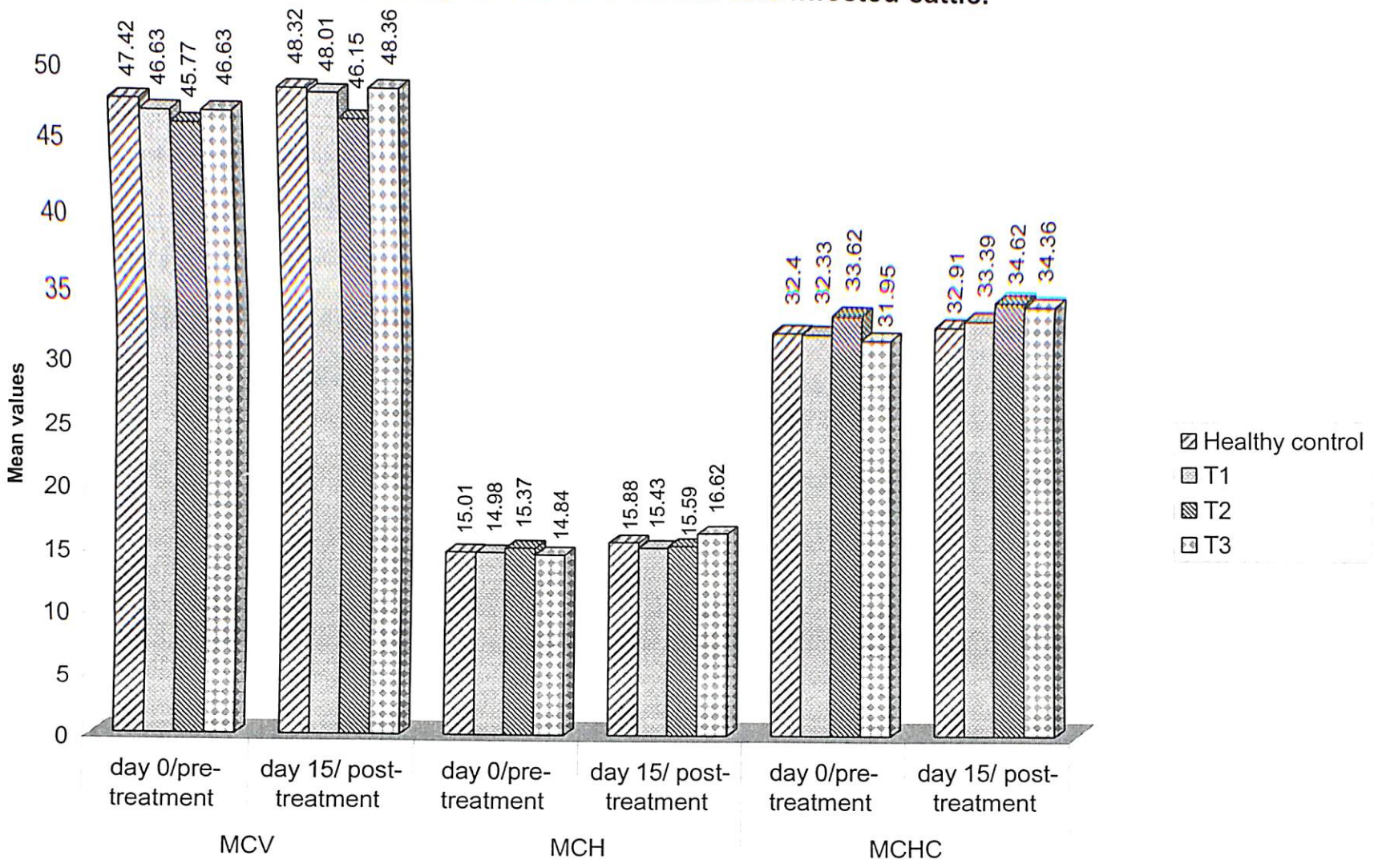


Table – 10 : Mean ± S.E. along with the CV% of various erythrocytic indices (MCV, MCH an MCHC) in the three treatment groups of cattle suffering from tropical theileriosis, includin healthy control.

Treatment Groups	MCV (fl)				MCH (pg)				MCHC (g/dl)			
	0 day/ pre-treatment		15th day/ post-treatment		0 day/ pre-treatment		15th day/post-treatment		0 day/ pre-treatment		15th day/post treatment	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %
Healthy Control	47.42^{NS} ± 2.58	15.35	48.32^{NS} ± 2.33	15.66	15.01^{NS} ± 0.36	6.73	15.88^{NS} ± 1.09	19.46	32.40^{NS} ± 1.83	15.99	32.91^{NS} ± 1.60	13.76
T_1	46.63^{NS} ± 2.29	13.92	48.01^{NS} ± 1.75	10.31	14.98^{NS} ± 0.55	10.48	15.43^{NS} ± 0.69	12.64	32.33^{NS} ± 0.71	6.22	33.39^{NS} ± 0.53	4.64
T_2	45.77^{NS} ± 1.81	11.19	46.15^{NS} ± 0.69	4.20	15.37^{NS} ± 0.64	11.84	15.59^{NS} ± 0.32	6.17	33.62^{NS} ± 0.82	6.87	34.62^{NS} ± 0.43	3.83
T_3	46.63^{NS} ± 1.79	10.85	48.36^{NS} ± 1.04	6.08	14.84^{NS} ± 0.51	9.84	16.62^{NS} ± 0.40	6.80	31.95^{NS} ± 0.85	7.54	34.36^{NS} ± 0.25	2.07

NB : NS = Non-significant

Table – 11 : Analysis of variance showing the effect of different treatments on various erythrocytic indices (MCV, MCH and MCHC) in cattle suffering from tropical theileriosis.

Source of variation	MCV (fl)			MCH (pg)			MCHC (g/dl)		
	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	12.49	0.41^{NS}	3	1.88	0.54^{NS}	3	2.70	0.28^{NS}
Between period	1	21.55	0.70^{NS}	1	6.06	1.74^{NS}	1	0.51	0.05^{NS}
Error	67	30.63		67	3.49		67	9.65	

NB : NS = Non-significant

Fig. 7: Histogram showing changes in Differential leukocyte counts in healthy control and theileriosis infected cattle.

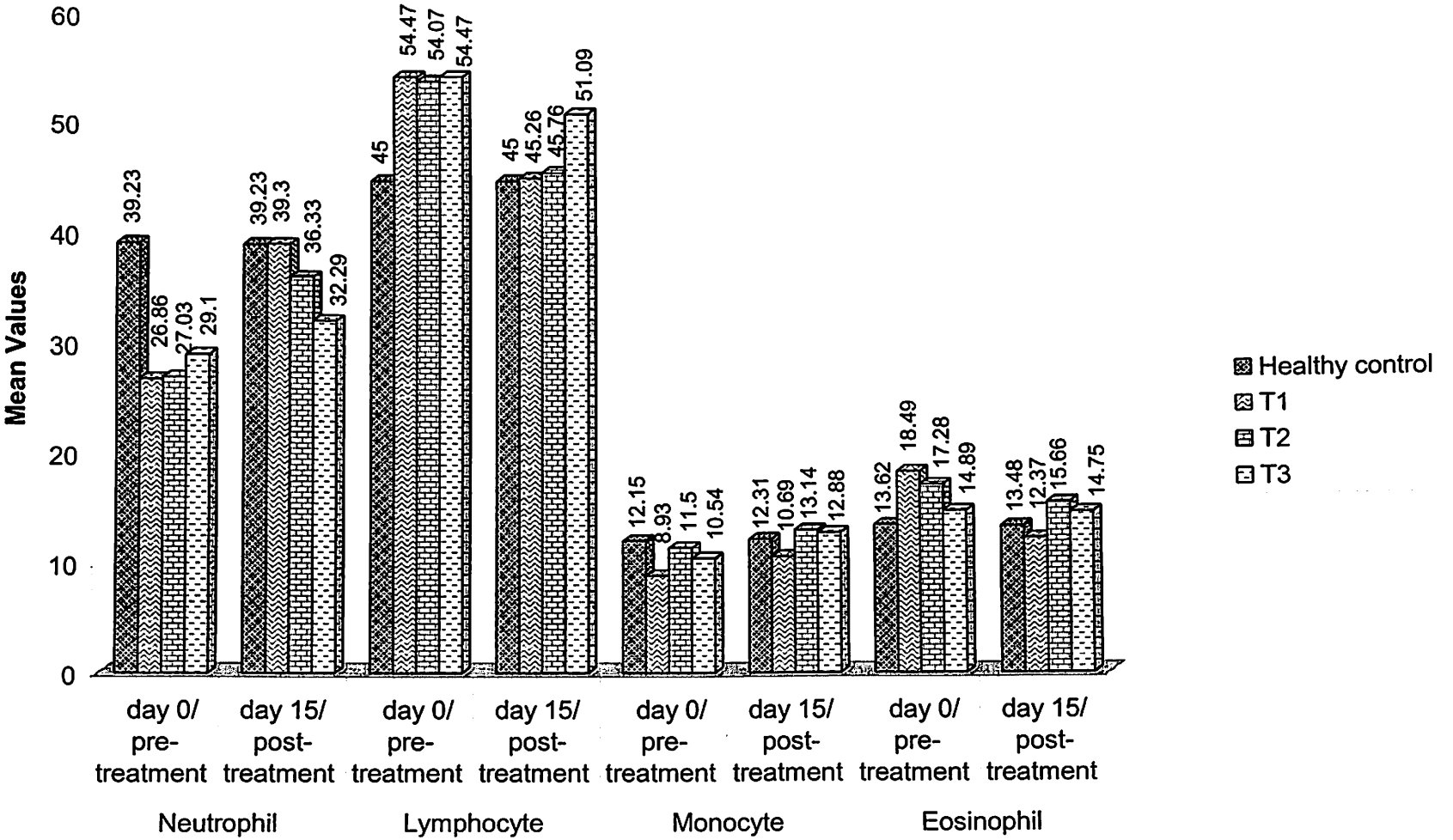


Table – 12 : Mean ± S.E. along with the CV% of various biochemical parameters in the three treatment groups of cattle suffering from tropical theileriosis, including healthy control.

