EPIDEMIOLOGICAL STUDIES ON LAMB MORTALITY IN ANDHRA PRADESH WITH PARTICULAR REFERENCE TO CLINICO-THERAPEUTIC ASPECTS OF HELMINTHIC INFESTATIONS

By

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CERTIFICATE

Mr. **MADDALI PADMANABHA REDDY** has satisfactorily prosecuted the course of research and that the thesis entitled **"EPIDEMIOLOGICAL STUDIES ON LAMB MORTALITY IN ANDHRA PRADESH WITH PARTICULAR REFERENCE TO CLINICO-THERAPEUTIC ASPECTS OF HELMINTHIC INFESTATIONS"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university.

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This is to certify that the thesis entitled **"EPIDEMIOLOGICAL STUDIES ON LAMB MORTALITY IN ANDHRA PRADESH WITH PARTICULAR REFERENCE TO CLINICO-THERAPEUTIC ASPECTS OF HELMINTHIC INFESTATIONS"** submitted in partial fulfilment of the requirements for the degree of **"DOCTOR OF PHILOSOPHY"** of the Acharya N.G. Ranga Agricultural University, Hyderabad, is a record of the bonafide research work carried out by **Mr.MADDALI PADMANABHA REDDY** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All asistance and help received during the course of the investigations have been duly acknowledged by the author of the thesis.

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ABSTRACT

An epidemiological survey was conducted in eleven organised sheep farms in Andhra Pradesh to assess the extent of lamb mortality during the period from 1985 to 1994. Out of 17,157 lambs born 2266 lambs died accounting for a mortality rate of 13.2 per cent. The minimum mortality was 4.08 per cent at Composite Livestock Farm, Chintaladevi, while a maximum of 29.94 per cent was recorded at Livestock Research Station, Garividi. The maximum number of deaths (2.44%) occurred before attaining the age of two months. The mortality was higher (53.6%) in crossbreds, low body weight of dam at lambing and during summer (48.68%) season. Among the

aetiological factors infectious causes were responsible for 77.63 per cent mortality of which the main factors were pneumonia, parasitic enteritis, hepatitis, blue tongue and sheep pox which resulted in 48.54 per cent, 13.15 per cent, 8.43 per cent, 1.68 per cent and 5.83 per cent lamb deaths respectively. Starvation Mis-mothering Exposure (SME) complex and heat stress were found to be the major factors for causing death due to non-infectious and miscellaneous agents.

Lambs belonging to the Department of Animal Science, College of Veterinary Science, Tirupati and Tondavada village were screened for helmintihic infestations. A group of six lambs each suffering from haemonchosis, monieziasis, fascioliasis and mixed infection of haemonchosis and fasioliasis (group II, III, IV and V) having a mean EPG count of 1116.67 ± 64.18, 950 ± 31.17, 1033.33 ± 30.42 and 1300 ± 30.42 (haemonchosis 788.33 ± 33.40 and fasciola 516.67 ± 19.38) were treated respectively with morantel citrate @ 5.94 mg/kg, niclosamide @ 100 mg/kg, triclabendazole @ 10 mg/kg and closantel, a broad spectrum anthelmintic @ 0.1 ml/kg by oral administration. Six apparently healthy lambs free from helminthic infections were selected as healthy control (Group I). The EPG, haematological and biochemical investigations before and at weekly intervals for four weeks after treatment.

The infected lambs exhibited symptoms like anorexia, loss in condition, rough hair coat and in some cases of fascioliasis oedema of intermandibular or neck region. Body temperature and respiration rates were normal, while in some cases there was an increase in pulse rate. Anaemia as reflected by low haemoglobin, PCV, TEC, change in MCH and MCHC (7.22 ± 0.19 g%, 23.67 ± 1.17%, 7.47 ± 0.23 millions/cm, 9.72 ± 0.37 fl and 31.01 ± 1.91 pg in group V) leucopenia, lymphopenia, neutrophilia and

degrees were commonly observed in all the infestations. Hypoproteinaemia, low albumin and lower A/G ratio (5.12 ± 0.34 g/dl, 1.63 ± 0.16 g/dl and 0.47 ± 0.04 in group V) were observed in the infected lambs. There was an increase in serum amino transferases (AST 118.80 ± 6.19 units/ml and ALT 23.39 ± 1.63 units/ml in group V).

Treatment with group specific anthelmintics such as, morantel citrate against haemonchosis, niclosamide against monieziasis and triclabendazole against fascioliasis resulted in reduction in the faecal egg count to zero level by 7th day. Only in three animals of group III an EPG of 100 was recorded by 28th day which could be due to incomplete elimination of the parasite or re-infection. Closantel, a broad spectrum anthelmintic was also tried against mixed infection due to haemonchosis and fascioliasis. There was marked improvement in the clinical symptoms by 7th day after treatment with closantel. The symptoms completely disappeared by 14th day and the lambs became normal. The haematological, biochemical and serum enzyme changes of all the four groups came to normal i.e., similar to the values of healthy control group on the 7th day of treatment and the levels remained so till 28th day except in group V, where the serum total protein and globulin remained significantly higher and albumin and A/G ratio continued to be significantly lower than HC group. All the three specific anthelmintics i.e., morantel citrate against haemonchosis, niclosamide against monieziasis and triclabendazole against fascioliasis and the broad spectrum anthelmintic closantel against the mixed infection of haemonchosis and fascioliasis were found to be cent per cent effective.

LIST OF ABBREVIATIONS AND SYMBOLS

@	:	at the rate of
A:G	:	Albumin-to-Globulin (ratio)
ANOVA	:	Analysis of Variance
ALT	:	Alanine amino transferase
AST	:	Asprartate aminotransferase
AT	:	After therapy
BM	:	Banminth
BT	:	Before therapy
°C	:	Degree centigrade
DC	:	Differential Count
df	:	Degrees of freedom
dl	:	Decilitre
EDTA	:	Ethylene diamino tetra acetic acid
EX	:	Exinot
°F	:	Degree Fahrenheit
FX	:	Fasinex
fl	:	Femtolitre
g	:	gram
>	:	grater than
Hb	:	Haemoglobin
Hc	:	Healthy control
Kg	:	Kilogram
LSD	:	Least significant difference

<	:	Lesser than
MCH	:	Mean Corpuscular Heamoglobin
MCHC	:	Mean Corpuscular Haemoglobin Concentration
MCV	:	Mean Corpuscular Volume
Mg	:	Milligram
Ml	:	Milli litre
N	:	Normal
NX	:	Niclex
PCV	:	Packed Cell Volume
%	:	Per cent
pg	:	Picogram
pH	:	Negative logarithm of hydrogen ion concentration
ppm	:	Parts per million
SED	:	Standard Error of Deviation
SEM	:	Stndard Error of Means
spp	:	Species (pl)
TEC	:	Total erythrocyte count
TLC	:	Total leukocyte count
TSP	:	Total serum protein
w/v	:	Weight/volume
w/w	:	Weight/weight
≈	:	range
1/c	:	dilution of one in hundred, one time
1/M	:	dilutions (successions) of one in hundred, one thousand times
IU	:	International units

Dedicated to

The Lotus Feet of

LORD SRI VENKATESWARA

(BALAJI)

Introduction

CHAPTER - I

INTRODUCTION

Sheep were domesticated probably in the early neolithic age and referred in the first writings of Man and also in the early passages of the "Bible". In Sanskrit the word "avi" is used for sheep and it means to keep or to guard. Sheep raising was of Man's oldest profession (Mahanta, 1987).

Domestic sheep belong to "OVIS ARIES" group. There are many wild varieties of sheep "OVIS ORIENTALIS VIGNEI" in the mountains from Afghanisthan to America and they were probably the ancestors of the domesticated sheep of India. The inhabitants of Mohanjo-daro and Harappa possessed domesticated sheep.

Sheep are important species of livestock in India due to their multifaceted utilization for production of milk, meat, wool and other by-products such as manure, animal casings and offals. Sheep rearing contribute significantly to the agrarian economy especially in areas where crop and dairy farming are not economical and it plays an important role in the livelihood of a large proportion of small and marginal farmers and landless labourers (Acharya, 1982).

Sheep can be easily domesticated and one person can care for a large flock. Their hardy nature enables to thrive well on shrubs, leaves and forage of low nutritive value and thus their farming is usually economical in arid, semi-arid and hilly regions of the Country, where crop farming is difficult and naturally available feed resources are scarce. The

modern view of the sheep is that it is a very smart cookie indeed, capable of single-trial learning and using tools (Geoffrey Hutson, 1996).

Of the total world population of 1081.290 million sheep, India possesses 44.810 million accounting to 4.14 per cent of the world sheep population (FAO, 1996). It was 52 million in 1987 indicating a decline in the sheep population. On the contrary, in Andhra Pradesh a 13 per cent increase in sheep population was seen during the period from 1987 to 1993. According to the 15th quinquennial livestock census in the state, the sheep population was 6.87 and 7.77 million in 1987 and 1993 respectively. Andhra Pradesh stands second and next to Rajasthan in India in terms of sheep population.

During the recent years, sheep rearing gained more popularity and well organised sheep farms have come into existence. One of the major constraints for the sheep industry is the lack of information on various causes and data of lamb mortality and appropriate health cover package in different parts of the country. More intensified work has to be carried out to minimise the lamb mortality.

Lambs are susceptible to several biotic and abiotic stresses that affect their health. Particularly helminthiasis is a serious threat to the health of lambs under field conditions causing decline in sheep population. Helminthiasis in general is insidious in nature with prolonged residual effects and some times without any spectacular clinical manifestations. Though mortality is uncommon due to helminthiasis, lambs with high worm burden together with poor nutrition might occasionally succumb to the disease and donot obtain the required body weight leading to substantial loss in the productivity.

Among endoparasitic infections haemonchosis, monieziasis and fascioliasis are of much concern in adult sheep and lambs. For treatment of these infections in the recent past several chemotherapeutic agents such as albendazole, mebendazole, thiabendazole, fenbendazole, levamisole, hexachloroethane, niclosamide, morantel, pyrantel, closantel, ivermectin etc., have been tried. However, drug resistance developed by the parasites often limits repeated use of a single anthelmintic and thus there is a need for alternate drugs and management practices to control helminthiasis and mortality in lambs.

Oral solution of Exinot (closantel), the new salicylanilide molecule has been introduced into the Indian Market recently by M/s Cadila Pharmaceuticals Private Limited, Ahmedabad and its broad spectrum antiparasitic effects in sheep and other livestock have been claimed. Detailed study regarding its anthelmintic efficacy against haemonchosis, moneziasis and fascioliasis in lambs on one hand and the efficacy of the specific anthelmintic drugs like Banminth (M/s Pfizer limited, Bombay) , Niclex (M/s Alved Pharmaceuticals Pvt. Ltd., Madras) and Fasinex (M/s Hindustan Ciba-Geigy limited, Bombay) against haemonchosis, monieziasis and fascioliasis respectively on the other hand has been taken up for comparative evaluation of the broad spectrum anthelmintic activity as compared to the activity of specific anthelmintic drugs.

Normal blood values would be always altered to some extent by the influence of parasitism (Schalm *et al.*, 1975). Reports are available in literature on certain haematological and biochemical changes due to parasitism in sheep (Lapage 1956, Sahai 1966, Pachlag *et al.*, 1973 and Rao 1992). Monitoring of biochemical changes in parasitic infections is of great significance in assessing the chemotherapeutic value of anthelmintics (Bhat *et al.*, 1987). The present study was therefore, undertaken to investigate the

epidemiological survey on lamb mortality during January 1985 - December 1994 (ten years) in organised sheep farms in Andhra Pradesh and also haematological and biochemical changes in lambs infected with helminthiasis before and after the treatment with anthelmintics in and around Tirupati, to study the above mentioned and other correlating factors. The objectives of the present investigation are:

1. Epidemiological survey of lamb mortality in Andhra Pradesh in certain organised sheep farms from the available records.
2. Epidemiological data pertaining to helminthic infestations in lambs during the current period of study and to carry out faecal sample examination and selected clinical cases based on EPG.
3. To study the efficacy of certain specific anthelmintics for the treatment of clinical cases of haemonchosis, monieziasis and fascioliasis in lambs.
4. To study the efficacy of broad spectrum anthelmintic (closantel) in mixed helminthic infections in lambs and compare it with specific anthelmintics.
5. To find out the haematological and biochemical changes before and after therapy.

Review of Literature

CHAPTER - II

REVIEW OF LITERATURE

2.1 EPIDEMIOLOGY OF LAMB MORTALITY

The earth sustains one billion sheep and the economic benefit of it is being utilised by the mankind. Although widely distributed in the nations, these animals are numerically concentrated in Australia, Russia, Newzealand, Argentina, South Africa, Turkey, Iran, India, Brazil and the United States of America (Ruejensen 1974)

Lamb mortality is one of the major problems for the sheep raising enterprises around the world. Many commercial sheep farmers do not record either the extent or the causes of lamb losses but this information is essential if the losses are to be reduced in future. The major causes of death in newly born lambs are reviewed together with the common predisposing factors. The development and practical application of a simple system for recording lamb mortality has been desired, initiated, supervised and interpreted by the clinicians. Few research works were undertaken as to how to reduce the loss of lambs by improving management and health programme (Eales *et al* 1986).

Various workers have reported the incidence of lamb mortality due to different causes including helminthic infection. clinical manifestations, haematological and biochemical changes in lambs suffering from helminthic infection were also reported.

2.1.1 INCIDENCE IN RELATION TO

2.1.1.1 Status of dam

Moule (1953) observed that the two important intrinsic factors influencing the survival of lambs on condition of ewe's udder and their mothering ability. It was suggested that there was an association between abnormal udders with uneven teats and lamb mortality.

From Australia, Alexander and Peterson (1961) reported that inadvertant undernutition of the ewes during the last few weeks of pregnancy appeared to contribute the poor vigour of the lambs.

Mc Donald (1962) revealed that nutritional status of the ewes had a profound influence on lamb survivability. According to him undernutrition during pregnancy affected the rate of growth and size of the lamb and also predisposed to the incidence of pregnancy toxaemia in ewes, based on his study in Newzealand.