Treatment Groups	Total serum protein (g/dl)				Total serum bilirubin (mg/dl)				Serum Iron (µg/ml)				Serum Copper (µg/ml			
	0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/post-treatment		0 day/pre-treatment		15th day/ treatme	
	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	CV %	Mean ± S.E.	
Healthy Control	6.63^{aA} ± 0.06	2.41	6.62^{aA} ± 0.05	1.96	0.14^{aA} ± 0.01	5.88	0.14^{aA} ± 0.01	5.84	3.80^{aA} ± 0.03	2.11	3.80^{aA} ± 0.02	1.17	0.86^{NS} ± 0.01	1.04	0.86^{NS} ± 0.01	0.
T_1	5.23^{bA} ± 0.01	0.38	6.62^{aB} ± 0.01	0.15	0.69^{bA} ± 0.01	2.90	0.15^{aB} ± 0.01	6.67	3.52^{bA} ± 0.04	3.35	3.80^{aB} ± 0.01	0.53	0.79^{NS} ± 0.01	1.58	0.86^{NS} ± 0.01	2.
T_2	5.23^{bA} ± 0.01	0.38	6.28^{acB} ± 0.01	0.32	0.69^{bA} ± 0.01	2.90	0.23^{cB} ± 0.01	13.04	3.43^{cA} ± 0.01	0.81	3.76^{aB} ± 0.01	0.53	0.78^{NS} ± 0.01	1.60	0.83^{NS} ± 0.01	2.
T_3	5.25^{bA} ± 0.01	0.19	5.97^{bB} ± 0.01	0.34	0.69^{bA} ± 0.00	1.45	0.49^{bB} ± 0.01	2.04	3.48^{cA} ± 0.01	0.85	3.54^{bB} ± 0.02	1.97	0.78^{NS} ± 0.01	2.26	0.81^{NS} ± 0.01	2.

NB : Means with different superscripts differ significantly (P<0.01) [Column-wise (small letter)], [Row-wise (capital letter)].
NS = Non-significant.

Table – 13 : Analysis of variance showing the effect of different treatments on various biochemical parameters in cattle suffering from tropical theileriosis.

Source of variation	Total serum protein (g/dl)			Total serum bilirubin (mg/dl)			Serum Iron (µg/ml)			Serum Copper (µg/ml)		
	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F	d.f.	MSS	F
Between treatment	3	3.66	45.75**	3	0.65	65.33**	3	0.27	27.33**	3	0.02	0.00^{NS}
Between period	1	11.21	140.13**	1	1.62	162.00**	1	0.51	51.00**	1	0.03	0.00^{NS}
Error	67	0.08		67	0.01		67	0.01		67	0.00	

NB : NS = Non-significant, ** Significant at P<0.01.

Fig. 6 : Histogram showing alterations in different biochemical parameters studied in healthy control and theileriosis infected cattle.

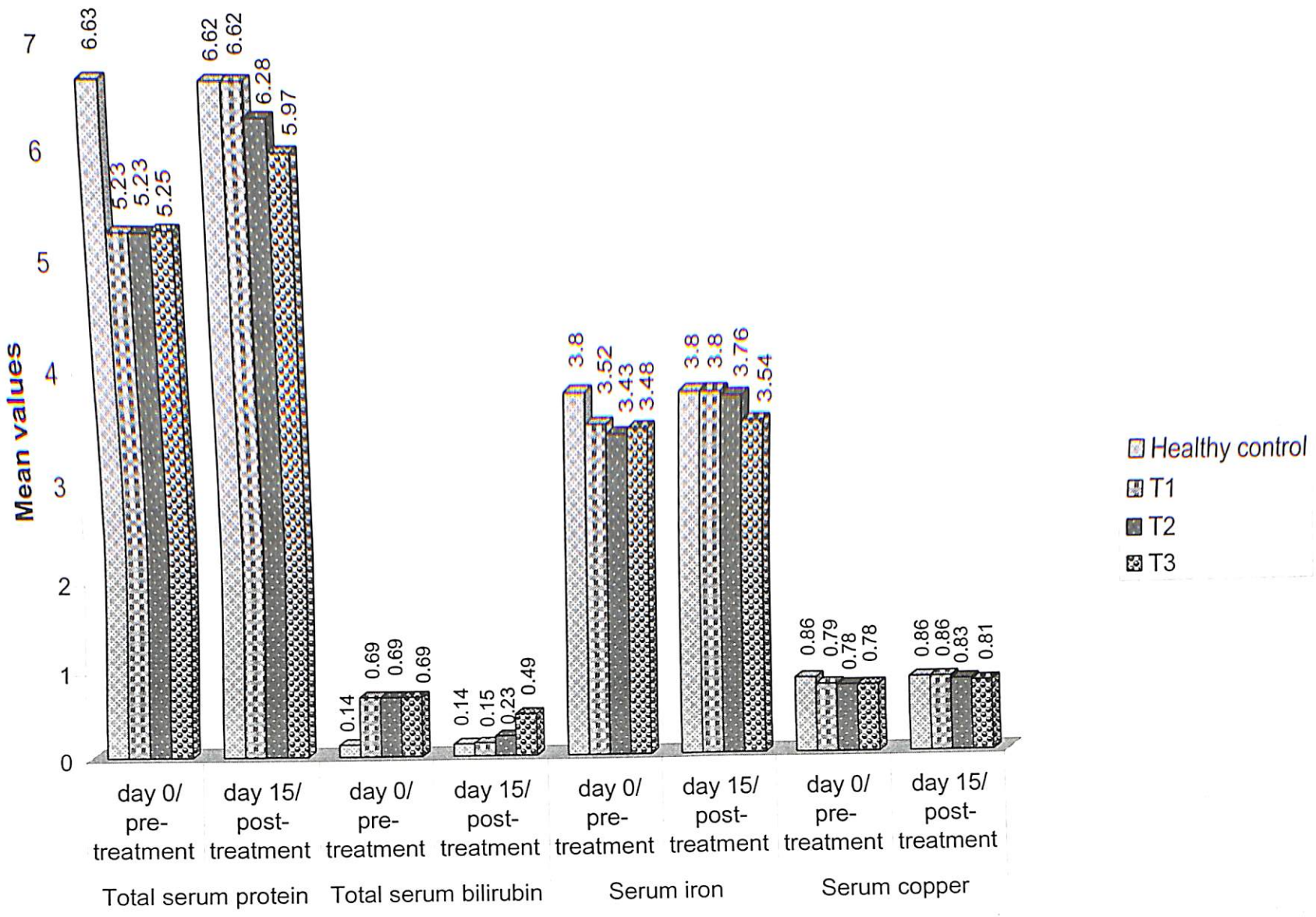
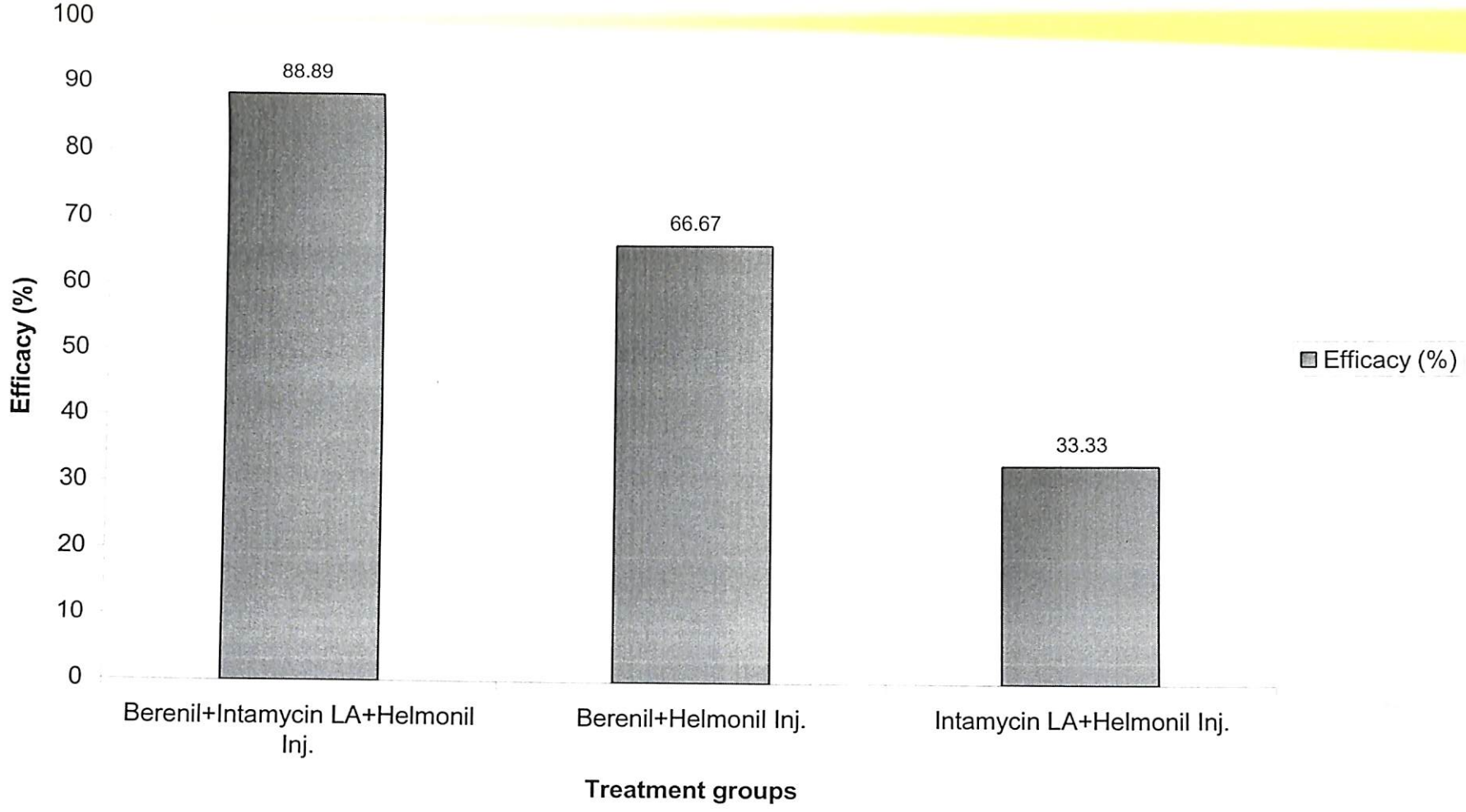
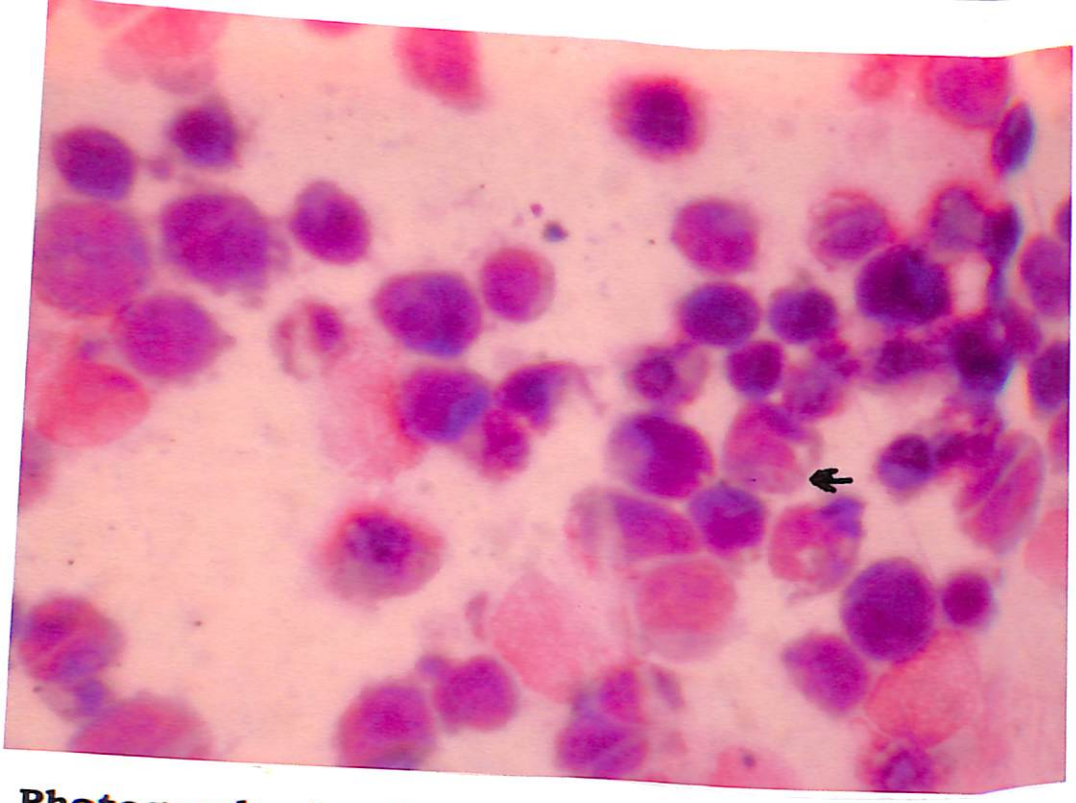