Dennis (1970) carried out a pioneering work on lamb mortality and stated that mastitis and faulty udder contributed to lamb mortality over to some extent. According to him, death due to starvation was as high as 12.4 per cent.

Mahajan and Acharya (1980) reported that body weight of ewe at lambing affect the preweaning lamb survivability.

Dumon and Seegers (1984) reported that the diet of pregnant ewes during the winters of 1980/81 and 1981/82 were too rich in energy and nitrogen during the first

half of gestation and rather deficient at the time of gestation. Lamb mortality was correlated with dietary energy given just before lambing and vitamin-A content of colostrum. Mortality during first 24 hours averaged 5-7 per cent in natural suckling lambs but 11 per cent in artificially fed lambs.

Dohoo *et al* (1985) reported that the importance of parasitism in ewes may be inadequately recognised at the farm level.

Olson *et al* (1987) studied the effect of cold stress (0^{o} and - $10^{oC)}$ in pregnant ewes during the last weeks of gestation and in their progeny up to 3 days old. According to their findings in general, ewes were unaffected by treatment where as there were changes in the stressed lambs. Cold-induced changes in lambs included physical weakness, depression and poor nursing response. The mortality rate was 40 per cent in stressed lambs and 10 per cent in lambs kept at warmer temperature.

2.1.1.2 Age

Alexander *et al* (1955) observed 421 lambings in Australia among Merinos and reported that 51 were either born dead or died with in the first month after birth.

Safford and Hoversland (1960) analysed that the mortality among 1051 lambs that died during the period from birth to weaning. The authors have recorded death rate of 23.5 per cent at Montana Agricultural Experimental Station, U.S.A.

Vetter *et al* (1990) studied pre-weaning losses in England and reported an average lamb mortality of 23 per cent.

Alexander and Peterson (1961) in their study on lambings in 52 ewes reported that 6 lambs died during birth and 15 lambs within 2 days after birth.

Dawes and Parry (1965) during course of their investigation in England noticed that 10-12 per cent of perinatal mortality occurred among full term lambs, 20.5 per cent among lambs in advanced stage of pregnancy.

Grommers (1967) reported that the incidence of still births or those that died within 24 hours after birth as 6.7 per cent among 343 lambs.

Singh and Singh (1970) reported that out of 438 Rambouillet lambs, 15 per cent were born dead and another 22 percent though born alive but died subsequently with in 16 weeks.

Dennis (1970) indicated that in Australia out of 133 lambs, a total of 62.2 per cent succumbed during a three years period. From among them, 5 per cent died antepartum, 85 per cent postpartum, immediately following postpartum 19 per cent, 2 per cent delayed postpartum and 22 per cent late postpartum.

Hughes *et al* (1971) reported that the percentage of postparturient deaths was as high as 50 per cent.

Houston and Maddox (1974) reported that mortality due to still births aggregated 22 per cent of the total lamb mortality among Scottish Black face lambs.

Juma *et al* (1974) observed that more losses occurred during first month (44.4%) and nearly 71.4 per cent of the total losses occurred before they were weaned.

Kirk *et al* (1985) recorded that most deaths after a few days of birth in the lambing sheds or in perns out side the shed. Cost benefit analysis revealed that the veterinary services cost 2.2-3.9 per cent of the gross returns from the sale of the lambs.

Theriez and Villette (1986) studied relationship between the lamb survival and behaviour during first hour after birth and determined that high risk lambs were those born after difficult parturition which needed aid, those from old ewes (6 years or more) and those with low birth weight as a result of high litter size. During the first hour of life, high is lambs tended to be inactive and did not stand up for atleast 30-60 minutes after birth and frequently later. Their body temperature fell to 38^0C. Their blood IgG level was low (10g /litre or less) Early bottle - feeding of these lambs with colostrum was beneficial.

Gurmez Singh *et al* (1987) studied the lamb mortality and its causes under farm conditions in semi arid tropics. The lamb mortality up to weaning at 90 days of age under AICRP on sheep breeding for fine wool at CSWRI was studied. Age group wise mortality was highest in the first week (8.5%) of life, decreasing linearly during 8-30 (3.9%) 31-60 (2.2%) and 61-90 (2.1%) days of age.

Ajit Maru *et al* (1987) studied the pattern and causes of lamb mortality in the housed sheep flocks of different breeds of central sheep and wool research institute, Avikanagar, Rajasthan for a period of four years. The author revealed that 2.35 per cent of all lambs born died with in two days of birth, 2.04 per cent of lambs died between 30-90 days after birth, 2.13 per cent of lambs died due to weakness and exposure. Death during post-natal period (< 2 days) due to weakness and exposure (1.5%) was the largest single cause of lamb loss. The over all lamb mortality was 6.39 per cent. The

authors also claimed that this study was useful in evolving preventive measures to decrease lamb loss through mortality.

Tuah *et al* (1987) studied that 54 lambs (West African Dwarf x West African Long legged ewes) of which 9 died with in 72 hours of birth. Neonatal morality was affected ($P< 0.05$) by lamb birth weight (highest in lambs) weighing (1.6-2.0 Kg.) but not only age of ewe, parity, type of birth (single or twin) or sex of lamb.

2.1.1.3 Sex

Bins et al (1963) reported that congenital malformation varied from 1 to 25 per cent.

Dennis and Nairn (1965) encountered two cases of congenital diaphragmatic hernias in Australian Merino sheep.

Singh and Singh (1970) observed that lamb mortality was not affected by sex.

Ercanbrack and Price (1971) observed various birth defects that contributed to the mortality such as crooked legs, hairy birth coat, bilateral cryptorchidism and still births.

Dennis (1972) stated that liver rapture was higher in males than in females during a course of study for three years.

Dennis and Leipold (1972) reported that congenital hernias were more in males and contributed to a mortality of 0.5 per cent.

Kabuga and Akowuah (1990) studied the relationship between minimum temperature and cumulative rainfall on lamb mortality. Birth weights of both males and females were positively and significantly associated with minimum temperature and cumulative rainfall in 2 - and 3 - months period prior to lambing respectively.

Sudan *et al* (1990) studied the effect of year, month, sex and breed on lamb mortality in 787 lambs during 1984-86 maintained under identical conditions. Sex of the lambs had no effect on mortality.

Yapi *et al* (1990) studied the effect of genetic and environmental factors on lamb mortality and observed that sex of lamb showed a moderate or non significant effect on lamb mortality.

Otesile (1994) investigated the incidence and aetiology of mortality among West African Dwarf (WAD) lambs aged 31 to 180 days. The mortality rates for male lambs (21.9%) and females (25.5%) were not significantly different.

2.1.1.4 Breed

Gunn and Robinson (1963) discussed lamb mortality in terms of the breed. According to them, mortality was 12 per cent and 6 percent in the Cheviot and Blackface respectively.

Shelton (1964) reported that crossbred lambs namely Rambouillet ewes x suffolk, Rambouillet x Dorset rams had 3.7 per cent less death losses than other straight Rambouillet lambs.

Pachlag *et al* (1974) reported that there was no difference in mortality between Rambouillet x Chokla and Rambouillet x Malpura crosses.

Rama Rao *et al* (1980) analysed the data available for over two decades (1958-1979) to throw light on the probable causes on lamb mortality in Andhra Pradesh. A total of 6934 tissues from 2008 lambs of different breeds that were received mainly from organised sheep farms formed the basis for the study. No difference in mortality with respect to sex and breed was noticed. The mortality was more in Nellore breed.

Vermorel and Vernet (1986) reviewed the thermogenesis in the new born lamb and the factor affecting it and observed that thermogenesis and cold resistance vary between breeds due to difference in thermolysis related to birth coat type especially the first hour of life and in hormonal status.

Jagatap *et al* (1989) studied that the influence on nongenetic factors on daily weight gain during different periods of age from 0-12 months in Deccani and its crosses with Dorset and Marino and recorded highest daily weight gain over 0-3 months while it was lowered by 0.5 to 0.25 after 3 months age.

Sudan *et al* (1990) studied the effect of year, month, sex and breed on lamb mortality in 787 lambs during 1984-86 and maintained under identical conditions. Improved management practices such as feeding and care during night lambing were probably responsible for the decrease in over all mortality from 72 per cent in 1984 to 26 per cent in 1986. Fewer corriedale than south down or polled Dorset lambs died. More death occurred in February and June and the major causes of death were pneumonia (51%), preumoenteritis (18.6%) and enteritis (18%).

Yapi *et al* (1990) studied the effect of genetic and environmental factors on lamb mortality. According to them the breed types included in the study were Dorest, Finnish Landrace (FL) Lincoln, Rambouillet, Suffolk, Targhee, 3 synthetic lines and crosses among Dorset, FL, Lincoln and Rambouillet. Two of the synthetic lines were FL crosses with 50 and 25% FL inheritance. Lamb mortality was defined as discreet score, normalised score, mortality at birth of all lambs born and mortality of weaning of all live born lambs. The effect of year of birth, birth weight and breed type of lamb were important ($P<0.01$) sources of variation for all expressions rate of lamb mortality. FL lambs had the lowest mortality rate in soffolks had the highest. The two synthetic lines from FL sheep had good lamb survival and ranked next to FL sheep. Heterosis, general combining ability, specific combing ability and maternal reciprocal effect were not important factors in lamb mortality.

Nevertheless, crossbred lambs were better than pure bred lambs with - 10.3 per cent and -18.7 per cent heterosis for mortality at weaning of all lambs born and all live born lambs respectively. FL x Dorset and Lincoln x Rambouillet crosses had the biggest lamb survival among crossbreds.

Hooda and Naqvi (1991) investigated the relative heat tolerance of native and cross bred sheep during Ad-libitum and restricted feeding in Malpura, Avikalin (RXM) and mutton synthetic (DXM) sheep, when exposed to thermal stress in a hot climatic chamber maintained at 40 ± 1^0C for 6 hours per day. Sweating increased due to feed restriction. The result indicated that cross bred sheep were physiologically less heat tolerant when given restricted feeding.

Kulkarni and Deshpande (1991) studied the birth weights in Deccan sheep and its crosses with exotic breeds and observed that grade, year of lambling and parity at lambling had highly significant influence on birth weight but reasoning of lambling had nonsignificant influence on birth weight.

Jagtap and Bansod (1994) reported that the efficacy of meat production is governed by growth rate and stage of fastergain in body weight. They studied the performance of Merino half breds in terms of daily gain in body weight per hundred kilogram (DNPH Kg) at various periods of growth and the influence of several nongenetic factors on these traits. They concluded that over all daily gain per 100 kg body weight of Merino half breds for ten periods. It was in increasing order from period 1 to 4 and decreasing in periods 5 to 7 and 9 to 10.

2.1.1.5 Season

Davis (1964) observed that losses in single lambs were higher in winter than in autumn and spring. Haughey (1973) reported that cold injury to lambs was more severe during autumn.

Pachlag *et al* (1974) stated that seasonal variations in Rambouillet and its crosses resulted in heavy losses during autumn as against spring.

Juma *et al* (1974) recorded that lambs those were born during summer suffered the heaviest mortality rate. They concluded that lambs born during November had higher survival chance than those born early or late in the year.

Rama Rao *et al* (1980) reported that lamb mortality patterns of different regions of Andhra Pradesh varied during different quarters of the year. Mortality of the lambs died during I (25 70%) and II quarters (39.99%)s with least mortality in III quarters (14.99%).

Kabuga and Akowuah (1990) studied the relation ships between month and climatic factors rain fall, ambient temperature, relative humidity (RH) and temperature humidty index (THI) with relation to the time of parturition, litter size, birth weight and preening mortality in Djal lonke and Djal lonke x Sahelian sheep. Births (4142) all year around although there were significant differences in the number of births per month. Peak conception occurred in the early parts of the major rainy season. There were also significant differences in birth weights and mortality per cent per month. Maximum and minimum values (of birth weights and mortalities) occurred on the later part of rainy seasons and dry periods respectively.

Sekar *et al* (1991) observed that lamb mortality at the sheep breeding research station, Sandynallah, Nilgiris was analysed over a period of 10 years. Mortality during the month of March was high (20.1%) which was due to lambing season and in June (15.2%) due to mansoon and weaning stress.

2.1.2 INCIDENCE IN RELATION TO AETIOLOGY

2.1.2.1 Non-infectious causes

Klenibok *et al* (1960) reported that 54 to 64 per cent of all deaths were due to non infectious causes.

Barr (1964) recorded a major out break of hypomyelinosis that accounted for a morbidity rate of 13 per cent accompanied by high mortality.

Darcel *et al* (1964) reported an out break of 'trembling' in a flock in Western Canada chorei form of twitching and shaking of the heads in young lambs associated with high mortality. They also observed fatak ataxic gait due to defective myelination which was not attributable to avitaminosis.

Dennis (1969) observed that the major cause of loss was neonatal starvation (2047) and 57.8 per cent of these carcases were mutilated after death. They examined 4417 lambs and revealed that damage by predators (mainly foxes) could be readily classified by post-mortem than examination into predation or mutilation.

Osburn *et al* (1972) stated that unthrifitness hairy fleece and termors were responsible for lamb mortality of 2 to 4 per cent.

Houston and Maddox (1974) reported that starvation was the main cause of lamb losses The authors also mentioned that during two consecutive lambing seasons, 282 young lambs died from 10 hill station farms. Still birth accounted for 22 per cent of the deaths but no diagnosis was arrived at for 60 per cent of the cases. Since visible fact reserves were absent in 120 of the 169 'no diagnosis' it appears that starvation was the main cause of death.

Wensvoort and Herweijer (1975) stated that the epidemilogical circumstances, hepatitis occurred in lambs in North Holland province was believed to be infectious rather than toxic.

Eales and Gilmour (1982) identified the causes of hypothermia in 89 lambs on the basis of history and clinical biochemistry. Excessive heat loss accounted for 24 per cent of the cases and depressed heat production because of either severe hypoxia during birth, immunity or starvation accounted for 72 per cent.

Gumbrell (1985) identified that dystocia and starvation (or exposure) were responsible for most of the deaths in lambs in 2420 from 24 flocks.