Table – 14 : Efficacy of different drug combinations used for the treatment of bovine tropical theileriosis.

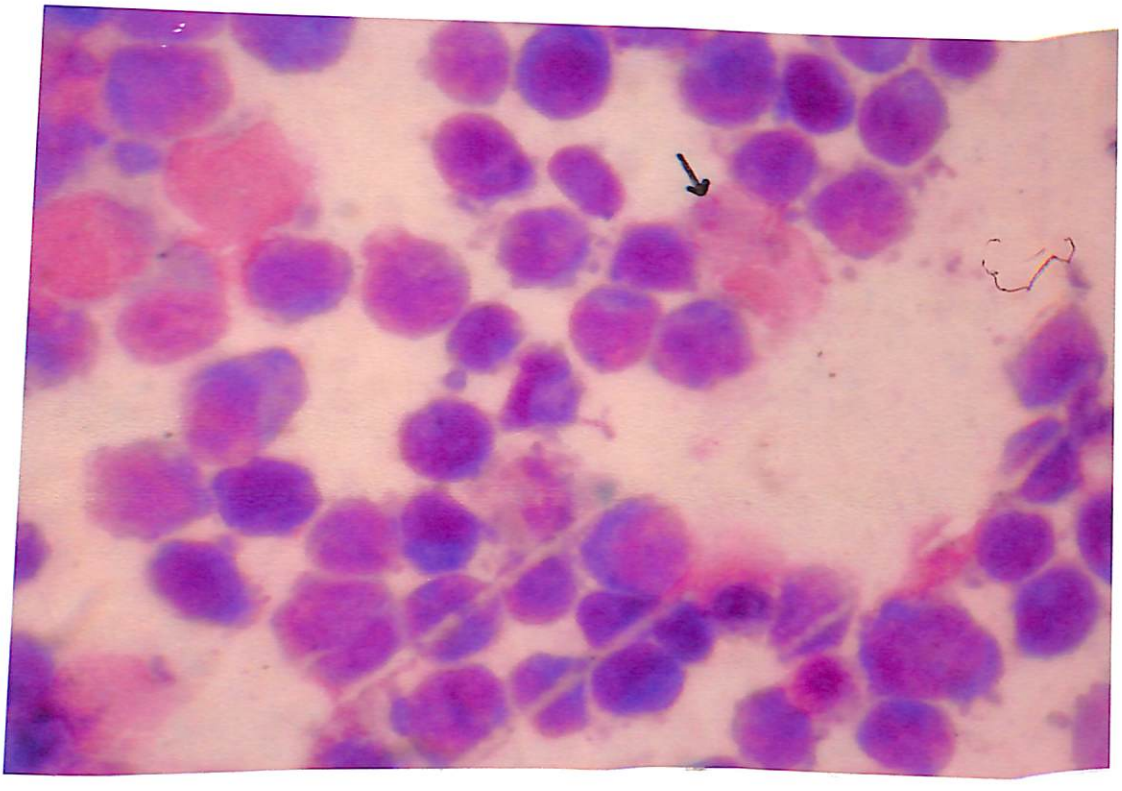
Treatment groups	No. of animals treated	No. of animals recovered	Efficacy (%)
Berenil + Intamycin LA + Helmonil Inj. (T_1)	9	8	88.89
Berenil + Helmonil Inj. (T_2)	9	6	66.67
Intamycin LA + Helmonil Inj. (T_3)	9	3	33.33
Total	**27**	**17**	**62.96**

of bovine tropical theileriosis.