Heath (1985) observed the mortality rate 3.5 per cent in 57 lambs injected S/c with 12.5 ml of serum on each side thorax at 24-36 hours of age and 14 per cent in 57 controls.

Krishna (1985) found that a higher incidence of mortality in habdomadal period (0-1 week) and during lambling and kidding seasons were attributed to the persistent intra-uterine infections along with stress and poor nourishment of dams infections along with stress and poor nourishment of dams while the fatal deaths in form of still and premature births were due to fetal lesions coupled with placentitis. The absorption of toxins or toxic products released by the organisms were thought to be a cause of early embryonic deaths.

Wensvoort (1986) reviewed the circumstances under which hypothermia lambs are found an Dutch sheep farms and observed that besides cases of low temperature due to exposure - starvation complex an ideopathic variant is encountered and concluded that there is a line between Juvenile adipose tissue and cold resistance.

Schoving and Sagartz (1986) stated that the major causes of death during the first week of life were failure to suck, congenital defects, congenital atelectasis and birth trauma

Barlow *et al* (1987) diagnosed that rectal temperature, birth weight and plasma concentration of fructose, insulin, throyxine and the third component at births and the weight at four months of age decreased with litter size. A correlation of the diagnosis deduced from clinical data with those made postmortem suggests that antenatal influences which result in constitutional weakness may lead to deaths in the postnatal period only a portion of which are accompanied by morphological changes.

Riesenfeld *et al* (1988) studied the influence of radiant heat stress on respiratory water loss in new born lambs and observed the signs of heat stress with an increase in respiratory water loss not accompanied by increase in oxygen consumption or carbondioxide production

Baker and Britt (1990) investigated the common causes of death in North Ronaldsay lambs were trauma due to behavioural patterns and starvation and hypothermia due in part to poor condition of the ewes.

Bekele *et al* (1992) explained that starvation mismothering exposure (SME) complex, abomasal impaction and physical injuries to be important constraints on productivity. They also estimated that neonatal mortalities were 51.5 per cent and 46.3 per cent on farms and on station respectively.

Kielsgaard (1992) discussed about the effects of parturition, maternal behaviour, litter size, hypothermia damage to the central nervous system and hypoxia on perinatal lamb mortality.

Green and Morgan (1993) studied the disease in lambs in 3 early lambing (housed) flocks, a total of 428 of 4413 (9.7%) lambs died. They observed that the most frequent abnormality was subscapular liver rapture (9.3-20.9 per 1000) with up to 60% of affected lambs also having signs of malpresentation. (Subcutaneous edema of neck) Early post-partum deaths (12.9-31.5 per 1000) were primarily associated with starvation.

2.1.2.2 Infectious causes

Kleinbok *et al* (1966) revealed that 13 per cent of lambs died due to pneumonia and lung defects.

Gray (1966) identified that Laikipia Lung Disease(L.L.D.) and Jaagsiekte were the major causes of lamb pneumonia and mortality in Kenya.

Stamp (1967) reported that viral bacterial and protozoa infections of the uterus, placenta, maternal influences, nutrition of the ewe and pregnancy toxaemia played an important role for lamb mortality

Broadbent (1972) identified that Listeria monocytogenes is an ubiquitous organism known to cause disease in many species of animals and in man. Listerial infection in the pregnant ewe may result in abortion of birth of weak, nonviable lambs, depending on the stage of gestation when infection occurs. Listeriosis causes ovine perinatal loss in victoria more frequently than has been thought previously. The abortion rate ranged up

20 per cent and neonatal mortality varied between 7 per cent and 33 per cent of lambs born.

Bhagwan and Singh (1972) examined 800 goats and 113 sheep slaughtered at three different places and observed that out these 170 and 35 cases respectively were affected with pneumonia.

Harris (1974) reported that pasteurellosis was the major cause of death among 150 lambs investigated.

Pachlag *et al* (1974) stated that preumonia contributed to a mortality of 43.05 per cent among Rambouillet sheep under semi arid conditions of Rajasthan.

Gillian Harris (1974) investigated an outbreak of pasteurelloses in lambs of about six month old, in which stressful changes could be associated with each case.

Korikov (1974) identified that lamb pneumonia was a serious problem on many sheep farms in the Soviet Union, after affecting 30-40 per cent of lambs and some times resulting in lesses between 40 percent and 70 per cent and concluded that the best approaches for prevention were attention to management (particularly from adverse environment factors).

Rama Rao *et al* (1980) analysed the data available for over two decades (1958-1979). The authors observed that pneumonia was observed in 58.38 per cent of the lesions in the lungs. No difference in the incidence of pneumonia was noticed between the sexes and majority occurred during I and II quarters with least incidence in III

quarter. Nellore breed suffered more and the least was Mandya. Enteritis was next common lesion.

Shrivastava *et al* (1983) concluded that pneumonia was a major contributory factor for lamb mortality. Grazing alone in natural pastural of hot-arid region without any supplimentary feeding is likely to precipitate heavy mortality in lambs.

Beverids *et al* (1985) stated that nematode infections were considered to be a predisposing cause with anaemia possibly due to infection with eperrythrozone ovis as the precipitating factor in mortalities.

Malone *et al* (1985) recorded that pasteurella pneumonia caused 33.7 per cent in the first year and 24.8 per cent in the second and urolithiasis caused 18.6 per cent of deaths in the first year 37.6 per cent in the second, in an intensive lamb fattening unit.

Purvis *et al* (1985) emphasized that during the period (1976-79) the size of the flock in Berkshire increased from 400 ewes in 1976 to 567 in 1979, lamb mortality was 11-12 per cent in 1979 and 1977, 18 per cent in 1978 and 21 per cent in 1979.

Schoving and Sagartz (1986) stated that the major causes for the 1-to-4 week period were bronchopneumonia, enteritis and starvation and after 4 weeks bronchopneumonia and enteritis, especially enteritis due to coccidia.

Trigo and Martinez (1986) investigated that pneumonia was the cause of death in 53 (28%) of 191 lambs at the state sheep centre.

Gurmez Sing *et al* (1987) studied the lamb mortalities and its causes under form conditions in semi-arid tropics The authors concluded that 556 carcasses examined at necropsy for gross pathological lesions, about one-quarter of lamblosses were due to septicaemia (23.9%) with almost similar proportion due to starvation/low birth weight (21 8%) followed by pneumonia (12.4%), enteritis (11.9%), dehydration/debility (7.4%), sheep pox (6.1%), internal haemorrhage/toxaemia/peritonitis (8.3%) and miscellaneous causes (8.3%)

Singh *et al* (1987) described that main causes of mortality were septicaemia, starvation or low birth weight, pneumonia and enteritis accounting for 23.9, 21.8, 12.4 and 11.9 per cent respectively of births

Muslin *et al* (1988) recorded highest incidence of internal parasites (69.28%) which included gasthointetinal parasites (37.14%), gastrointestinal parasites with ***lung worms*** (17.26%), ***lung worms*** (11.32%), ***moniezia*** (2.84%) and ***fasciola*** (0.72%) followed by protozoan infections (7.53%).

Sreeramulu (1988) surveyed the lamb mortality in Andhra Pradesh in lambs upto 6 months of age, between 1972-1982. The author concluded that the incidence of pneumonia was highest in February to May and was higher in crossbred lambs 11.8-20.6 per cent compared to native breeds 3.4-3.8 per cent.

Chaarani and Robinson (1988) carried out the epidemiological study of lamb mortality in Morocco 1984-86 and observed that enteritis and septicaemia were also important causes for lamb mortality. *E. coli* was isolated from 18.5 per cent and 63.2 per cent of enteritis cases and 0 per cent and 38.5 per cent of septicaemia cases.

Clarkson (1989) reported that the cost of a control scheme based on prevention of snail infection by fasciola hepatica by treating 1800 ewes grazed on fluke - infected river line land with four treatments/ewe of ***triclabendazole*** is compared with the cost on leaving the sheep untreated It is estimated that if sheep were not treated three would be a total loss of £ 8272 per annum due to reduction in lamb carcass and fleace weights (this is a conservative estimate mortality, liver condemnation and the effect of immature flukes are ignored) where as treating the sheep could cost only £ 864 per annum.

Dubey *et al* (1989) recorded the causes of lamb mortality under field conditions in the semi-arid region of Rajasthan Out of 4570 lambs, 876 (18.4%) aged up to 1 year were died Mortality rate was 22.2 per cent in crossbred and 16.5 per cent in native lambs respectively The main causes of death were pneumonia (4.86%), FMD (2.54%) parasitic gastroenteritis (2.33), perinatal deaths (1.85%), debility (1.66%) and septicaemia (1.32%) and miscellaneous diseases such as bloat, impaction and piroplasmosis (2.9%). The pattern of mortality was similar in native and crossbred lambs.

Bird (1989) stated that 10 per cent of lambs die from disease from every year, the major causes of loss caused by abortion and parasitic infections.

Sudan *et al* (1990) observed that the most of the lamb mortality occurred in February and June and major causes of death were pneumonia (51%), pneumoenteritis (18.6%) and enteritis (18%).

Bekele *et al* (1992) studied the neonatal mortality in Ethiopian high land sheep and reported that the major causes of mortality were pneumonia (21.2%), enteritis (15.2%), and other (18.1%) as recorded in the postmortem examination of 33 lambs.

Fitzgerald *et al* (1993) investigated an out break of neurological disease in a flock of 5 months old Rambouillet lambs in Indiana (USA), clinical signs included anorexia, weight loss, loss or coordination, shift lamb, trembling and general weakness. During a 4 week period in summer 1990, 32 of 48 lambs in one pen were affected with this neuogicial disorder and of these 22 died and the authors concluded that the mortality was due to sarcocystosis with involvement of the central nervous system in lambs.

Hovers *et al* (1994) noted that the hepatosis dietetice (Vit.E deficiency) in lambs as a cause of death

Manohar *et al* (1995) reported that 5 5 - 33 3 per cent of lamb deaths were due to an attack of Rift valley fever like disease in Tamilnadu, India.

Pekelder and Clarkson (1995) observed that indurative lymphocytic mastitis caused due to maedi-visna virus resulted lamb mortality relatively low at 10 per cent but 50 per cent of post natal mortality was attributed to agalactia caused by lymphocytic mastitis is the principle feature of maedi-visna virus infection in Texel sheep resulting in a reduced prewaning growth of lambs.

2.1.2.3 Miscellaneous causes

Vihan *et al* (1982) evaluated that various factors influencing mortality in lambs up to one year of age. The author concluded that the mortality in lambs could be reduced considerably provided management pays special attention to feeding of pregnant ewes for ensuring better birth weights, better milk flow and provision of warm shelter during nights in the cooler part of the year.

Yeoman (1983) explained the copper in relation to lamb losses by manu-whitney 'U' test According to the author the mean liver copper content of all the lambs from undosed ewes 44 ppm dry matter and that of the lambs from dosed ewes 99 ppm dry matter, a highly significant difference ($P<0.001$)

Blain *et al* (1984) analysed the extent and causes of mortality in lambs and concluded that following environmental factors were responsible for lamb mortality. Temperature, humidity, state of ventillation and the presence of noxious gases (NH3, Co2) in the atmosphere factors following respiratory disease. High density of lambs in the pens and the condition of litter are also discussed as factors affecting mortality. The types of infection causing mortality and the relationship between the date of birth and the subsequent viability of lambs are also discussed.

Barnouin *et al* (1985) explained that improvements were needed in the fertilization of pastures, provision of copper, zinc and cobalt, control of ***Fasciola hepatica***, various management practices and disease surveillance.

Malone *et al* (1985) observed that incidence of respiratory disease was more shearing and housing consumption of contaminated drinking water which some of the sheep refused to drink contributed to urolithiasis. When clean water was provided the problem was greatly reduced.

Reid (1985) suggested that the immeasurable benefit of injecting sheep serum into neonatal lambs is a valid concept.

Fredrikson and Skidell (1986) discussed about hypothermia in new born lambs to prevent the deaths by using indor lamps, treating the condition by injecting glucose and placing the lambs under a lamp or in a special designed box.

Alexander and Peterson (1987) studied the fostering in which the odour of the foster lamb was made similar to that of the ewes own lamb was attempted with Merino and crossbred ewes whose lambs had been killed 30 minutes postpartum to stimulate natural eraly postpartum death. The authors concluded that there was no indication that success rates were influenced by the genotype of the ewe or by restraining ewes over night with the lamb having access to the udder. The traditional method of skinning the dead lambs appears to be the method of choice because the dead lambs does not have to be found and treated before fostering.

Dorenda and Janiak (1988) studied the exposure of lambs to cold demonstrated hypothermia ranging from 36.4 to 35.2^{0}C and hypoglycaemia with a mean value of 1.059 m mol/litre and observed the effect of cold-starvation syndrome in lambs.

Jordan and Feuvre (1989) observed that the mortality of lambs died within one week of birth with the highest mortalities occurring in the lighter lambs. In the pen study here were more lamb deaths from starvation, mismothering and desertion.

Ducrot *et al* (1989) carried out ecopathological survey on 92 sheep farms in South east France and confirmed that infection was a cause of lamb perinatal mortality. They also showed that the management practices during gestation and especially stress factors, poor body condition of ewes, parasitism and absence of shearing , birth weight (mortality four times higher in lambs weighing less than 2.5 kg at birth than in lambs

weighing over 2 5 kg.), environmental conditions especially temperature, hygiene of the sheep pen and use of lambing boxes, combinations of different risk factors were associated with different perinatal mortality rates.

Green *et al* (1994) described that major problems of lamb mortality included farm selection, farmer compliance, number of farms, accurate identification and detection of lambs, collection of morbidity data and handling of data before analysis.

2.2 HELMINTHIASIS IN LAMBS

Helminths belong to two phyla namely Platyhelminths and Nemathelminths. Phylum Platyhelminths consists of different classes like Turbellaria, Trematoda, Eucestoda and Cotyloda whereas Nemathelminths consists of classes Nematoda, Nematomorpha and Acanthocephala Among these haemonchosis, monieziasis and fascioliasis are the common helminthic infections belong to class Nematoda, Cestoda and Trematoda respectively in lambs are of high clinical significance in sheep industry. The present review narrates the available literature about the incidence, clinical symptoms, haematological and biochemical changes in lambs infected with haemonchosis, monieziasis and fascioliasis. The efficacies of morantel citrate, niclosamide, tridabendazole and ***closantel*** against these helminthic infections were also reviewed.

2.2.1 Incidence

The common helminthic parasites of sheep namely ***Haemonchus contortus*** found in the abomasum, ***Moniezia expansa*** in the small intestines and ***Fasciola hepatica*** in the bile duct were first recorded by Rudolphi (1803), Blanchard (1891) and Linnaeus (1758) respectively. Muslin *et al* (1988) recorded highest incidence of internal parasites

(69.28%) which included gastrointestinal parasites (37.14%), gastrointestinal parasites with lung worms (17.26%), lung worms (11.32%), moniezia (2.84%) and fasciola (0.72%)

Bird (1989) stated that 10 per cent of lambs die from disease every year, the major causes of loss caused by abortion and parasitic infections.

Clarkson (1989) reported that the cost of the scheme for prevention of fascioliasis by snail infection by treating 1800 ewes grazed on fluke-infected river line land with four treatments/ewe of triclabendazole is compared with the cost of leaving the sheep untreated

It is estimated that if sheep were not treated there would be a loss of £ 8272 per annum due to reduction in lamb carcass and fleace weights (This is a conservative estimate as mortality, liver condemnation and the effect of immature flukes are ignored). As compared to this treating the sheep could cost only £ 864 per annum.

Bekele *et al* (1992) studied the factors affecting morbidity and mortality of the Ethiopian high land sheep both on-farm and on-station between 1989 and 1990. Primary causes of infectious origin resulted in high morbidity (88.4% on-farm) and mortality (72.9% on-farm and 71.8% on-station) rates Nutritional and managemental factors were also responsible for mortalities in lambs. The frequency of some of the major causes of morbidity and mortality such as pneumonia, fascioliasis and enteritis were significantly ($P<0.01$) affected by age of an animal and season during which the diseases occur.

Coles *et al* (1994) made a list of nine proposals for research and five proposals for control of anthelminthic resistance in a recent European union meeting on anthelminthic resistant nematodes of farm animals.

2.2.2 Clinical symptoms

Haemonchosis, monieziasis and fascioliasis are the common parasitic infections of lambs and sheep.

Martin and Ross (1934) observed that 2000 *Haemonchus contortus* could suck a minimum of 29 c c. of blood per day from the host, thus causing anaemia, progressive debility and other pathogenic effects.

Lapage (1956) described that the young 4th stage larvae of *Haemonchus contortus* and the adult worms, both suck the host's blood by attacking the abomasal mucosa, probably after depositing an anticoagulatory substance into the site. He also made it clear that haemonchosis interferes with the digestion and absorption of protein, calcium and phosphorous. Lambs or young sheep were the most susceptible and in acute cases they died without exhibiting any marked symptoms except anaemia and hydraemia. The situation was different in chronic cases where anaemia was coupled with oedematous swellings that appeared under the jaw and were hence called "bottle jaw" or "water poke". These swellings were also not uncommon along the ventral aspect of the abdomen. Diarrhoea and constipation was encountered occasionally and the appetite was variable.

Shumard *et al.* (1957) worked on the physiological and nutritional changes in nematode infected lambs. They observed that as the infection progressed, feed

consumption decreased and there were consequent rapid weight losses. *H.contortus, T. colubriformis* and *Nematodirus spathiger* were the more common nematodes that infected lambs

Smith and Jones (1957) described that in acute haemonchosis anaemia was the predominant symptom particularly in lambs which died from severe blood loss. When the infection is prolonged, in addition to anaemia, other clinical symptoms like oedematous swellings under the jaw and some times the ventral abdomen were noticed. Emaciation was apparent whenever the body fat was replaced by gelatinous tissue. Progressive weakness and a staggering gait made the affected animals moribund and ultimately led to death In such cases it was observed that trichostrongylids were predominant which caused thin, foetid, dark coloured diarrhoea in addition to anaemia and cachexia.

Udall (1964) mentioned that the stomach worm disease in lambs rendered them dull and unthrifty. Also their mucous membranes were pale and the wool was shaggy.

Levine (1968) described both the 4th stage larvae and adult *Haemonchus* spp. as blood suckers, thereby producing anaemia, oedema under the jaws, emaciation and general digestive disturbances. The first sign included loss of weight, weakness and paleness of the mucous membranes. Majority of these signs occurred during the prepatent period. Pathogenic effects occurred with maximum intensity 19 days after infection and about 9 days before the eggs appeared in faeces.

Owen (1970) infected 3 lambs with 2 oral doses of 34,000 and 14,000 larvae of *H. contortus*, 4 days apart. Two lambs developed severe oedema of the neck and intermandibular region (worm burden 7000-9000).

Misra and Ruprah (1972) studied the clinical manifestations in 2½-3½ month old lambs that were subjected to experimental infection of *H. contortus*. Eleven out of the total 78 infected lambs died during the experimental period and their faeces were heavily positive for *H. contortus* eggs. The clinical manifestations started on the 7th day of infection and included light greenish diarrhoea alternating with constipation, weakness, loss of wool, anorexia leading to recumbency followed by dry neck and stiffening of the hind quarters terminating in death. Anaemia as indicated by pale gums and conjunctiva was common. Some of them developed wool eating and wall and floor licking habits. Wool balls and sand particles could be recovered from the abomasum of the dead and sacrificed lambs. A 2.5 kg reduction in the average body weight of infected lambs was noticed over a period of 21 days of infection.

Bali and Fotedar (1974) induced experimental infection of bursate nematodes in sheep. Lambs infected with 1500-3000, 3000-6000 or 6000-9000 infective larvae of *Cabertia himalayana*, *Haemonchus contortus* var. *Kashmirenesis*, *Ostertagia ovis* or *Bunostomum trigonocephalum* showed reductions in weight gain, wool production and haematocrit values.

Jensen (1974) described *H. contortus* as a widely distributed worm, a major metazoan pathogen of sheep of 2 to 24 months age. It inhabits the abomasum and feeds by sucking blood from the mucosa. In lambs, the growth was retarded, they lost weight and died finally.

Movsesijan *et al.* (1975) reported that in haemonchus infected sheep, when the worm burden exceeded 8000 there was heavy blood loss, severe anaemia and a marked

haematological disturbance They also opined that a worm burden of 374 could cause severe anaemia in lambs

Reid (1976) stated that diarrhoea is common in animals of all ages with helminthic infections can result in significant mortality while in older animals, besides decrease growth rates and weight loss.

Malviya *et al* (1979) reported observations in EPG and blood loss in lambs experimentally infected each with 2500 infective third stage larvae of *H. contortus*. The mean daily blood loss in the infected sheep was 59 ml for 24 hours and 0.07 ml was the mean blood loss for each worm. There was a correlatioon between the intensity of infection, daily blood loss and the packed cell volume.

Soulsby (1982) stressed *H. contortus* as one of the most pathogenic parasites of sheep Haemonchosis occurred in the acute form in young susceptible animals if they were infected heavily. Though mortality was low, morbidity reached 100 per cent. Affected sheep became weak and emaciated. The severity of anaemia and hypoproteinaemia were correlated well with the erythropoietic capacity of the animal.

According to Morgan and Hawkins (1983) the hair coat or wool of the animals revealed the first signs of parasitism. The wool become dry, lusterless, later became scaly and harsh and showed breaks. Anaemia, oedema and distended abdomen were common symptoms. Stools were either normal, diarrhoeic or constipated depending upon the parasite that caused the infection. In advanced cases the eye ball developed a chalky white colour.

Radostits *et al.* (1994) described the acute and chronic forms of the haemonchosis. According to these authors, acute form is commonly encountered in lambs and young sheep when the animals are found dead without any premonitary symptoms. Such sheep always had extremely pale mucosae and conjuctivae. Constipation was more common in these sheep rather than diarrhoea.

2.2.3 EPG Count

Stoll and Hausheer (1926) developed a technique of counting the number of eggs per gram of faeces. This method is popularly known as 'Stoll's method' of determining EPG.

An estimate of the daily output of eggs can be obtained by multiplying the number of eggs per gram by the total weight of the faecal sample that was collected during 24 hours.

Lapage (1956) published the guidelines to estimate the infestation but suggested that the clinical symptoms and other factors should be considered. According to the author an EPG of 2,000-60,000 falls under severe infestation category and when the EPG nearly 1000, or above treatment is advisable.

According to Soulsby (1965) the egg counting devised by "Gordon and Whitlock" was the most convenient one for practical purposes and this technique required a McMaster Counting Chamber.

Su and Lee (1986) observed a rise in faecal nematode egg counts in a herd of milking ewes in China immediately after parturition. Peaks were observed 7-8 and 11-12

weeks after parturition and the egg counts dropped gradually after weaning. The counts did not rise in non-pregnant ewes and in those whose lambs were removed immediately after birth

Reddy and Hafeez (1987b) selected Helmonil as the anthelmintic of choice against gastro-intestinal nematodes of sheep They performed the drug trial on 24 lambs after determining the EPG by McMaster Counting Method. The EPG varied between 400 to 1400 The authors expressed the percentage efficacy of the drug based on the reduction in EPG after treatment

2.2.4 Haematological changes

Helminthiasis bring about significant changes in the affected lambs. Following literature describes the changes in haemogram and leukogram of the infected lambs.

2.2.4.1 Haemoglobin

Levine (1968) reported that in haemonchosis the haemoglobin level dropped from 60 per cent to as low as 10 per cent and during this period the weight gain was markedly reduced

Misra and Ruprah (1972) observed microcytic, hypochromic anaemia as the primary symptom haemonchosis in lambs, based on the observation of MCV and MCHC% in infected lambs and uninfected controls. Very low level of haemoglobin (5.0 ± 0.25), MCV (26.6 cubic microns) and MCHC (25.7%) were recorded in the infected lambs while in the uninfected controls these values were found to be 12.5 ± 0.25, 34.3 and 31.6 respectively.

Pradhan and Johnstone (1972) infected 35 lambs with *H. contortus* larvae either daily or weekly and made haematological observations on them. They noticed a decrease in haemoglobin which was apparent by the 7th day, become pronounced by 15th day and continued to decline further upto 21 days.

Grazebula *et al* (1978) reported that in case of mixed nematodal infections, the haemoglobin and haematocrit values in the affected sheep was 30 per cent below normal when compared to the corresponding values in healthy sheep.

Bezubik *et al* (1980) observed that the decrease in the haemoglobin and haematocrit in sheep started during the first two weeks after infection.

Levine (1983) summarized the work on haemonchosis of lambs and described that the haemoglobin level might drop markedly and the body weight gain might be reduced or some times even eliminated.

Morgan and Hawkins (1983) also observed a drop in haemoglobin content of blood in the strongyle infected animals. A significant fall ($P<0.05$) in haemoglobin concentration and MCHC was reported by Rahman and Collins (1990) in goats experimentally infected with a sheep derived strain of *H. contortus*.

2.2.4.2 Packed Cell Volume (PCV)

Owen (1970) studied the plasma and blood volume changes in sheep experimentally infected with *H. contortus*. He observed that the least affected lamb showed 16.2 per cent net decrease in haematocrit value. The heavily infected lambs

showed a net decrease of 22.1 to 24.2 per cent haematocrit value and 17 and 22 per cent increase packed cell volume (PCV).

Misra and Ruprah (1972) found the PCV per cent in haemonchus infected lambs to be lower (19.5 ± 0.5) than uninfected controls (39.5 ± 0.5).

Pradhan and Johnstone (1972) reported a decrease in packed cell volume in experimental *H. contortus* infection. This decrease in PCV continued upto 21 days.

Pachlag *et al.* (1973) reported lowered values of packed cell volume in 4 different genetic groups of sheep utilised for determining haematological attributes in severe nematodiosis, and the authors noted that a record of hosts PCV is much more valuable than a record of number of eggs in the host faeces in order to monitor the course of *H. contortus* infection. This was because eggs did not appear in the sheep faeces until bout 21 days after infection but by as early as the 10th day it was possible to show that an infection has taken by observing the PCV.

Anosa (1977) noticed that the strongyle infected lambs had low packed cell volume when compared to the healthy group.

Kell *et al.* (1978) conducted a study in nematode infected sheep. They observed that the mean PCV per cent was 36 for both groups before infection and it fell significantly ($P<0.01$) after infection in all groups which received treatment. The changes in PCV were reflected by the haemoglobin levels and erythrocyte counts.

Ogunsusu (1978) opined that a steady fall in PCV, haemoglobin, TEC and TLC with an increase in egg output was quite characteristic of chronic helminthiasis.

Malviya *et al.* (1979) in the studies on blood loss caused by *H. contortus* infection in sheep reported a lowered mean PCV value (22%) in the experimentally infected sheep while in control its value was 39 per cent.

Soulsby (1982) differentiated the anaemia that developed during haemonchosis into 3 stages In the first stage of anaemia that developed during 7 to 25 days after infection there was a rapid fall in the PCV from 30 to 22%. This rapid drop in PCV was attributed to the time lag that occurred between loss of blood and the activation of the hosts erythropoietic system which compensates for the blood loss. In the second phase i e during 6-14 weeks, the PCV was lower than normal, but was maintained at a steady state The author felt that absolute anaemia developed during the third phase. In this phase an iron deficiency led to dyshaemopoiesis and was responsible for causing a rapid drop in PCV.

Urquhart *et al* (1987) described ovine haemonshosis as an acute haemorrahgic anaemia that became apparent by about 2 weeks after infection and was characterised by a progressive and dramatic fall in the packed cell volume.

Rahman and Collins (1990) reported a significant reduction ($P<0.05$) in the PCV of goats infected with a sheep derived strain of *H. contortus*.

Sekar *et al.* (1990) studied the haemotological parameters like haemoglobin, PCV, MCHC, during pre and post weaning stages in lambs belonging to five genetic groups and observed no significant differences between genetic groups and sexes in haematological parameters from pre to post weaning period. But there was significant decine for PCV only.