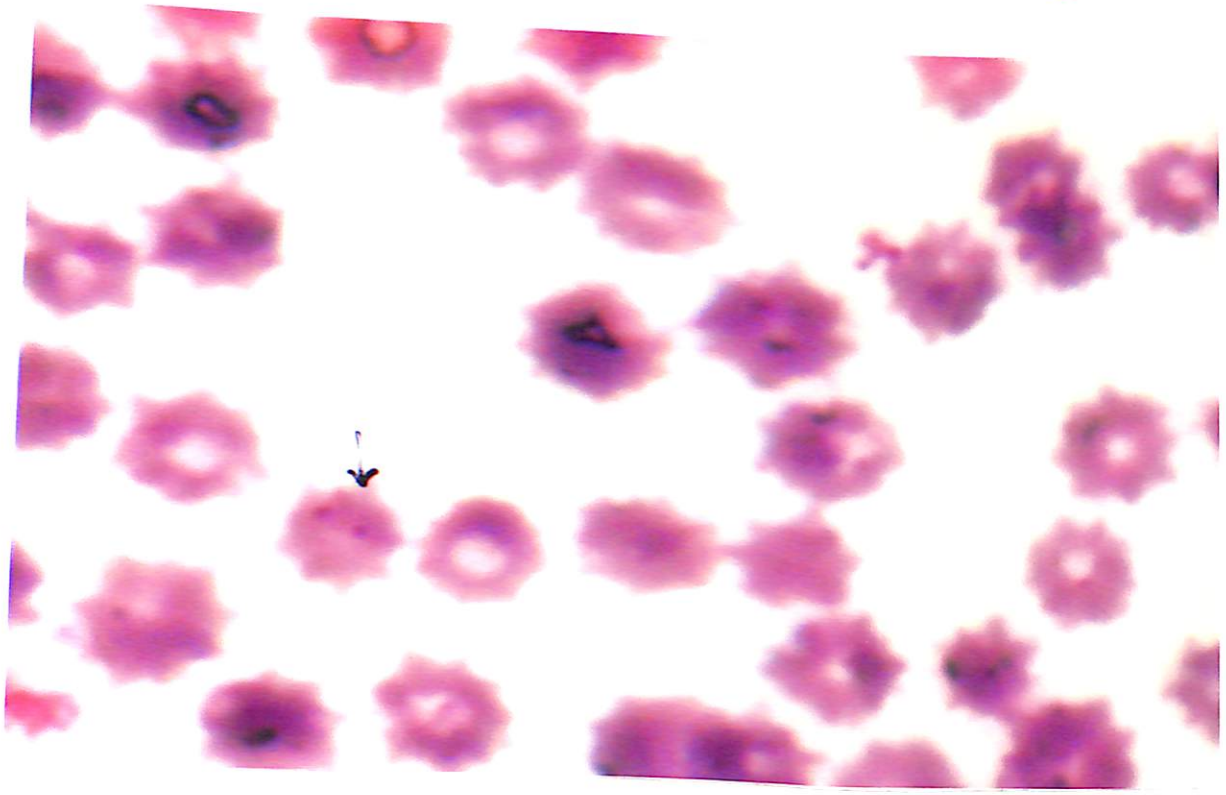




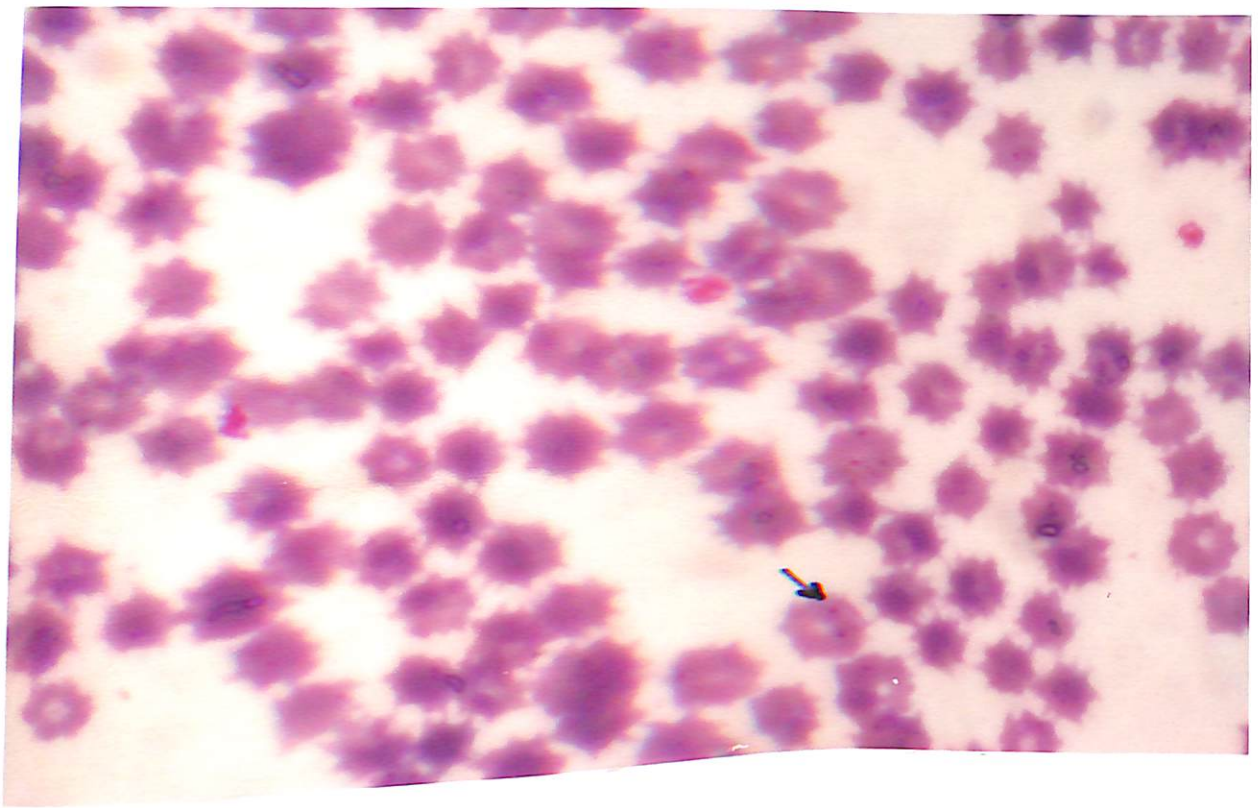
Photograph - 1 : *Theileria annulata* schizont (Koch's blue body) in a clinical case of tropical bovine theileriosis.



Photograph - 4 : Chromatin particles in the cytoplasm of lymphocyte of a calf infected with tropical bovine theileriosis.



Photograph - 3 : Theilerial piroplasms in the RBC of a clinical case infected with tropical bovine theileriosis.



Photograph - 2 : Theilerial piroplasms in the RBC of a calf infected with tropical bovine theileriosis.

CHAPTER - V

DISCUSSION

DISCUSSION

Theileriosis is a highly fatal blood protozoan disease of exotic, cross-bred and indigenous young calves (Sen & Srinivasan, 1937; Sinha and Pathak, 1964 and Sharma and Gautam, 1971). The *Theileria annulata* infection is a major constraint to the improvement of the livestock industry in the Indian subcontinent. Occurrence of the disease has increased considerably on account of import of taurine breeds of cattle for upgrading indigenous stock in order to have more milk. The *Bos taurus* cattle are highly susceptible and their cross-bred progeny are much more susceptible to this infection. The Zebu cattle are less susceptible compared to the exotic cattle because of their inherent ability to limit the explosive multiplication of schizonts during the acute phase (Otto M. Radostitis, Clive C. Gay, Douglas C. Blood and Kenneth W. Hinchcliff, 2000). Great economic losses are incurred in dairy industry due to this disease. Moreover, a large cattle population has come up, which is at a grave risk to theileriosis. Keeping this in view, the objectives of study were to observe closely the clinical manifestations in diseased animals, to ascertain the haemato-biochemical alterations and to treat cattle suffering from theileriosis with chemotherapeutic agents which are also affordable and effective.

Clinical findings :

All the clinical cases showed mild to high degree of enlargement of superficial lymph glands particularly the

prescapular lymph glands. This clinical finding is in agreement with the findings of several workers (Sen & Srinivasan, 1937; Gautam *et al.*, 1970; Anantwar *et al.*, 1986; Srivastava and Sharma, 1981 and Mehta *et al.*, 1988). Anorexia in theileriosis affected animals has also been observed by Bulman *et al.* (1979), Anantwar *et al.* (1986) and Omer *et al.* (2003). The observation of anaemia in almost all the cases of theileriosis is in agreement with those of Sen and Srinivasan (1937), Gautam *et al.* (1970) and Anantwar *et al.* (1986). In some cases the animals showed presence of icteric conjunctiva as recorded by Gill *et al.* (1977). Most of the clinical cases were found to be suffering from haemoglobinuria and excreted high coloured urine. This is in agreement with the observations of Narsimhamurthy *et al.* (1968) and Gautam *et al.* (1970) respectively. The theileriosis affected cows gave lower milk yields (Anantwar *et al.*, 1986). Some cases did not feed and remained dull which might have been due to additional factors of stress.

Clinical Parameters:

The presence of significantly high temperature levels in clinical cases of theileriosis was in agreement with the findings of several workers (Sen and Srinivasan, 1937; Narasimhamurthy, 1968; Gautam *et al.*, 1970 and Srivastava and Sharma, 1981). Increased pulse and respiration rates were also found by Erturk *et al.* (1976), Gill *et al.* (1977), Amer *et al.* (1987) and Sharma *et al.* (1987).

Haematological Changes :

Changes in the erythrocytic series of the blood cells were due to the fact that the theilerial piroplasms infected the erythrocytes. The haematological changes were assessed in all the clinical cases before and after therapeutic trials. There was a significant decrease in the mean pre-treatment values of haemoglobin, packed cell volume and total erythrocytic count from that of the normal values in all the clinical cases. Dhar and Gautam (1979a), Lal and Soni (1983), Lal and Soni (1985), Dumali *et al.* (1987), Sharma *et al.* (1987), Sudhan *et al.* (1988), Rayalu *et al.* (1995), Sahu *et al.* (1996), Aulakh *et al.* (1998), Sandhu *et al.* (1998), Farah *et al.* (1999) and Ceylan *et al.* (2004) also observed fall in Hb, PCV and TEC in clinical cases of bovine tropical theileriosis. Since *Theileria annulata* is intraerythrocytic, destruction of red cells is maximum and the piroplasms attack the erythrocytes in large numbers which is the cause of haemolytic anaemia (Hooshmand, 1976; Dhar and Gautam, 1979a; Sinha and Gunay, 1981; Srivastava and Sharma, 1981; Kanaya, 1985 and Omer *et al.*, 2002). Liablin (1978), however, observed that anaemia was of aplastic type. There was no significant change in the values of various erythrocytic indices such as MCV, MCH and MCHC. This is in agreement with the findings of Sudhan *et al.* (1988). However, according to the findings of Rayalu *et al.* (1995), the MCV and MCHC values were significantly ($P<0.01$) altered whereas the MCH values were significant ($P<0.05$). The values of ESR showed a non-significant elevation in the clinical cases (Sahu *et al.*, 1996 and Aulakh *et al.*, 1998).

The leukogram presented a slightly variable picture because the cases used for study were perhaps at different stages of the disease. The clinical cases showed significantly lowered values of total leukocyte count in the pre-treatment period which is in agreement with the findings of Sharma *et al.* (1987), Sahu *et al.* (1996) and Aulakh *et al.* (1998). Neutropenia observed in this study was also recorded by Srivastava and Sharma (1981), Dumali *et al.* (1987), Rayalu *et al.* (1995), Aulakh *et al.* (1998) and Omer *et al.* (2002). Significant increase in the lymphocyte count as noted in this study is in agreement with the findings of Dumali *et al.* (1987), Rayalu *et al.* (1995), Aulakh *et al.* (1998) and Muraleedharan *et al.* (2005). Dumali *et al.* (1987) and Rayalu *et al.* (1995) observed no significant alteration in monocyte and eosinophil counts. Whereas the monocyte count is in agreement with the findings of the above mentioned authors, marked eosinophilia was observed in the clinical cases under study. This may be due to the fact that the number of eosinophils is generally found to be higher in parasitic infections.