Rao (1992) studied stronglyosis in sheep with an EPG ranging between 400-700. The PCV values in the infected sheep were significantly lower than those of the healthy controls After treatment with either levamisole or ivermectin or fenbendazole, these values returned to normal by about 28 days after the treatment.

Taylor and Munt (1993) studied the use of anthelmitics to suppress the faecal egg output of *Fasciola hepatica* from sheep and reduce the prevalence of infection on a sheep farm with a history of chromic fascioliasis. Triclabendazole was administered four times annually for three years During the first year, treatments in April, June, August and October failed to reduce the prevalence. In the subsequent two years the first annual treatment was brought forward to January and February, and the prevalence was reduced by 74 6 and 69 7 per cent, respectively. The mean plasma gamma-glutamyl-transpeptidase concentration of the flock was significantly reduced from 55.9 units/litre before the experiment to 40 9 and 38 3 units/litre. In the second and third years the Packed Cell Volume increased from 0.29/litre to 0.36/litre and percentage of infected. Lymnea truncalula decreased to zero.

2.2.4.3 Total Erythrocyte Count

Lapage (1956) reported that haemonchosis in sheep caused a marked decrease in total erythrocyte count and was characterised by the presence of various immature and abnormal red blood cells in circulation.

Sahai (1966) recorded a decrease in total erythrocyte count as 9.0 ± 0.01 millions/cmm by 4th week after infection of haemarhosis in sheep whereas the TEC was 10.33 millions/cmm before infection.

Barowicz and Petryszak (1970) studied the blood picture of lambs infected with gastrointestinal nematodes in haemonchus infected lambs while in healthy controls it was found to be 11 5 ± 0.18.

Pradhan and Johnstone (1972) injected 35 lambs either daily or weekly with *H. contortus* larvae and reported that the erythrocyte count decreased from 15th day to 21st day of infection

Markedly lowered values of TEC in Rambonillet and its back cross and slightly lowered values of TEC in Malpura and its crosses with Rambouiillet were reported by Pachlag *et al* (1973).

Anosa (1977) conducted experiments on helminthiasis caused by *H. contortus* in Nigerian dwarf sheep and recovered low red cell counts.

Georgi (1980) was of the opinion that in lambs *H. contortus* might remove one quarter of the circulating erythrocyte volume per day at the peak of infection and could on an average deplete one tenth of the circulating erythrocyte volume per day over the course of the non fatal infections lasting two months.

Levine (1983) observed that the erythrotye count during haemonchosis dropped to 2 5 million/cmm from the initial value of 10 million/cmm.

Patil *et al.* (1993) studied the mixed worm infestation mainly encountered was a combination of Haemonchus and Trichuris species. The animals were randomly divided into four groups of six each The sheep in the first three groups of six each. The sheep in the direct three groups received Robendal bolus @ 10 mg/kg, Nuvon[xx] @ 50 mg/kg

and Nilverm @ 35 kg/kg respectively. Animals of group-IV were kept untreated control. Animals of all the groups were subjected to EPG count (Stoll's method) and Hb, PCV, TEC and Total proteins estimated before and after six weeks of anthelmintic treatment, using standard proceedings. The change in the body weight gain was also recorded. The levels of TEC in these animals were lower as compared to those reported in healthy sheep (Misra and Ruprah, 1972; Sharma et al. 1973) indicating severe degree of anaemia.

2.2.4.4 Erythrocytic Indices (MCV, MCH and MCHC)

Misra and Ruprah (1972) observed microcytic, hypochromic anaemia as the primary symptom of haemonchosis in lambs based on the observation of MCV and MCHC per cent in infected lambs and uninfected controls. Very low level of MCV (26.6 cubic microns) and MCHC (25.7%) were recorded in the infected lambs while in the uninfected controls these values were found to be 34.3 and 31.6 respectively.

Morgan and Hawkins (1983) also observed a drop in haemoglobin content of blood in the strongiye infected animals. A significant fall ($P<0.05$) in haemoglobin and MCHC was reported by Rahman and Collins (1990) in goats experimentally infected with a sheep derived strain of *H. contortus*.

Das *et al.* (1992) studied the haematological status during pre and post weaning stage in black bengal kids (Capra hircus) and reported that in the post weaning stage, the increase in the levels of MCHC along with decrease in level of Hb, PCV and TEC in comparison to preweaning stage.

2.2.4.5 Total Leukocyte Count

Barowicz and Petryszak (1970) studied the blood picture of lambs infected with gastrointestinal nematodes. The study leucopenia lasting over 100 days.

Misra and Ruprah (1972) reported a reduction in the leukocyte count (7.8 ± 0.18) thousands/cmm during the course of haemonchosis in experimental lambs. In healthy controls this value was 10.1 ± 0.21.

Pachlag *et al.* (1973) found the total leukocyte counts to be lowered in all the 4 different genetic groups of sheep utilized for studying haematological attributes in severe nematodiasis.

More and Sahni (1979) studied some haematological changes during three months after birth of chokla lambs under semi-arid conditions. According to them, blood samples were taken from preweaned lambs at 20, 40, 60 and 90 days after birth. Leukocyte count increased significantly upto 40 days of age. Subsequent values were initially low but reached higher levels at 60 days after birth.

Adams (1981) stated that *H. contortus* infection in sheep caused anaemia due to blood loss and thymus atrophy, decrease in size of the spleen and enlargement of adrenal glands and attributed these to the stress of infection.

Yaman *et al.* (1988) observed that there was no significant difference in the blood values measured when ewes (2-5 years age) naturally infected with fasciola and gastrointestinal nematodes.

Rahman and Collins (1990) observed leucopenia in goats each infected with 20,000 larvae of sheep derived strain of *H. contortus*. The goats were given ***H. contortus*** 3rd stage larvae @10,000 per animal and another 10 goats were given @20,000 per animal. Six goats died during the course of the experiment. Diarrhoea and ill thrift were observed. Worms numbering from 1587 to 4361 were recovered from the abomasum of the dead goats. The animals in both the groups lost weight significantly and the difference between the groups was also significant ($P<0.05$).

2.2.4.6 Differential Leukocyte Count

Sahai (1966) described that on experimental helminthiasis in sheep, an increase in the per cent of monocytes, neutrophills and a proportionate decrease in lymphocytes were observed. A slight decrease in the per cent of eosiophil was also observed.

Barowicz and Petryszac (1970) explained the blood picture of lambs infected with helminthiasis and observed eosinophilia during 30 to 75 days after infection. The degree of haematological changes was higher in animals infected.

Misra and Ruprah (1972) explained a decrease in lymphocytes per cent and a proportionate increase in neutrophil per cent in experimental helminthiasis in sheep. An increase in monocytes and eosinophils was also noticed. The values of neutrophils per cent, lymphocytes per cent, monocytes per cent, basophils per cent and eosinophils per cent in infected lambs were 86.0 ± 1.0, 47.0 ± 0.9, 11.5 ± 0.3, 0.5 ± 0 and 4.6 ± 0.5 while in healthy controls these values were 29.5 ± 0.5, 61.5 ± 0.7, 6.7 ± 0.5, 0.5 ± 0 and 2.0 ± 0.3 respectively.

Pachlag *et al* (1973) with proportioned lymphopenia was reported in severe nematodiasis in sheep.

Lymphopenia in sheep with ***H. contortus*** was reported by Adams (1981).

Aksaka and Ozer (1987) found that there were no helminthic eggs in the faeces of the 24 treated animals and they showed increase in their haematocrit values (to 29% from 26% before treatment) and a decrease in the eosinophil count (to 3.0% from 7.7%) after 30 days later of the treatment of ten month old lambs.

Rahman and Collins (1990) worked together and described a significant ($P<0.05$) decrease in lymphocytes and a proportionate increase in neutrophils during phase three of experimental helminthiasis in goats. There was no significant change in monocyte but eosinophil counts increased significantly ($P<0.05$) during infection.

2.2.5 Biochemical Changes

Helminthic infections causes alterations in biochemical constituents of blood in the infected lambs. Literature on cetain pertinent blood biochemical profile in the infected lambs is reviewed below

2.2.5.1 Total Serum Protein and A/G ratio

Martin *et al.* (1957) reported that abnormally low level of serum albumin in clinical helminthiasis. Heavy infestation resulted in serum albumin level decreasing to 1.3 - 1.68/100 ml. Anthelmintic treatment followed by heavy concentrate feeding resulted in rapid increase in serum albumin.

Shumard *et al* (1957) carried out trials on physiological and nutritional changes during helminthiasis in lambs They observed an increase in globulin with a corresponding decrease in albumin in the infected lambs. Depression in total protein values occurred between 10th and 19th day infection. Recovery to nearly normal levels occurred in all the infected animals a few days before death.

Jungmann (1960) reported a decrease in albumin and alpha 2 globulin in eleven (11) sheep with helminthiasis.

Owen (1970) infected 3 lambs with 2 oral doses of *H. contortus* larvae 4 days apart and observed plasma and blood volume changes in them. After 41 days a decrease in total serum protein and haematocrit values were recorded in 2 lambs.

Rajasekaraiah and Venkatarathnam (1973) noticed no change in the serum protein levels in sheep those were naturally infected with strongylosis but a decrease in albumin with corresponding increase in globulin concentraations was observed.

Kelly *et al* (1978) studied changes in plasma total protein levels in 2 groups of strongyle infected sheep. The pre infection levels for total plasma proteins in the two groups ranged between 6 and 7 g/dl with a mean of 6.63 g/dl. Forty-two days after infection the mean total plasma protein levels for the two groups A and B were respectively 5.73 and 5.24 g/dl.

Soulsby (1982) reported that sheep infected with ***H. contortus*** and having an EPG upto 100,000 manifested first hypoproteinaemia later on followed by oedema. Of the intermandibular region.

Siddiqua *et al* (1989) undertook a study on the biochemical changes in 14 black Bengal goats naturally infected with ***Haemonchus*** spp. serum total protein was found to be lower in the infected sheep (5 34 g%) compared to 6.67 g per cent in the healthy control A lowered serum albumin (2 59 g%) and proportionately elevated globulin levels (2 81%) were found in the animals In the untreated controls the values for albumin and globulin were 3 96 g per cent and 2 6 g per cent respectively.

In experimental haemonchosis Ahmad *et al.* (1990) reported decrease in serum total protein levels and albumin/globulin ratio

Rahman and Collins (1990) carried out a study in which the authors have compared the total protein and albumin value of sheep infected with a strain of *H. contortus* derived from goats. The values of serum total protein and albumin in the infected group was significantly ($P<0.05$) lower as compared values of healthy control.

Rahman and Collins (1990) observed that sheep derived strain of *H. contortus* significantly ($P<0.05$) reduced the serum total protein and albumin values in goats.

Patil *et al* (1991) conducted trials on the comparative efficacy of some anthelmintic drugs in sheep and found an increase in total serum proteins in all the treated groups compared to those of untreated control group.

Rao (1992) reported lowered serum total protein levels in the infected sheep than the healthy controls After the treatment the values were with in normal range by about 14-28 days

2.2.5.2 Serum amino transferases

Thorpe (1965) reported that higher values of AST (SGOT) and lower level of serum albumin together with higher level of globulin is a sensitive indicator of liver damage in different species of animals

More and Sahni (1979) studied some biochemical changes during three months after birth of Chokla lambs under semi-arid conditions. GOT (AST) activity declined with age

Siddiqua *et al* (1989) reported higher vaalues of SGOT (30 units/ml) in natural infection of haemonchosis in goats, when compared to 11.0 units/ml in the healthy control

2.2.6 Therapy

2.2.6.1 Morantel citrate

Morantel citrate is a highly effective anthelmintic against immature and adult gastrointestinal nematodes in sheep, goats, cattle, pigs and horses. Banminth is a product of original Pfizer research and is internationally accepted in major sheep rearing countries. It belongs to tetrahydropyrimidine group and has proven to be effective against the known benzimidazole resistant field strains of nematodes. Unlike the benzimidazoles Morental citrate kills worms in two distinctly different ways, by the inhibition of succinate dehydrogenase and also by a depolarising neuromuscular blocking action. It is a salt of the tetrahydropyrimidine base and citric acid. The chemical nomenclature (Morantel

citrate) was that of 1,4,5,6-tetrahydro-1-methyl-2(trans-2(3-methyl-2-thienyl)-vinyl pyrimidine citrate monohydrate.

Morental citrate tablets are recommended at a dose rate of 5.94 mg/kg BW. It is safe at 15-20 times the recommended dose and no specific contra indications were observed.

In India, the first report on morental citrate appeared as early as 1968. Kulkarni (1968) found it to be highly satisfactory against mature and immature ***Strongyle*** spp., ***Trichuris*** spp. and amphistomes in goats and sheep.

Patwardhan (1968) found morental citrate 91.8 to 100% effective in controlling natural out break of oesophagostomiasis in goats and sheep.

Katiyar (1970) evaluated morental citrate against gastrointestinal parasites of naturally infected sheep and goats. They recorded high efficacy upto 100 per cent.

Misra and Ruprah (1972) reported 100 per cent efficacy of morental citrate in a comparative trial of various anthelmintics on *Haemonchus contortus* in experimental lambs.

Baldini (1972) found that morental citrate was effective in increasing the weight gain and wool production of corriedale sheep during the 31 days post treatment.

Rao and Sivasankar (1984) assessed the efficacy of phenothiazine, parbendazole, tetramisole and morantel citrate before and after treatment in 990 sheep naturally infected with ***Haemonchus contortus*** and ***Oesophagastomum*** species. Tetramisole was found

to be 93 per cent, Parbendazole 87 per cent, Morantel citrate 73 per cent and Phenothiazine 63 per cent efficacy. None was active against paramphistomes.

Louw and Reineck (1993) carried out the controlled anthelmintic tests and faecal egg count reduction tests on natural infections of nematode parasites in sheep on 4 farms in the southern cape province. A combination of albendazole and closantel sodium and morantel citrate were tested and the adult and immature nematodirus species to albendazole/closantel.

2.2.6.2 Niclosamide

The use of Niclosamide has increased through out the world for tape worm infections of domestic animals and humans since early 1960s. Niclex has widely used against Moniezia infections of cattle, sheep and goats.

Pharmacodynamic data of Niclosamide suggests that it is poorly absorbed from the host gastrointestinal tract which perhaps accounts for its low toxicity. The small quantities absorbed are transformed into an inactive metabolite, amino niclosamide which has virtually no pharmacodynamic action.

The basic chemical structure of Niclosamide is that of 2,5-dichloro-4'-nitrosalicylamide.

Niclosamide is a taeniacidal drug. The dead tape worm is subject to digestion before passing from the host. Therefore identification of proglottids and scolices in faeces of treated patients generally is not possible.

Cestodicidal activity is due to inhibition of absorption of glucose by the tape worm and uncoupling of the oxidative phosphorylation process in the mitochondria of cestodes. Resultant blocking of the Kreb's cycle leads to accumulations of lactic acid which kills the tape worm. The glycogen content on tissues of *H. nana* decreases substantially following treatment of infected mice with the drug. It is also thought that over stimulation of adinosine triphosphatase (ATPase) activity of the mitochondria may be related to cestodicidal action of niclosamide. In either case the degree of destruction of the tape worm is directly proportional to duration of contact with the drug.

Niclosamide is administered orally in tablet form at a dose of 100 mg/kg for sheep and goats. An over night fast is recommended for all animals prior to treatment. Niclosamide has a wide margin of safety. Single over doses upto 40 times the therapeutic dose in cattle and sheep have been found to be non toxic. There are no known contraindications to use of niclosamide even in debilitated and pregnant patients without ill effects.

Several trials were conducted both in India and abroad to assess the therapeutic efficacy of niclosamide some of which are detailed below.

Terblanche (1983) made drug trail on 7 lambs, 11 yearlings, 15 aged 18 months on sheep in South Africa. Naturally infected with tape worms were dosed with niclosamide at the rate of 50 µg/kg body weight. When killed 4 days later they were free from tape worms while 23 untreated controls harboured 44 ***Moniezia exapansa***, 21 ***Thysanieza giardia*** and 23 ***Avitellina centrpunctata***.

Reddy and Hafeez (1987a) studied the efficacy of Niclex against amphistomiasis of lambs aged 3 to 4 months infected with 10,000 paramphistomus epiclitum metacercariae. They observed that the cure rates varied from 94-96 to 100%. Lambs treated 40 and 50 days 'Pi' and necropsied 10 days later were uninfected. Controls harboured 40002 and 4452 immature flukes respectively.

2.2.6.3 Triclabendazole

The triclabendazole is a totally new fasciolicide which has a strong and selective action against all stages of liver fluke in ruminants. It is a major advance in the treatment of liver fluke infection.

Efficacy and pharmacokinetic data suggest that the sulfoxide derivative of triclabendazole is the active principle for fasciolicidal activity in vivo. Unlike salicylanilides, which through uncoupling activity affects flukes immediately, triclabendazole or its metabolite exerts a slow killing effect and when given at suboptimal dosage rates will retard maturation of the parasite. Indirect evidence eg., lack of nematocidal activity despite high bioavailability, suggests that triclabendazole acts differently from benzimidazole-2-carbamates. These are believed to interfere with fumerate reductase and microtubular functions.

The basic chemical structure of Triclabendazole (Fasinex) was that of 6-chloro-5(2,3-dichlorophenoxyl)-2-methyl thiobenzimidazole.

Following oral administration trichlabendazole is readily absorbed and biotransformed. Oxidation to the sulfoxide and sulfone was found to be a major

pathway. Majority of orally administered triclabendazole get distributed in the blood and milk as the parent compound and the 2 metabolites.

Radioactive tracer studies in sheep and goats showed that an oral dose of 10 mg/kg results in peak blood levels of 15 ppm triclabendazole equivalents between 24 and 36 hours post application declining to 0.1 ppm within 10 days. Steady state was reached within 48 hours and the depletion curve followed first order kintetics with an apparent biological half life time of 22-34 hours. Milk levels in the goat peaked between 8 and 24 hours at 1.79 ppm similarly declining to 0.012 ppm within 10 days. More than 95 per cent of the dose is excreted in faeces, about 2 per cent in the urine and less than 1 per cent in the milk. Residues of triclabendazole and its metabolites are detectable in muscle, liver, kidney and fat. However, these residues are steadily excreted and levels in muscle have dropped below 0.6 ppm 14 days after treatment and to insignificant levels after 28 days. Thus a with-holding period of 28 days between treatment and slaughter for human consumption is recommended for the both sheep and goats.

Armour and Bogan (1982) revealed that theory and practice have shown that the most effective way to break the fasciola life cycle is by elminating both the flukes present in grazing animals and the source of infection on the pasture.

Smeal and Hall (1983) studied the activity of triclabendazole against immature and adult fasciola hepatica infections in sheep and reported that triclabendazole to be 99 per cent effective at the dose rate of 10 mg/kg body weight against mixed burdens of fluke aged one to twelve weeks.

Infective metacercariae on the pasture come from the intermediate host snail which is always associated with wet or marshy areas. Steps taken to reduce the exposure of livestock to snail infested areas (drainage, fencing, use of molluscides etc.) will help in control of fluke disease. While much can be done to reduce exposure of animals to fluke infection, the key to success in control of fluke disease is elimination of both immature and mature flukes already present in the animals.

Treatment of animals harbouring mixed age infections of fluke will be ineffective unless all 3 stages of the parasite are eliminated. Surviving immature stages will continue to grow, damaging the animals liver in the process. Eventually they will become adult flukes and produce eggs, contaminating the pasture. Similarly, if the treatment does not kill adult flukes, they remain in the bile ducts producing eggs and causing chronic fascioliasis.

Trials have shown that Fascinex has the same efficacy to all other flukicides. It is important to eliminate all liver flukes present in the animals. "Control of adult fluke, is no control of all immature flukes remained in the host".

Misra (1987) described that a single oral dose of Fascinex at 10 mg/kg body weight for goats revealed 100% efficacy against chronic fascioliasis.

Avasthi (1988) performed a comparative study and reported that triclabendazole has a better effect on both immature and mature ***Fasciola-gigantica*** in sheep and described that flukes take approximately 12 weeks in sheep to mature fully. Fascinex kills all 3 stages of liver fluke.

2.2.6.4 Closantel

The closantel 15% was introduced for the first time in India as Exinot by M/s Cadila Pharmaceuticals Limited, Ahmedabad is "A dawn of new era in Anti-parasitic world" constituted a new chemical class of anthelmintic agent which displayed an excellent broad spectrum action and kills all economically important round worms, tape worms, liverflukes, ticks, lice and fleas at every stage of development in bovines, ovines and canines.

This was "The New Salicylanilide Molecule" for outing external and internal parasites. Exinot kills both endo and ecto parasites by altering the mitochondrial phosphorylation thereby decreasing ATP synthesis in them. This difficults the absorption and transport of nutritive substances of the parasite, with a decrease in the macromolecule synthesis at a dosage rate of 2.5 ml/25 kg.b.wt. (100 ml contains closantel 15 gms).

The basic chemical structure of Exinot (closantel 15% oral suspension) was that of N-(5-chloro-4)(4-chlorophenyl)-(2-methylphenyl)-2-hydroxy-3,5-diiodobenzamide.

Marcel Michiels *et al.* (1986) conducted experiments in sheep with 14^C closantel revealed that the plasma radioactivity is almost exclusively due to the nonmetabolized drug, metabolites accounting for less than 2 per cent. Atleast 80 per cent of the dose was excreted in the faeces over the investigation period of 8 weeks and less than 0.5% with the urine, closantel was only poorly metabolized. Over 90% of the faecal radioactivity was due to the parent compound. The two monoiodoclosantel isomers were the only faecal metabolites detected with radio-HPLC.

The distribution of closantel in tissue was limited by its high protein binding. Closantel binds strongly (>99%) and almost exclusively to plasma albumin. Accordingly, tissue concentration were many times lower than the corresponding plasma levels. Residual radioactivityy in sheep in all tissues but liver was entirely due to closantel. About 30 to 40 per cent of the liver radioactivity could be attributed to monoiodoclosantel. In both sheep and cattle, residual tissue concentrations decline parallel to the plasma concentrations. Consequently, the plasma kinetics of closantel reliably reflect its depletion from tissues.

Several trials were coonducted both in India and abroad to assess the therapeutic efficacy of Exinot (Closantel 15%), some of which are listed below.

Hall (1981) suggested that treatment with closantel compound provided substantial control of *H. contortus* infections (susceptible or resistant strains) for a period upto 2 months. This period of continuous anthelmintic action was superior to that provided by conventiional anthelmintics, where reinfestation occurs immediately after treatment.

Kovalev (1984) tested closantel against Fasciola in naturally infected sheep in USSR. No flukes were present in the livers of 13 sheep at autopsy 16 days after subcutaneous injection of closantel at 5 mg/kg b.wt. Thirteen untreated controls contained from 22 to 127 flukes. In field trials on 520 sheep, some with severe clinical disease, one egg was found in the faeces of 4 out of 260 sheep examined 21 days after treatment. No side effects or swelling at the injection site were observed. He opined that at therapeutic doses, the anthelmintic may be used safely in young, pregnant and weak animals.

Stromberg (1984) studied the efficacy of closantel in 12 sheep less than 12 months old infected with ***F. magna***. Eight weeks after infection, sheep were treated orally with 20 mg/kg.b.wt. of closantel. The efficacy of closantel in controlling ***F.magna*** infection was 100%. No flukes were found in the liver or any other organ of treated animals at autopsy 16 weeks later.

Cauteren Van (1985) studied the toxicological properties (acute, sub acute and chronic toxicity) of clsantel is a well tolerated substance in laboratory animals.

Reproduction studies in laboratory animal revealed that there is no embyrotoxic or teratogenic potential in rats and rabbits. Further there is also no carcinogenic effect in rats.

Cankovic (1986) found that ewes excreting eggs of ***F. hepatica*** and ***Dicrocoelium dendriticum*** to be substantially reduced when treated with closantel. After the treatment, the lambs of treated ewes were about 200g heavier at birth and 1.5 kg heavier at 2 months age than those of untreated controls.

Dash (1986) reported that closantel at the dose rate of 7.5 mg/kg was very effective against ***Haemonchus contortus*** the most serious nematode parasite in sheep.

Veselova (1986) reported that closantel when given to 36 ewes with natural fasciola infections in USSR at doses of 2.5 and 5.0 mg/kg was 100% effective against immature flukes and cured 66.7% and 83.3% of adult worms in sheep respectively. The adult worm burdens were reduced by 98.2% and 99.5% respectively for the 2 doses.

Dash (1986) studied that treatment of ewes with broad spectrum anthelmintic (concurrent Oxfenbendazole and Levamisole) in August (preweaning) and early November and in early Febraury was effective in controlling infections with ***Trichostrongylus*** spp. in lambs reared on contaminated pastures under set-stocked conditions. It was ineffective in controlling infections wiith ***Haemonchus contortus***, 82 per cent of lambs had to be withdrawn from the experiment because of severe haemonchosis.

Treatment with closantel (7.5 mg/kg) at the same time was very effective against ***H. contortus*** but ineffective against ***Trichostrongylus*** spp. The same schedule using broad spectrum anthelmintic and closantel administered concurrently was effective against both parasites; no lambs had to withdrawn and the body weight gain of lambs was higher than in lambs treated with broad spectrum anthelmintic or closantel alone.

Besier and Lyon (1990) confirmed that the effectiveness of applying anthelmintic drench in high rain fall areas, when the pasture is drying off and they found that early drenching should be given in mid-late November, as the pasture is drying off together with the administration of 'closantel', in order to keep worm burdens i.e., particularly of ***Ostertagia*** spp, ***Trychostronglus*** spp. and ***H. contortus*** low. The 2nd drenching should be given in January or earlyy February, if given later it may fail if rain come in late summer or early autumn due to the rapid development of ***Trichostronglus*** larvae.

Yadav *et al.* (1992) reported that closantel at the dosage rate of 10 mg/kg was 100 per cent effective in eliminating adult luminal and immature mucosal stages of parasites in kids naturally infected with ***H. contortus***. After 21 days period of treatment, the treated animal showed improvement in general health, reduced severity of clinical

signs and weight loss without any mortality while acute haemonchosis with rapid weight loss and mortality were recorded in untreated kids.

Abdul Rahman (1993) evaluated the efficacy of the broad spectrum anthelmintic and acaricide closantel-15% (Exinot) in the treatment of sheep infected with helminthiasis in a small unit having 15 crossbread sheep. All the animals had heavy infestation of ***Oestrus ovis***. Faecal examination revealed strongyle eggs. Sheep were treated with closantel 15% (Exinot) orally at the dose rate of 10 mg/kg b.wt. within 48 hours of administration, 95% of the ***O. ovis*** larvae were found dead and remaining after 72 hours. Three weeks after oral administration, the faecal samples were negative for strongyle eggs. All the animals in the trial did not show any parasitic infestation for three months following the treatment with closantel and there were no adverse reaction to the drug.

Yadav *et al.* (1993) reported the 'first report' of an outbreak of haemonchosis associated with fenbendazole and morantel resistance in a strain of ***H. contortus*** in sheep. They reported that closantel and ivermectin were 100% effective against ***Haemonchus contortus***.

Uppal *et al.* (1993) evaluated the anthelmintic efficacy of closantel and found that closantel at the rate of 10 mg/kg body weight was 100 per cent effective against ***H.contortus*** in sheep.

Pandy and Shivraj (1994) concluded that no resistance of ***H. contortus*** of closantel and levamisole was observed. But anthelmintic resistance to benzimidazoles and probenzimidazole, febantel is a serious and wide spread problem in ***H. contortus*** in sheep in Malaysia.

Yadav *et al* (1996) observed that 8 to 9 months old lambs of mixed breeds Nali and crosses of Corriedale and Merino on a farm where an out break of clinical haemonchosis in which the parasite have developed resistance to fenbendazole and morantel. Initial egg counts in all the groups were almost similar (700-800). Closantel treatment caused 100 per cent reduction in EPG whereas morental and fenbendazole treatment caused no significant reduction in EPG. The reduction in egg count in treated lambs corresponded well with body weight gains.