Biochemical Changes :

All the clinical cases recorded significantly higher pre-treatment values of total serum protein than the normal healthy controls. Similar results have been obtained by Dhar and Guatam (1979b), Srivastava and Sharma (1981), Sudhan *et al.* (1988), Farah *et al.* (1999) and Omer *et al.* (2003). However, Sandhu *et al.* (1998) observed a non-significant decrease in the concentration of total serum protein.

The concentration of serum bilirubin was found to be significantly higher than that of the normal animals. It was due to the breakdown of a large number of erythrocytes as a result of intraerythrocytic theilerial piroplasms. Bansal and Gaur (1977), Liablin *et al.* (1978), Sinha and Gunay (1981), Srivastava and Sharma (1981), Amer *et al.* (1987), Dumali *et al.* (1987), Sudhan *et al.* (1988), Sandhu *et al.* (1998), Farah *et al.* (1999) and Omer *et al.* (2003) also observed increased bilirubin levels in cattle suffering from theileriosis. Moreover, increase in serum billirubin might also have been due to severe liver damage.

In this study, the serum iron levels were found to be significantly lowered whereas the serum copper levels were found to be lowered non-significantly. In whatever literature is available, there is mention of only Omer *et al.* (2003) who seem to have worked on these two metabolites. While the findings of serum iron levels are in agreement with the observation made by Omer *et al.* (2003), the values of total serum copper concentration detected in this study were in contrast with their findings.

Therapeutic trials :

During the present investigation, the following three groups of drugs were tried to evaluate the efficacy of each separately in clinical cases of bovine tropical theileriosis.

Treatment Group 1(T_1): Berenil + Intamycin LA + Helmonil Inj.

Treatment Group 2(T_2) : Berenil + Helmonil Inj.

Treatment Group 3(T_3) : Intamycin LA + Helmonil Inj.

Group 1 (T_1) :

esting to note that although there are records of along with oxytetracycline, there is no mention available literature about the trial of above nbination therapy along with levamisole for the cases affected with theileriosis. Berenil in ith oxytetracycline has been found to yield good eral workers (Tripathi, 1981; Mishra *et al.*, 1983; ., 1984; Tanwar *et al.*, 1984; Nayak and Dey, adhyay *et al.*, 1994 ; Al-Khafaji, 1996; Al-Abdaly nd Srivastava *et al.*, 2001). Levamisole is known ell-mediated immunity (CMI) in immunologically nimals besides helping overcome stress of other arasitic infections by way of its antinematodal a result of this that the efficacy of treatment in s group was found very satisfactory. Of the nine ed with Berenil, Intamycin LA and Helmonil Inj., recovered completely thereby giving an efficacy %. The lone death which occurred was registered e 20th day post-treatment. However, the died calf ormal in appearance and more so no parasite cted in blood smear examination. The death of be ascribed to the severe anaemia and subnormal ture. The satisfactory results of this combination supported by the improvement in the normal ie animals and almost all the haematological and parameters studied. The use of supportive

therapy at appropriate time further helped in the recovery of the theileriosis affected animals.

Treatment of Group 2 (T_2) :

While there is mention of use of Berenil with oxytetracycline, there is no available literature regarding trial of a combination therapy comprising Berenil plus levamisole. Of the nine animals treated in this group, six animals recovered completely while three animals reported death on different days after 15th day post-treatment. Thus, the efficacy was found to be about 66.67%. Berenil is known to have bactericidal effect along with its potent antiprotozoal effect. Levamisole as mentioned earlier is a potent immunomodulator. These effects of berenil and levamisole coupled with the use of supportive therapy like liver extract and Vit B_{12} might have helped achieve this rate of success in this treatment group.

Treatment of Group 3 (T_3) :

The efficacy of combination therapy of Intamycin LA (Oxytetracycline) with Helmonil Inj. (Levamisole) was found to 33.33% only. Similar results have been obtained by Bandopadhyay *et al.* (1994). Gill *et al.* (1978), Bagherwal (1989) and Bandopadhyay *et al.* (1994) have also earlier used long acting oxytetracycline for the treatment of theileriosis. This combination was also used by Kumar *et al.* (1988) who claimed that levamisole plays an important role in the recovery of the animal. Levamisole perhaps acts through the cell-mediated immune response by altering the cAMP : cGMP in T cells. Increased level of cGMP augments lymphocyte functions such as proliferation of lymphokine production and

lymphotoxicity as well as macrophage proliferation and phagocytosis. Though there was, in general, some improvement in almost all the parameters under study, it resulted in recovery of only three of the nine animals treated and thus was found to demonstrate poor efficacy. According to Avapal and Kumar (2003), oxytetracycline usually is ineffective after the establishment of infection. Supportive therapy would have definitely given a boost to haemopoeitic tissue, but was also of not much help either, in presence of the ineffective combination of drugs used.

Supportive Therapy :

Apart from chemotherapy, supportive therapy using Vitamin B complex with liver extract and iron dextran were adopted in all the three treatment groups . This simply helped in speedy recovery and in gaining normal health after elimination of theilerial piroplasms from the erythrocytes.

The supportive therapy viz. liver extract, Vit. B complex and hematinics have also been used in theileriosis along with specific therapy by several workers such as Mishra *et al.* (1983), Sudhan *et al.* (1987), Kumar *et al.* (1988), Nayak and Dey (1991) and Sudhan and Sinha (1991).

****

CHAPTER - VI

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

For the present study, 27 clinical cases of bovine tropical theileriosis were taken up for detailed observation of changes in various clinical, haematological and biochemical parameters with three different combination therapies. The first treatment group (T_1) was treated with a combination of Berenil (diminazine aceturate), Intamycin LA (a long acting oxytetracycline) and Helmonil Inj. (Levamisole). The second treatment group (T_2) was treated with a combination of Berenil and Helmonil Inj. while the third treatment group (T_3) was treated with a combination of Intamycin LA and Helmonil Inj. In addition, a group of nine healthy control animals were taken up for recording the normal values of various clinico-haemato-biochemical parameters.

The clinical cases were confirmed by the presence of theilerial piroplasms in the thin blood smears and by the presence of Koch's blue bodies in lymph node biopsy smears besides other characteristic features of the disease. All the major clinical, haematological and biochemical parameters were recorded in all clinical cases prior to any treatment. There

nt increase in temperature, pulse and all the clinical cases prior to treatment.

am studies showed significant decrease in values of hemoglobin, packed cell volume, ount and total leukocyte count. There was a ncrease in the values of erythrocyte e. The differential leukocyte counts showed utropenia, lymphocytosis and eosinophilia in fering from theileriosis. The pre-treatment erythrocytic indices (MCV, MCH and MCHC) ificant alterations from that of the values in controls. Biochemcial analyses of serum icant decrease in the mean values of total nd serum iron. The total serum bilirubin icant increase from the values in healthy ere was only a non-significant decrease in the ean values of serum copper. Besides this o-haemato-biochemical observations in the they also revealed various clinical such as enlargement of superficial lymph) complete loss of appetite, weakness, icteric moglobinuria, anaemia and decreased milk

he treatment regime was followed in the three sisting of 9 clinical cases of theileriosis. The emotherapeutic trials was judged on the basis

of the return to normal of various clinical, haematological and biochemical parameters and the absence of theilerial piroplasms and Koch's blue bodies from the thin blood smears and lymph node biopsy smears respectively. Supportive therapy in the form of liver extract, Vit. B_{12} and hematinics were given .

All clinical cases of the first treatment group (T_1) were given a single dose of Berenil @ 800mg/100kg. Body weight intramuscularly and Helmonil Inj. @ 3 mg/kg body weight subcutaneously. Intamycin LA was administered @ 20 mg/kg body weight intravenously for five days at 72 hrs. interval. The use of this trio of drugs cured 8 of 9 cattle in this group. Death was reported in a calf which died of anaemia and subnormal body temperature. No side-effect was observed with this schedule of treatment. All clinical, haematological and biochemical parameters returned to normal on 15th day post-treatment. The efficacy of this treatment turned out to be 88.89%.

The second treatment group (T_2) was given a combination of Berenil @ 5 ml/100 kg. body weight intramuscularly along with Helmonil Inj. @ 3mg/kg. body weight subcutaneously, both as a single dose. This combination cured 6 out of the 9 cattle, thus resulting in an efficacy of about 66.67%. Though there was a significant improvement in all the parameters under study, yet some parameters such as pulse, respiration rate, Hb, PCV, neutrophil and eosinophil counts and total

serum bilirubin differed significantly with the normal values. Besides these, all other parameters including temperature were found to differ non-significantly with that of the healthy controls. Three cases succumbed to infection despite all attempts made through supportive therapy in addition to the specific therapy adopted.

Intamycin LA (long-acting oxytetracycline) in combination with Helmonil Inj. (Levamisole) was used in animals of the third treatment group (T_3). All the clinical, haematological and biochemical parameters under observation were found to differ significantly with that of the healthy controls even after 15th day post-treatment. However, most of the parameters revealed significant changes in the 15th day post-treatment mean values from that of their pre-treatment 0 day mean values. Only three animals were cured in this group while rest of them died on different days after 15th day post-treatment. Moreover, the animals which recovered were seen to be mainly Zebu cattle which are known to be more resistant genetically. The efficacy recorded in this treatment group was unsatisfactory at around 33.33% only and is, therefore, not recommended for the treatment of bovine tropical theileriosis.