Compared to the control group, the weight gain in treated groups was 150 per cent (closantel), 52.5 per cent (fenbendazole) and 47 per cent (morantel) at the end of the trial. The increase was significant however only in the group receiving closantel, similar trend was noticed in the weight of wool from lambs at the end of the trial.

Materials and Methods

CHAPTER - III

MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Records of organised sheep farms

The Lamb Mortality was ascertained by examining records from various organised sheep farms located in the three different regions viz., Rayalaseema, Coastal and Telangana of Andhra Pradesh as detailed below.

1.	Sheep unit	:	Department of Animal Science College of Veterinary Science, Tirupati
2.	Net work programme on sheep improvement	:	Palamaner, Chittoor District
3.	Livestock Research station	:	Chintaladevi, Nellore District
4.	Composite Livestock farm	:	Chintaladevi, Nellore District
5.	Government sheep farm	:	Penukonda, Anantapur District
6.	Ram Multiplication farm	:	Siddarampuram, Anantapur District
7.	Livestock Research Station	:	Mahaboob Nagar
8.	Government Livestock farm	:	Mamnoor, Warangal District
9.	Sheep unit	:	Department of Animal Science Rajendra Nagar, Hyderabad
10.	Livestock Research Station	:	Garividi, Vizianagaram District
11.	Large scale sheep breeding farm	:	Mamidipally, Ranga Reddy District

The mortality registers and relevant records of the above eleven organized sheep farms were screened for calculating the lamb mortality for the period for 1985-94. Based on the post mortem reports available, cause of death was also recorded.

3.1.2 Glassware and Chemicals

All the glasswares utilized during the present study were procured from M/s Borosil, Bombay and Chemicals from M/s Qualigens, Bombay. For biochemical investigation kits were obtained from M/s Stangen Immunodiagnostics, Hyderabad.

3.1.3 Selection of animals

Lambs of the Department of Animal Science, College of Veterinary Science, Tirupati and lambs of Tondavada village near Tirupati, Chittoor district, formed the material for this study. Faecal samples were collected from lambs and were screened for helminthic infestations. From these flocks, lambs aged between 2-6 months and weighing 10-15 kg were selected.

Twenty four lambs which were positive for helminthiasis and manifesting clinical symptoms were chosen for the comparative drug trial. For identification these animals were allotted each with a totoo number and were divided at random into four groups (Groups II, III, IV and V). Another group of six randomly selected lambs that were healthy and free from any infection served as healthy control (Group I).

3.1.4 Clinical Material

3.1.4.1 *Faecal samples*

Feacal samples from each of the selected animals were collected per rectum at pre treatment and at weekly intervals starting from the 0th day for 4 weeks and post treatment and screened for the presence of helminths.

3.1.4.2 *Blood and Serum Samples*

For carrying out haematological studies, blood was collected by Jugular Venipuncture using sterile twenty gauze needle into clean glass vials containing di-sodium EDTA (ethylene diamino tetra acetic acid) as anticoagulant at the concentration of 1 mg/ml of blood, as described by Jain (1986). Another 5 ml of blood was collected from each animal separately into sterile test tubes for serum separation.

3.1.5 Therapeutic agents

The anthelmintics employed in the therapeutic trial, alongwith their trade names, presentation and procurement are listed below:

Sl. No.	Drug	Trade name	Presentation	Manufacturer
1.	Morantel citrate	Banminth	118.8 mg tablets	M/s Pfizer Limited, Bombay
2.	Niclosamide	Niclex	1.0 gm tablets	M/s Alved Pharma & Foods Pvt. Ltd., Madras
3.	Triclabendazole	Fasinex	5% w/v oral solution	M/s Hindustan Cibageizy Limited, Bombay
4.	Closantel	Exinot	15% w/v oral solution	M/s Cadila Pharmaceuticals Limited, Ahmedabad

3.2 METHODS

3.2.1 Incidence

An epidemiological survey was undertaken in various organized sheep farms of ANGR Agricultural University and Department of Animal Husbandry to findout the incidence of lamb mortality during January 1985 - December 1994 (Ten years) by scrutinizing the records of the sheep farms. The incidence of lamb mortality due to various primary and secondary causes in relation to lamb's age, sex, breed, season, non-infections causes, infections causes and miscellaneous causes was calculated.

The data collected was related to lamb mortality during the preweaning and postweaning period alongwith other relevant particulars including the postmortem findings as entered in the records of the respective centres during the ten years period (January, 1985 to December, 1994).

The data thus gathered was analysed in order to ascertain the association of various epidemiological factors mentioned above with the incidence of lamb mortality. Lambings from all the centres selected were investigated at random and a detailed record was maintained. The data were analysed to findout the possible effect of helminthiasis on lamb mortality and other related parameters.

All the infected lambs in the sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati and sheep belonging to Tondavada village were subjected to clinical examination and postmortem was carried out on the dead lambs. The lambs that were showing helminthic infestation were subjected to detailed study.

3.2.2 Clinical examination

All the experimental animals positive for helminthic infestation as ascent aimed by faecal examination, were subjected to detailed clinical examination to rule out the presence of other systemic and/or infectious diseases. Detailed history (anamnesis) in relation to age, sex, breed, season, lamb's birth weight, litter size, managemental practices etc., were collected. Environmental history with reference to surroundings was also collected. General inspection with respect to physical condition, general attitude, posture, gait, conformation and the condition of the skin and hair coat were recorded.

The clinical examination comprised of recording rectal temperature, respiratory and pulse rate, heart rate, colour of visible mucous membranes and rumen motility. This was then followed by an examination of various body regions. Abnormalities if any, in head carriage, eyes, neck, thoracic and abdominal region, lymph nodes, deformity in legs and condition of joints etc., were recorded. Brisket area, ventral abdomen extending from brisket to perineum and both the limbs were palpated for any swelling.

Fresh faeces were collected from healthy control and the clinical cases. The faecal samples were examined thoroughly for colour, consistency and frequency of passing faeces were also recorded.

3.2.3 Faecal examination

All the faecal samples were procesed to determine the eggs per gram (EPG) of faeces as per Stoll's dilution method (Stoll and Hausheer, 1926). Precisely 1 gram of faeces was weighed and mixed with 10 ml of water. The contents were mixed well and sieved through a strainer. Exactly 0.1 ml of the diluted sample was placed on a slide

and was covered with a cover slip. The smear was examined under the low power (10 x objective) of a microscope. The number of eggs present in the entire smear was noted and multiplied by 100 to get the EPG.

3.2.4 Haematological examination

All the glassware used were cleaned with chromic acid, rinsed thoroughly with tap water, followed by demineralised water and then with double distilled water.

Into the clean glass vials 0.15 to 0.3 ml of 3.5% solutions of ethylene diamino tetra acetic acid (EDTA) disodium salt was pipetted and were then kept in hot air oven at 60°C for one hour.

Haematological studies were undertaken on blood samples collected from healthy and infected lambs with helminthic infestation before and after treatment. About 10 ml of blood was collected from Jugular vein into a steril anticoagulant vial containing disodium salt of EDTA at a rate of one mg per ml of blood-prepared by taking all aseptic precuations. These vials were then labelled, stoppered, packed into a thermocool box and brought to the laboratory with minimum agitation. During the present investigation blood samples were collected at different points of time and regardless of the time of collection, the samples were examined on the same day by different techniques. This sample was used for estimation of haemoglobin (Hb), Packed cell volume (PCV), total erythrocyte count (TEC), total leukocyte count (TLC), differential leucocyte count (DLC) and erythrocytic indices. All haematological estimations were carried out on the same day of collection.

3.2.4.1 Haemoglobin (Hb)

Haemoglobin was estimated by following acid hematin method using Sahli's haemometer as described by Jain (1993) and the values were expressed as grams per 100 ml of blood.

3.2.4.2 Packed Cell Voume (PCV)

Packed cell volume was measured by following the microhaematocrit method using plain capillary tube (7 mm x 1 mm) and was read on Adam's microhaematocrit reader as described by Jain (1993). The packed cell volume was expressed in per cent.

3.2.4.3 Total Erythrocyte Count (TEC)

Total erythrocyte count was estimated according to the method described by Jain (1986) and expressed in millions/cmm.

3.2.4.4 Erythrocytic indices

Erythrocytic indices - namely Mean Corpuscular Volume (MCV), Mean Corpscular Haemoglobin (MCH) and Mean Corpscular Haemoglobin Concentration (MCHC) were calculated as per the formulae given by Jain (1993) and were expressed in fl, pg and per cent respectively.

3.2.4.5 Total Leukocyte Count (TLC)

Total leukocyte count was done as per the method described by Jain (1993) and expressed in thousands/cmm.

3.2.4.6 Differential Leukocyte Count (DLC)

Thin blood smears prepared on grease free slides were allowed to air dry and covered with Leishman's strain for 1-3 minutes. Then double the quantity of distilled water was added to the slide, the stain was mixed by slow blowing of air and kept undisturbed for 15 minutes. The slides were washed with water, air dried and examined under the oil immersion objective (100 x) of a microscope to findout the per cent of different leukocytes.

3.2.5 Biochemical studies

Another sample of blood about 10 ml was collected into a clean, dry, sterilized test tube without adding anticoagulant and was used for separation of serum. These tubes were placed in a slanting position for suitable time (nearly 1½ hour) to facilitate complete clotting. Later these were placed in a refrigerator for one hour to allow the clot to retract, oozing serum onto the top. The serum was then separated and gently transferred into small tubes and centrifuged to get clean supernatant serum. This serum was stored in sterile screw capped vials and placed in deep freeze until biochemical analysis (except for enzyme analysis) was carriedout within 48 hours. Clear serum obtained after centrifugation was transferred into a sterilized plastic vial and stored at -20°C till use i.e., 72 hours of collection of blood, within which all biochemical estimations were carriedout. Following biochemical parameters were studied in healthy and the infected lambs pre- and post-treatment.

3.2.5.1 Total Serum Protein

The quantitative determination of total proteins and albumin in serum was done by the Biuret and BCG Dye binding methods respectively. The kit employed was of Dr.Reddy's laboratories, Hyderabad.

The kit contained the following reagents:

1. Biuret reagent
2. Buffered dye reagent
3. Standard

Test Procedure

For estimating the total protein 1 ml of biuret reagent was taken in test labelled STANDARD(S) and TEST (T) and 2 ml of distilled was added to both the tubes. To the 'S' tube 0.05 ml of the standard (reagent 3) was added, while 0.05 ml of serum was added to the 'T' tubes. The contents of the tubes were mixed well and incubated at 37°C for 10 minutes. The absorption of the 'S' and 'T' against blank (B) were measured in a spectrophotometer at nm wave length.

Calculations:

Total protein in the serum samples was calculated using the formula

$$\text{Total protein (g\%)} = \frac{\text{Absorbance of (T)}}{\text{Absorbance of (S)}} \times \text{Concentration of total protein}$$

Where concentration = 6.4 g% (Stamped on the vial) of total protein

Serum albumin

The same kit that was used for total protein assay was employed for the quantitative determination of albumin in serum.

Procedure

1 ml of buffered dye reagent (reagent 2) was taken into clear test tubes, one of which was labelled as 'S' (standard). Distilled water (2 ml) was added to all the tubes. Then 0.01 ml of standard (reagent 3) and 0.01 ml serum were added to the tubes labelled standard and test respectively. The contents in all the tubes were mixed well.

The absorbance of 'S' and 'T' against blank (B) was measured immediately in a spectrophotometer at a wave length of 630 nm.

$$\text{Albumin (g\%)} = \frac{\text{Absorbance of (T)}}{\text{Absorbance of (S)}} \times \text{Concentration of total protein}$$

Where concentration = 4.9 g% (Stamped on the vial) of albumin

Serum globulin

The value of serum globulin was determined by substracting the albumin from total protein. The values were expressed in g%.

Albumin: Globulin Ratio

Albumin-to-globulin ratio was obtained by dividing the per cent of albumin with the per cent globulin in the serum.

3.2.5.2 Serum Amino Transferases (AST & ALT)

The AST activity in serum was determined by the method of Reitman and Frankel (1957). Kit from Stangen Immunadiagnositics was employed and it contained the following reagents.

1. Buffered substrate, pH 7.4
2. DNPH Colour reagent
3. Sodium hydroxide, 4 N
4. Pyruvate standard, 2 mM

Sodium hydroxide was diluted 1:10 with distilled water before use.

A standard curve was plotted using different concentrations of the reagent for estimating the enzyme activity of unknown samples as detailed below.

Tube No.	1	2	3	4	5
Enzyme activity (Units/ml)	0	24	61	114	190
Buffered substrate (1) (ml)	0.5	0.45	0.40	0.35	0.30
Pyruvate standard (4) (ml)	-	0.05	0.1	0.15	0.2
Distilled water (ml)	0.1	0.1	0.1	0.1	0.1
DNPH colour reagent (2) (ml)	0.5	0.5	0.5	0.5	0.5
Kept at room temperature for 20 minutes					
Working NaOH (ml)	5.0	5.0	5.0	5.0	5.0

Procedure

For testing the AST activity 0.5 ml of buffered substrate (pH 7.4) was taken in a test tube incubated at 37°C for 3 minutes. To the above substrate, 0.1 ml of serum was added and incubated for one hour at 37°C, 0.5 ml of DNPH colour reagent was added and allowed to stand at room temperature for 20 minutes. Finally 5 ml of working sodium hydroxide was added to the above tube, the contents were then mixed well and allowed to stand at room temperature for 10 minutes. The optical density was measured against blank (distilled water) in ELICO-CL-24 Spectrophotometer at a wave length of 505 nm.

The corresponding AST values for optical densities of 'test' were obtained from the above standard curve and expressed in units/ml.

The ALT activity in serum was determined by the method of Reitman & Frankel (1957). Kit from Stangen Immunodiagnostics was employed and it contained the following reagents.

1. Buffered substrate 7.4 pH
2. DNPH colour reagent
3. Sodium hydroxide 4N
4. Pyruvate standard 2 mM

Sodium hydroxide was diluted 1:10 with distilled water before use.