Overall, Berenil along with Intamycin LA and Helmonil Inj. was found to be superior to the combination therapy of Berenil and Helmonil Inj. while the Intamycin LA and Helmonil Inj. combination was not found efficacious enough. Therefore, the first treatment regime that was followed in animals of the

first treatment group (T_1) along with supportive therapy is recommended for the treatment of cases of bovine tropical theileriosis.

****

CHAPTER - VII

BIBLIOGRAPHY

BIBLIOGRAPHY

Abdel-Rehman, M.S.; Samia, Ahmed, A.; Hassan, H.A.; Fahmy, M.M. and Ashmawy, K. (1987). Control of tick-borne blood parasite *Theileria annulata* by vaccination of food producing animals. 1. Immunization of cattle against *Theileria* infection by using infection and treatment method. *Vet. Med. J.*, **35** (2) : 259-274.

Al-Abdaly-IBA and Al-Khafaji-NJ (2000). Therapeutic efficacy of diminazine and quinuronium sulphate in sheep and cows. *Iraqi Journal of Veterinary Sciences*, **13** : (2), 331-339.

Al-Khafaji-NJ (1996). Comparative treatment of bovine theileriosis under field conditio Mosul, Iraq. *Iraqi Journal of Veterinary Sciences,* 51-67.

Amer, A.A.; Mourd, M.I., and Salem 987). Theileriosis in Friesian catttle in Upper ssiut *Veterinary Medical Journal,* **18** (36) : 148

Anantwar, LG; Samad, A.; Ali-MS u-DN (1986). Theileriosis associated with k -bred cows-a clinical note. *Livestock Advis* 2.

Anjaria, J.V.; Jhala, V.M. and She hloroquine phosphate in the treatment exotic and cross-bred cattle : A clinic pproach. *Guj. Agril. Univ. Res. J.*, **1** (2

Ashok-Kumar; Sarup, S; Sharma-RD; Nichani-AK; Parveen-Goel; Kumar, A. and Goel, P. (1998). Chemotherapeutic efficacy of buparvaquone against various stages of *Theileria annulata* infection in cattle. *International J. of Anim. Sciences*, **13** : (2), 133-138.

Aulakh, R.S.; Gill, J.P.S.; Johal, H.S.; Jugal, P.D. and Joshi, D.V. (1998). Haematological observations in *Theileria annulata* infected cross-bred cattle and their treatment with buparvaquone. *J. of Research, PAU*, **35** (1/2) : 86-88.

Avapal, R.S. and Kumar, A. (2003). Theileriosis in cross-bred calves and its treatment. *Indian Vet. Med. Jour.*, Vol. **27** : 371.

Bagherwal, R.K. (1989). Oxytetracycline (Telon LA) as chemotherapeutic agent against bovine tropical theileriosis in cross-bred cattle. *Indian Vet. J.*, **66** : 652-655.

Bandopadhyay, L.N.; Maity, B.; Bhandari, S.K. and Gupta, R. (1994). Studies on efficacy of some drugs against bovine theileriosis in field condition at Bethuadahari, Nadia, West Bengal. *Indian Journal of Anim. Health*, **33** : (1), 29-31.

Banerjee, P.K.; Guha, C.; Gupta, R.; Potdar, R.R. and Dutta, A.K. (1986). Studies on the efficacy of some anti-theilerial drugs with special references to halofuginone

Ashok-Kumar; Sarup, S; Sharma-RD; Nichani-AK; Parveen-Goel; Kumar, A. and Goel, P. (1998). Chemotherapeutic efficacy of buparvaquone against various stages of *Theileria annulata* infection in cattle. *International J. of Anim. Sciences*, **13** : (2), 133-138.

Aulakh, R.S.; Gill, J.P.S.; Johal, H.S.; Jugal, P.D. and Joshi, D.V. (1998). Haematological observations in *Theileria annulata* infected cross-bred cattle and their treatment with buparvaquone. *J. of Research, PAU*, **35** (1/2) : 86-88.

Avapal, R.S. and Kumar, A. (2003). Theileriosis in cross-bred calves and its treatment. *Indian Vet. Med. Jour.*, Vol. **27** : 371.

Bagherwal, R.K. (1989). Oxytetracycline (Telon LA) as chemotherapeutic agent against bovine tropical theileriosis in cross-bred cattle. *Indian Vet. J.*, **66** : 652-655.

Bandopadhyay, L.N.; Maity, B.; Bhandari, S.K. and Gupta, R. (1994). Studies on efficacy of some drugs against bovine theileriosis in field condition at Bethuadahari, Nadia, West Bengal. *Indian Journal of Anim. Health*, **33** : (1), 29-31.

Banerjee, P.K.; Guha, C.; Gupta, R.; Potdar, R.R. and Dutta, A.K. (1986). Studies on the efficacy of some anti-theilerial drugs with special references to halofuginone

lactate in clinical cases of theileriosis in cross-bred cattle. *Indian Vet J.*, **63** (3) : 237-241.

Banerjee, P.K.; Guha, C.; Samaddar, J.; Chanda, A. and Potdar, R.R. (1988). Efficacy of a new hydroxynaphthoquinone derivative, BW 720C (Buparvaquone) on clinical cases of bovine tropical theileriosis. *Indian Vet. J.*, **65** : 720-724.

Bansal, G.C. and Gaur, S.N.S. (1977). Note on biochemical changes in experimental bovine theileriosis. *Pantnagar J. of Research*, **2** (2) : 221-222.

Bansal, G.C. and Sharma, S.P. (1986). Efficacy of parvaquone and long acting oxytetracycline in *T. annulata* infection. *Vet. Parasitol.*, **21** (3) : 145-149.

Bulman, G.M.; Arzo, G.M. and Nassimi, M.N.(1979). An outbreak of tropical theileriosis in cattle in Afghanistan. *Tropical Animal Health and Production*, **11**:(1),17-20

Can, R.; Guler, S. and Bedemir, H. (1987). Treatment of tropical theileriosis by administration of halofuginone and tranexamic acid. *Veteriner Fakultesi Dergisi, Ankara Universitesi*, **34** (1) : 39-44.

Ceylan, E.; Agaoglu, Z.; Gul, Y.; Meral, I. and Dabak, M. (2004). Erythropoietin level and some blood parameters in cattle with tropical theileriosis. *Indian Vet. Journal*, **81** (5) : 584-585.

Chandel, B.S. (1982). A note on therapeutic value of garlic extract against *Theileria annulata* infection. *Indian Vet. Medical Journal*, **6** : (2), 107-108.

Dhar, S. and Gautam, O.P. (1979a). Observations on anaemia in experimentally induced *Theileria annulata* infection of calves. *Indian J. of Animal Sciences*, **49** (2) : 122-126.

Dhar, S. and Gautam, O.P. (1979b). Serum proteins in experimental *Theileria annulata* infection of cattle. *Indian J. of Anim. Sci.*, **49** (7) : 511-516.

Dhar, S.; Malhotra, D.V.; Bhushan, C. and Gautam, O.P. (1986). Chemotherapy of *Theileria annulata* infection with buparvaquone. *Vet. Rec.* **119** (25/26) : 635-636.

Dhar, S.; Malhotra, D.V., Bhushan, C. and Gautam, O.P. (1987a). Treatment of clinical cases of bovine tropical theileriosis with buparvaquone (BW 720C). *Indian Vet. J.*, **64** (4) : 331-334.

Dhar, S.; Malhotra, D.V.; Bhushan, C. and Gautam, O.P. (1987b). Chemoimmunoprophylaxis with buparvaquone against theileriosis in calves. *Vet. Rec.*, **120** (15) : 375.

Dhar, S.; Malhotra, D.V.; Bhushan, C. and Gautam, O.P. (1988). Treatment of experimentally induced *Theileria annulata* infection in cross-bred calves with buparvaquone. *J. Vet. Parasitology*, **27** (3-4) : 267-275.

har, S.; Malhotra, D.V.; Bhushan, C. and Gautam, O.P. (1990). Chemotherapy of different stages of

experimentally induced bovine tropical theileriosis with buparvaquone. *Indian Vet. J.*, **67** : 598-602.

Dinesh-Patel; Misraulia, K.S.; Reddy, A.G.; Garg, U.K.; Sharma, R.K.; Bagherwal, R.K. and Gupta, B.K. (2001). Effectiveness of artemether in induced bovine tropical theileriosis in cross-bred calves. *Indian Vet. Journal*, **78** (5) : 386-389.

Dumali, N.; Kelestimur, H. and Nizamlioglu, M. (1987). Haematological studies in calves experimentally infected with *Theileria annulata*. *Doga, Veterinerlik ve Havvancilik*, **11** (2) : 108-114.

Dwivedi, S.K.; Muslin, N.J.; Joshi, H.C. and Ahmed, N.J. (1984). Evaluation of chemotherapeutic agents against bovine theileriosis in Iraq. *Indian J. of Vet. Medicine*, **4** (1) : 37-40.

El-Magd, M.M.A.; El-Seifyi, M.A. and Salim, M.K. (1987). The effect of pan-terramycin (Oxytetracycline hydrochloride) on schizonts of *T. annulata* under Egyptian environmental conditions. *Assiut Veterinary Medical Journal*, **9** (37) : 196-200.

Erturk, E.; Laiblin, C. and Urman, H.K. (1976). A clinico-pathologic study on calves experimentally infected with *Theileria annulata* (Dschunkowsky and Luhs, 1904) Wenyon, 1926, *Veteriner Fakultesi Dergisi*, **23** (9/4) : 352-367.

Evplov, N.N. (1977). The therapy of theileriosis. Arakhnozy-I-protozoiny-bolezni-sel'skokhzyaistvennykh-zhivotnykh-Nauchnye-Trudy-VASKhNIL, 140-145.

Farah, A.W.; Soliman, F.A.; El-Din, H.Y.G. and El-Abdin, A.M.Z. (1999). Clinical changes in the blood of cattle vaccinated and infected with *Theileria annulata*. *Vet. Medical Journal, Giza*, **47** (2) : 255-266.

Fujimoto, W.; Kimura, K.; Suzuki, M.; Synto, B.; Onuma, M. and Iwanaga, T. (2004). Quantitative changes in serum concentration of bovine gut chitinase in *Theileria* infection. *Journal of Vet. Medical Science*, **66** (3) : 291-294.

Gautam, O.P.; Kalra, D.S. and Sharma, R.D. (1970). Theileriosis in exotic breeds and a Sahiwal calf. *Indian Vet. J.*, **47** : 78-83.

Gill, B.S.; Bhattacharyulu, Y. and Kaur, D. (1977). Symptoms and Pathology of experimental bovine tropical theilesiosis (*T. annulata* infection). *Annales de Parasitologie Humaine et Comparee*, **52** (6) : 597-608.

Gill, B.S., Bhattacharyulu, Y.; Kaur, D. and Singh, A. (1978). Chemoprophylaxis with tetracycline drugs in the immunization of cattle against *Theileria annulata* infection. *Int. J. Parasitol.*, **8** (6) : 467-469.

Gill, B.S.; Bhattacharyulu, Y.; Singh, A. and Kaur, D. (1984). Chemotherapy of bovine tropical theileriosis. *Theileria*

annulata infection. *Research in Vet. Sci,* **37** (2) : 247-248.

Guler, S. (1982). Halofuginone treatment of *Theileria annulata* infection in cattle. *Veteriner Fakultesi Dergisi Ankara Universitesi,* **29** (1/2) : 175-183.

Guralp, N. (1985). Two new drugs in the treatment of *Theileria annulata* infection in cattle. *Veteriner Fakultesi Dergisi Ankara Universitesi,* **32** (1) : 231-235.

Hang, Z.Z. (1987). Elimination of gametocytes of *T. annulata* of cattle by primaquin phosphate. *Vet. Parasitol.*, **23** (1/2) : 11-21.

Hashemi-Fesharki, R. (1991). Chemotherapeutic value of parvaquone and buparvaquone against *Theileria annulata* infection of cattle. *Research in Vet. Sci.*, **50** (2) : 204-207.

Hashemi-Fesharki, R. and Shad-Del, F. (1975). The therapeutic value of oxytetracycline hydrochloride (Terramycin) in cattle infected experimentally with *Theileria annulata. Archives-de-L'Institut-Razi, Iran,* **27** : 67-70.

Hedge, K.S.; Rahman, S.A. and Wajid, H.R.A. (1973). Treatment of theileriosis in cattle with Nivaquine. *Kajian Veterinarie,* **2** : 77-82.

Hooshmand-Rad, P. (1976). The pathogenesis of anemia in *Theileria annulata* infection. *Res. Vet. Sci.*, **20** (3) : 324-329.

Jagdish, S. (1977). Studies on certain aspects of *Theileria annulata* infection in cattle with particular references to chemotherapy and chemoprophylaxis and some serum enzyme changes. Ph.D. Thesis submitted to H.A.U., Hissar.

Jones, T.O. (1971). Treatment of East Coast fever. *Vet. Res.*, **88** : 316.

Kanaya, M. (1985). Studies on the diagnosis of theileriosis in cattle : Significance of reticulocytes. *Yamaguchi Journal of Veterinary Medicine*, **12** : 1-32.

Khalifa, K. and Kadhim, J.K. (1967). Unusual lesions in *Theileria annulata* infection in calf. *Vet. Rec.*, **81** : 76-78.

Khanna, B.M.; Dhar, S.; Gautam, O.P.; Gautam, O.P. (ed.); Sharma, R.D. (ed.) and Dhar, S. (1983). Chemotherapy of experimental *Theileria annulata* infection in bovine calves. Haemoprotozoan diseases of domestic animals. [Proc. Seminar (CwVA Asian-Australian regions) Haryana Agric. Univ., Hissar, India, 27 Oct. to 1 Nov. 1980]. 74-80.

Khanna, B.M.; Kharole, M.U.; Dhar, S. and Gautam, O.P. (1982). Histopathological studies in cerebral theileriosis of calves experimentally infected with *Theileria annulata*. *Indian J. Parasitol.*, **6** (1) : 91-94.

Kumar, S. Prasanna; Setty, D.R.L.; Yathiraj, S. and Kamalapur, P.N. (1988). Use of levamisole along with

oxytetracycline and supportive therapy for the treatment of theileriosis in cattle. *Indian Vet. J.*, **65** (7) : 634-637.

Laiblin, C. (1978). I. Clinical investigations in cattle experimentally infected with *Theileria annulata*. II. Haematological investigations, *Berl. Munch. Tierzartl. Wschr.*, **91** : 48-50.

Laiblin, C.; Baysu, N. and Muller, M. (1978). Clinical investigations in cattle experimentally infected with *Theileria annulata*. I. Clinico-chemical investigations of enzyme and bilirubin activity in blood. *Berl. Munch. Tierarztl. Wschr.*, **91** : 25-27.

Lal, H. and Soni, J.L. (1983). Auto-immune reactions associated with experimental *Theileria annulata* infection. *Indian J. Anim. Sci.*, **53** : (6) : 654-658.

Lal, H. and Soni, J.L. (1985). Erythrophagocytosis in relation to anaemia in acute *Theileria annulata* infection in calves. *Indian J. Anim. Sci.*, **55** (2) : 85-90.

Maisuradze-Dzh, G. (1975). Field trials of the chemotherapy and prophylaxis of theileriosis in cattle. Sbornik-Rabot-Leningradskii – Veterinarnyi-Institut., **40** : 62-66.

Mallick, K.P.; Dwivedi, S.K.; Srivastava, N.K. and Kumar, S. (1987). A report on the occurrence of haemoprotozoan infections in rural livestock. *Indian J. Parasitol.*, **11** (1) : 25-26.

McHardy, N. and Morgan, D.W.T. (1985). Treatment of *Theileria annulata* infection in calves with parvaquone. *Res. Vet. Sci.*, **39** (1) : 1-4.

McHardy, N.; Wekesa, L.S.; Hudson, A.T. and Randall, A.W. (1985). Antitheilerial activity of BW 720 (Buparvaquone) : a comparison with parvaquone. *Res. Vet. Sci.*, **39** (1) : 29-33.

Mehta, H.K.; Sisodia, R.S. and Misraulia, K.S. (1987). Efficacy of clexon in clinical cases of theileriosis. *Indian Vet. J.*, **64** (9) : 789-790.

Mehta, H.K.; Sisodia, R.S. and Misraulia, K.S. (1988). Clinical and haematological observations in experimentally induced cases of bovine tropical theileriosis. *Indian J. Anim. Sci.*, **58** : 584-587.

Mishra, K.C.; Achar, K.C. and Lama, N.D. (1983). Efficacy of some chemotherapeutic agents against clinical *Theileria annulata* infection in exotic cattle. *Indian Veterinary Journal*, **60** (4) : 313-318.

Mohanty, D.N.; Pradhan, R.K.; Dey, P.C. and Tripathy, S.B. (1983). Achromycin intravenous in the treatment of tropical theileriosis. *Livestock Advisor*, **8** (9) : 35-39.

Mohapatra, K.C. and Tripathy, S.B. (1986). Therapeutic efficacy of oxytetracycline hydrochloride in bovine theileriosis. *Indian Journal of Veterinary Medicine*, **6** (1) : 70-71.

Morgan, D.W.T. and McHardy, N. (1982). Comparison of the anti-theilerial effect of Wellcome 993C and halofuginone. *Res. Vet. Sci.*, **32** (1) : 84-88.

Morgan, D.W.T. and McHardy, N. (1986). The therapy and prophylaxis of theileriosis with a new naphthoquinone, Buparvaquone (BW 720C). Proceeding of 14th World Conference on diseases of cattle, Dublin, **2** : 1271-1276.

Muraleedharan, K.; Ziauddin, K.S.; Hussain, P.M.; Puttabyattappa, R. and Seshadri, S.J. (2005). Haematological observations on *Theileria annulata* infection in cattle and buffaloes. *Journal of Vet. Parasitology*, **19** (1) : 71-72.

Musisi, F.L.; Morgan, D.W.T. and Schels, H.F. (1985). Treatment of theileriosis with parvaquone in Zambia. *Vet. Res.*, **117** (13) : 338-339.

Narsimhamurthy, G.; Satyanarayan Reddy and Eswariah (1968). A case of theileriosis and its treatment. *Indian Vet. J.*, **45** (4) : 358-364.

Nayak, D.C. and Dey, P.C. (1991). Acute clinical theileriosis in a pure-bred Jersey cow and its successful treatment. *Orissa Veterinary Journal*, **16** (1-2) : 45-48.

Nirmal, Sangwan and Sangwan, A.K. (1999). Thiamine, riboflavin and ascorbic acid in relation to tropical theileriosis in cattle. *Indian Journal of Animal Sciences*, **69** (5) : 316-317.

Omer, O.H.; El-Malik, K.H.; Magzoub, M.; Mahmoud, O.M.; Haroun, E.M; Hawas, A. and Omar, H.M. (2003). Biochemical profiles in Friesian cattle naturally infected with *Theileria annulata* in Saudi Arabia. *Veterinary Research Communications*, **27** (1) : 15-25.

Omer, O.H.; El-Malik, K.H.; Mahmoud, O.M.; Haroun, E.M.; Hawas, A; Sweeney, D. and Magzoub, M. (2002). Haematological profiles in pure-bred cattle naturally infected with *Theileria annulata* in Saudi Arabia. *Veterinary Parasitology*, **107** (1/2) : 161-168.

Omer, O.H.; Haroun, E.M.; Mahmoud, O.M.; Abdel-Magied, E.M.; El-Malik, K.H. and Magzoub, M. (2003). Parasitological and clinico-pathological profiles in Friesian cattle naturally infected with *Theileria annulata* in Saudi Arabia. *Journal of Veterinary Medicine, Series-B*, **50** (4) : 200-203.

Otto, M. Radostits, Clive C. Gay, Douglas C. Blood and Kenneth W. Hinchcliff (2000). A textbook of the diseases of cattle, sheep, pigs, goats and horses : Diseases caused by protozoa. Veterinary Medicine, 9th edn : 1326.

Patel, D.; Misraulia, K.S.; Reddy, A.G.; Garg, U.K.; Sharma, R.K. and Gupta, B.K. (2001). Experimental studies on the efficacy of artesunate and oxytetracycline combination against induced BTT in cross-bred calves. *Indian Journal of Animal Sciences*, **71** (8) : 741-744.

Patil, N.A.; Lakshmaiah, K.R. and Harapanahalli, M.D. (1995). Efficacy of Butalex (Buparvaquone) in the treatment of clinical cases of bovine tropical theileriosis. *Indian Journal of Animal Research*, **29** (1) : 59-61.

Pipano, E.; Samish, M.; Kriegel, Y. and Yeruham, I. (1981). Immunization of Friesian cattle against *Theileria annulata* by the infection and treatment method, *Br. Vet. J.*, **137** (4) : 416-420.

Prem Sagar; Gupta, S.L.; Malhotra, D.V. and Sagar, P. (2002). Erythrocyte associated haemato-biochemical changes in cross-bred calves experimentally infected with *Theileria annulata*. *Indian Journal of Veterinary Research*, **11** (1) : 18-24.

Rafail, A.H. El. and Michael, S.A. (1976). The application of imidocarb diproprionate for the control of *Theileria annulata* infection in Egyptian cattle used for testing rinderpest vaccine. *Br. Vet. J.*, **132** (4) : 363-368.

Ramaiah, B. (1946). Bovine theileriosis, *Indian Vet. J.*, **23** : 470-471.

Rana, Y.S. and Dhar, S. (1993). Immunization of bovine calves against bovine tropical theileriosis by infection and treatment method. *Indian Vet. J.*, **70** (5) : 408-410.

Randhawa, S.S.; Nauriyal, D.C. and Singh, K.B. (1983). Atypical ocular lesions in theileriosis in cross-bred calves. *Indian J. Vet. Med.*, **3** : 99-100.

Rayalu, V.C. and Hafez, M.D. (1995). Haematological values in cattle infected with *Theileria annulata*. *Indian Journal of Animal Science*, **65** (11) : 1202-1203.

Sahu, P.K.; Misra, S.C.; Panda, D.N. and Mohapatra, M. (1996). Haematological and biochemical alterations in *Theileria annulata* infected cross-bred cattle. *Indian Veterinary Journal*, **73** (9) : 995-997.

Samish, M. and Pipano, E. (1978). Oxytetracyline in the immunization of cattle against *Theileria annulata* infection. [No. 236]. *Journal of Protozoology*, **25** (3) , Pt. 2, 15 B-168.

Sandhu, G.S.; Grewal, A.S.; Singh, A.; Kondal, J.K.; Singh, J and Brar, R.S. (1998). Haematological and biochemical studies on experimental *Theileria annulata* infection in cross-bred calves. *Veterinary Research Communications*, **22** (5) : 347-354.

Sen, S.K. and Srinivasan, M.K. (1937). Theileriosis of cattle in India. *Indian J. Vet. Sci.*, **7** : 15.

Sharma, L.D.; Sharma, N.N.; Sabir, M. and Bhattacharya, N.K. (1987). Clinico-haematological and biochemical changes in experimental *Theileria annulata* infection in cross-bred cow calves. *Indian Journal of Vet. Medicine*, **7** (2) : 154-156.

Sharma, N.N. and Mishra, A.K. (1990). Treatment of bovine tropical theileriosis with buparvaquone. *Tropical Animal Health and Production*, **22** (1) : 63-65.

Sharma, R.D. and Gautam, O.P. (1971). Theileriosis. II Clinical cases in indigenous calves. *Indian Vet. J.*, **48** : 83-91.

Sharma, R.D. and Gautam, O.P. (1975). Theileriosis in exotic cross-bred and indigenous cattle in India. *J. Remount. Vet. Corps*, **14** : 107-119.

Sharma, R.D. and Gautam, O.P. (1977). Theileriosis in cattle. *Indian J. Parasitol.*, **1** (2) : 87-91.

Shastri, U.V. (1989). Chemotherapy and chemoprophylaxis of *T. annulata* infection in cross-bred calves with Buparvaquone (BW 720C). *Indian Vet. J.*, **66** : 342-344.

Shastri, U.V. and Deshpande, P.D. (1986). Efficacy of Parvaquone (Wellcome 933C) against clinical *Theileria annulata* infection in cross-bred calves. *Indian Vet. J.*, **63** (5) : 414-418.

Shastri, U.V.; Deshpande, P.D.; Awaz, K.B. and Khedkar, P.M. (1982). Cutaneous lesions and some other unusual findings in cases of theileriosis in graded calves. *Indian Vet. J.*, **59** (3) : 188-190.

Shomein, A.M. and Obeid, H.M. (1973). Experimental treatment trial of *Theileria* species in cattle in Sudan. *Sudan Journal of Veterinary Science and Animal Husbandry*, **14** (2) : 65-70.

Singh, A.; Singh, J.; Grewal, A.S. and Brar, R.S. (2001). Studies on some blood parameters of cross-bred calves

with experimental *Theileria annulata* infections. *Res. Communications*, **25** (4) : 289-300.

Singh, B.; Anantwar, L.G.; Bhonsle, V.G. and Samad, A. (1980). Chemotherapeutic activity of oxytetracycline against clinical cases of *Theileria annulata* infection in exotic and cross-bred cattle. *Indian Vet. J.*, **57** : 849-852.

Singh, D.K.; Thakur, M.; Raghav, P.R.S. and Varshney, B.C. (1993). Chemotherapeutic trials with four drugs in cross-bred calves experimentally infected with *Theileria annulata*. *Research in Vet. Science*, **54** (1) : 68-71.

Singh, J.; Gill, J.S.; Kwatra, M.S. and Sharma, K.K. (1993). Treatment of theileriosis in cross-bred cattle in Punjab. *Tropical Animal Health and Production*, **25** (2) : 75-78.

Sinha, M. and Gunay, M. (1981). Erythrocytes, leukocytes, haemoglobin, PCV, total bilirubin and copper in the blood of splenectomized and intact calves inoculated with attenuated or virulent *Theileria annulata* schizonts. *Pendik Veteriner Mikrobiyoloi Enstitusis Dergist*, **13** (1) : 35-39.

Srivastava, A.K. and Sharma, D.N. (1981). Studies on the occurrence, clinical features and clinico-pathological and patho-morphological aspects of theileriosis in calves. *Veterinary Research Journal*, **4** (1) : 22-29.

Srivastava, P.K.; Agarwal, P. and Datta, A.K. (2001). Case report : efficacy of Berenil Reg.vet. 7% RTU (Ready to

Use) in cases of some blood protozoan disease. *The Blood Cross Book*, (17) : 43.

Srivastava, P.S. and Sharma, N.N. (1976). Note on bovine cerebral theileriosis in cross-bred calves. Pantnagar *Journal of Research*, **1** (2) : 147-149.

Srivastava, R.V.N.; Ray, D.; Lal, J.; Bansal, G.C. and Subramanian, G. (1987). Chemotherapeutic use of two indigenous drugs in infection of *Theileria annulata* in cattle. *Indian Veterinary Medical Journal*, **11** (2) : 106-107.

Sudhan, N.A. and Sinha, B.P. (1991). Effect of Berenil-Reverin combination on some haemato-biochemical parameters in clinical cases of bovine tropical theileriosis. *Journal of Vet. Parasitology*, **5** (1) : 55-57.

Sudhan, N.A.; Sinha, B.P. and Verma, S.P. (1987). Ocular involvement of calves in *Theileria annulata* infection. *Indian Journal of Vet. Medicine*, **7** (2) : 133-134.

Sudhan, N.A.; Sinha, B.P. and Verma, S.P. (1988). Haematological and biochemical changes in cross-bred calves infected experimentally with *Theileria annulata*. *Journal of Vet. Parasitology*, **2** (1) : 25-30.

Tanwar, R.K.; Kumar, A.; Yadav, J.S.; Sharma, S.N. and Lodha, K.R. (1984). Theileriosis (*Theileria annulata*) in indigenous Rathi calves. *Indian Journal of Animal Sciences*, **54** (1) : 118-120.

Thandaveswar, M.G.; Panduranga, G.L.; Rao, P.M. and Taranath, D.M. (1978). Allotriophagia (pica) in a cow associated with theileriosis. *Current Research*, **7** (9) : 151-152.

Tripathy, S.B. (1981). Observation on treatment of bovine theileriosis. *Indian Veterinary Journal*, **58** (1) : 66-71.

Unsuren, H.; Kurtdede, A. and Goksu, K. (1988). Effectiveness of parvaquone in cattle infected with *Theileria annulata*. *Tropical Animal Health and Production*, **20** (4) : 256-258.

Venkataraman, K.S. and Manickam, R. (1992). Theileriosis in cross-bred calves. *Indian Journal of Veterinary Medicine*, **12** (1) : 14.

Yadav, C.L. and Sharma, N.N. (1986). Changes in blood chemical components during experimentally induced *T. annulata* infection in cattle. *Vet. Parasitol.*, **21** (2) : 91-98.

****