A standard curve was plotted using different concentrations of the reagent for estimating the enzyme activity of unknown samples as detailed below.

Tube No.	1	2	3	4	5
Enzyme activity (Units/ml)	0	28	57	97	150
Buffered substrate (1) (ml)	0.5	0.45	0.40	0.35	0.30
Pyruvate standard (4) (ml)	-	0.05	0.1	0.15	0.2
Distilled water (ml)	0.1	0.1	0.1	0.1	0.1
DNPH colour reagent (2) (ml)	0.5	0.5	0.5	0.5	0.5
Working NaOH (ml)	5.0	5.0	5.0	5.0	5.0

Procedure

For testing the ALT activity 0.5 ml of buffered substrate (pH 7.4) was taken in a test tube and incubated at 37°C for 30 minutes. To the above substrate, 0.1 ml of serum was adoled was added and incubated for one hour at 37°C, 0.5 ml of DNPH colour reagent was added and allowed to stand at room temperature for 20 minutes. Finally 5 ml of working sodium hydroxide was added to the above tube, the contents wre then mixed well and allowed to stand at room temeprature for 10 minutes. The optical density was measured against blank (Distilled water) in ELICO-CL-24 Spectrophotoemter at a wave length of 505 nm.

The corresponding ALT values for optical density of 'test' were expressed in units/ml.

3.2.6 Therapeutic Trial

The six selected infection free and apparently healthy lambs were pooled under healthy control (HC) group (Group I) that received no treatment and the twenty four lambs were randomly assigned to four treatment groups of six each (Groups II, III, IV and V) positive for helminthiasis such as haemonchosis, moneziasis and fasciolisasis and mixed infection of haemonchiosis and fascioliasis respectively. Basing on the anthelmintic efficacy four different drugs were selected for evaluating therapeutic efficacy against helminthiasis. Allotment of treatments to the groups is detailed below.

Sl. No.	Group	Drug administered	Faecal sample examination	Dose and route*
1.	Healthy Control (Group I)	-	-	-
2.	Group II	Banminth	positive for haemonchosis	5.94 mg/kg orally
3.	Group III	Niclex	positive for monieziasis	100 mg/kg orally
4.	Group IV	Fasinex	positive for fascioliasis	10 mg/kg orally
5.	Group V	Exinot	positive for haemonchosis and fascioliasis	0.1 ml/kg orally

*The drugs were administered only once i.e., on the 0th day.

All the lambs were subjected to detailed clinical haematological and biochemical evaluation pre and post treatment.

Based upon the improvement in clinical symptoms, abilities to reduce faecal egg counts and to bring the haematological and biochemical, profiles to normal the comparative anthelminthic efficacy of the drugs administered was assessed.

3.2.7 Statistical analysis

The epidemiological data for incidence of lamb mortality were analysed by normal deviate test for proportions and chi-square test. In the present study the data pertaining to various clinical, haematological and biochemical parameters from healthy control (Group I) and lambs treated with different anthelminthic such as Banminth (Group II), Niclex (Group III), Fasinex (Group IV) and Exinot (Group V) were subjected to two-way analysis of variance technique as per the statistical design prescribed by Snedecor and Cochran (1994) using basic programming techniques in IBM Personnel Computers. Post-ANOVA tests were carried out by employing least significnt difference (LSD) design.

All means were expressed with ± SE. Three types of per cent change were calculated for each parameter. First one, is the per cent change in clinical cases over healthy control; while second and third are per cent change in after treatment values as compared with their pre-treatment and healthy control values respectively. Positive sign indicates an increase and negative as decrease from their corresponding value.

Results

CHAPTER - IV

RESULTS

4.1 INCIDENCE OF LAMB MORTALITY

An epidemiological survey was conducted in eleven organised sheep farms in Andhra Pradesh to assess the extent of lamb mortality. The data was collected for a period of ten years from 1985-94. The detailed abstract of the survey on lamb mortality is presented in Table 1.

A total of 17157 lambs were born in all the centres surveyed during the period of study, out of which 2266 lambs died. Thus, the mean mortality percentage across the eleven centres for ten years was 13.2 per cent (Table 1).

At sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, out of 471 lambs born during the period of ten years, 51 lambs died with a mortality percentage of 10.82, while at net work programme on sheep improvement, Palamaner, out of 2579 lambs born during the period of ten years, 407 lambs died representing the morality percentage of 15.78.

In both the sheep farms located at Chintaladevi namely Livestock Research Station and composite live sotck farm, out of 2845 and 2744 lambs born during the period of ten years, 346 and 112 lambs died amounting to the mortality percentage of 12.16 and 4.08 respectively. The composite livestock farm, Chintaladevi recorded the lowest lamb mortality rate.

At composite livestock farm, Penukonda and Government livestock farm, Mamnoor, the lamb mortality rate was also lower, where out of 888 and 1528 lambs born during the period of study, 75 and 140 lambs died resulting in mortality percentage of 8.44 and 9.16 for the two farms respectively.

The mortality rate was moderate at Ram multiplication farm, Siddarampuram, out of 1149 lambs born during the period of ten years, 177 lambs died resulting in the mortality of 15.4 per cent.

At Livestock Research Station, Mahaboobnagar, out of 324 lambs born during the period of two years (January 1993 to December, 1994), 69 lambs died exhibting a mortality percentage of 21.29.

At large scale sheep breeding farm, Mamidipally, out of 3965 lambs born during the period of ten years, 718 lambs died indicating the mortality percentage of 18.10.

The mortality rate was also higher at sheep unit, Departmnet of Animal Science, College of Veterinary Science, Hyderabad, where out of 497 lambs born during the period of ten years 121 lambs died expressing the mortality of 24.34 per cent.

At Live Stock Research Station, Garividi, out of 167 lambs born during the period of two years (January 1993 to December, 1994), 50 lambs died expressing the mortality of 29.94 per cent, which is the highest among the eleven different organised sheep farms surveyed.

4.1.1 Status of Dam

The influence of the body weight of the dam at lambing on the lamb mortality was indicated as the status of dam and it was recorded in four centres only and the data presented in Table 2.

Across the four centres surveyed the mortality of lambs was minimum when the dam's body weight at lambing was between 36-40 kg, while the lamb mortality was maximum when the dam's body weight at lambing was between 26-30 kg. The lamb mortality was slightly lesser with dam's body weight of 31-35 kg than 26-30 kg. When the dam's body weight was 20-25 kg the lamb mortality was still lesser compared to the dam's body weight of 31-35 kg.

Among the four centres surveyed, the lamb mortality was higher in Livestock Research Station, Chintaladevi and Net work programme on sheep improvement, Palamaner than sheep unit, Tirupati and Livestock Research Station, Garividi.

4.1.2 Age

Lamb mortality was assessed in all the organised sheep farms for a period of ten years in relation to the age of the lamb at the time of death. The data of lamb mortality was recorded monthwise upto four months of age (Table 3) as well as pre-weaning and post-weaning (Table 3-A).

Out of the total lamb population of 17157, the largest number (419) of lambs died within the second month followed by third month (336), first month (330) and

fourth month (276) after lambing. The percentage of mortality was 2.44, 1.95,1.92 and 1.61 during second, third, first and fourth month after lambing respectively (Fig.1).

The mortality of the lambs was higher in the post weaning (1325) than the preweaning period (941) with a percentage of 58.48 and 41.52 during the post and pre weaning respectively (Fig.1-A).

4.1.3 Sex

Out of the total of 17157 lambs born in all the eleven centres, 8242 were male and the remaining 8915 were female. The lamb mortality did not differ prominently between the two sexes. As could seen from table 4, out of 2074 lamb deaths, 1077 were female while 997 were male. The percentage of mortality with reference to total number of births was 13.21 and 13.20 in males and female respectively (Fig.2).

4.1.4 Breed

An attempt was made to assess the lamb mortality among different breeds surveyed across various centres. However, the same breeds did not figure in all the centres surveyed (Table 5). Therefore, five breeds viz., Dorest x Nellore, Mandya, Dorset x Mandya, Nellore brown, Nellore synthetic and Mandya were considered for comparison at the centre of Network programme on sheep improvement, Palamaner. Among the five breeds, the lamb mortality was maximum (53.61%) in Dorset x Nellore while the death of lambs of Mandya breed was the minimum with 2.24 per cent. Among the other breeds the percentage of mortality was in the order of 20.65, 15.19 and 8.73 per cent in the breeds of Dorset x Mandya, Nellore brown and Nellore synthetic respectively (Fig.3).

4.1.5 Season

The pattern of lamb mortality among different seasons, viz., Summer, monsoon and winter was assessed by survey from eleven centres across the state (Table 6). Out of the total number of 2266 lambs died in various centres, the maximum number of lambs (1103) died during the summer season with a mortality percentage of 48.68. The death of lambs was lowest (495) during monsoon season with a mortality percentage of 21.84 while 668 lamb deaths were recorded during winter season accounting to 29.48 per cent mortality. Regardless of the centre of survey, the pattern of lamb mortality with the season was almost similar (Fig.4).

4.1.6 Aetiology

Out of the total of 2266 lamb deaths recorded in the eleven centres surveyed, the cause of mortality was assessed (Table 7). Infectious diseases resulted in the largest number of lamb deaths (1759) with 77.63 per cent mortality. Regarding the mortality of the remaining lambs, non-infectious diseases and miscellaneous causes did not show any noticeable variation. As could be seen from the data from all the centres with 258 and 249 lamb deaths accounting to 11.38 and 10.99 per cent of mortality due to miscellaneous causes and non infectious diseases respectively (Fig.5).

4.1.6.1 Infectious

Out of the total of 2266 lamb deaths recorded across the eleven centres, surveyed, 1100 lambs died due to pneumonia accounting to 48.54 per cent (Table 7-A) (Fig.5). The other infectious causes of lamb mortality were parasitic enteritis, hepatitis, blue tongue and sheep pox which resulted in the death of lambs to the extent of 298,

191, 38 and 132, exhibiting the mortality percentage to 13.15, 8.43, 1.68 and 5.83 respectively. Thus, the maximum number of lamb deaths occurred due to pneumonia compared to other infectious causes.

4.1.6.2 Non-infectious

Similarly, different non-infectious causes resulted in varying number of lamb deaths (Table 7-B) (Fig.5). Among the non-infectious (SME) complex, dystocia, trembling and hypothermia were observed in the present study which caused the death of lambs to an extent of 111, 55, 55 and 28 representing to 4.90, 2.43, 2.43 and 1.24 per cent respectively. Obviously SME complex contemplated more number of lamb deaths than the other non-infectious causes noticed in the present study.

4.1.6.3 Miscellaneous

Out of the total of 2266 lamb deaths recorded in the eleven centres surveyed, miscellaneous causes resulted in the mortality of 258 lambs (Table 7-C) (Fig.5). Out of these 258, 111 lambs died due to heat stress, while 56 lambs died due to their poor birth weight, 37 lamb deaths were caused by predators, 34 lambs died due to copper deficiency and 20 lambs died by drinking the contaminated water, with a mortality percentage of 4.90, 2.47, 1.63, 1.50 and 0.88 respectively.

The percentage of lamb mortality due to different causes has been worked out to the total number of lambs died.

TABLE 1. INCIDENCE OF LAMB MORTALITY IN VARIOUS ORGANISED SHEEP FARMS FROM JANUARY 1985 TO DECEMBER 1994

S.No	Name of the Centre	Year	Total Lambs Born	Total Lambs Died	Percentage of Mortality
1.	Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chittoor District.	1985-94	471	51	10.82
2.	Net work Programme on sheep improvement, Palamaner Chittoor District	1985-94	2579	407	15.78
3.	Live Stock Research Station, Chintaladevi, Nellore District	1985-94	2845	346	12.16
4.	Composite Live Stock Farm, Chintaladevi, Nellore District	1985-94	2744	112	4.08
5.	Government sheep farm, Penukonda, Anantapur District	1985-94	888	75	8.44
6.	Ram Multiplication farm, Siddarampuram, Anantapur District	1985-94	1149	177	15.40
7.	Live Stock Research Station, Mahaboob Nagar	1993-94	324	69	21.29
8.	Government Live Stock farm, Mamnoor, Warangal District	1985-94	1528	140	9.16
9.	Sheep unit, Department of Animal Science, College of Veterinary Science, Rajendra Nagar, Hyderabad	1985-94	497	121	24.34
10.	Live stock Research Station, Garividi, Vizianagaram District	1993-94	167	50	29.94
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	1985-94	3965	718	18.10
		Total	**17157**	**2266**	**13.20**

TABLE 1-A. INCIDENCE OF LAMB MORTALITY IN DIFFERENT REGIONS OF ANDHRA PRADESH FROM JANUARY 1985 TO DECEMBER 1994

S.No	Name of the region		Name of the Centre	Year	Total lambs born	Total lambs died	Percentage of Mortality
I	Rayalaseema	1.	Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chittoor District.	1985-94	471	51	10.82
		2.	Net work Programme on sheep improvement, Palamaner, Chittoor Dist.	1985-94	2579	407	15.78
		3.	Government sheep farm, Penukonda, Anantapur District	1985-94	888	75	8.44
		4	Ram Multiplication Farm, Siddarampuram, Anantapur District	1985-94	1149	177	15.40
			Total		5087	710	13.95
II	Coastal	1.	Livestock Research Station, Chintaladevi, Nellore District	1985-94	2845	346	12.16
		2.	Composite Livestock Farm, Chintaladevi, Nellore District	1985-94	2744	112	4.08
		3.	Live stock Research Station, Garividi, Vizianagaram District	1993-94	167	50	29.94
			Total		5756	508	8.82
III	Telangana	1.	Live Stock Research Station, Mahaboob Nagar	1993-94	324	69	21.29
		2.	Government Live Stock farm, Mamnoor, Warangal District	1985-94	1528	140	9.16
		3.	Sheep unit, Department of Animal Science, College of Veterinary Science, Rajendra Nagar, Hyderabad	1985-94	497	121	24.34
		4.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	1985-94	3965	718	18.10
			Total		6314	1048	16.59

TABLE 2: STATUS OF DAM: WEIGHT OF DAM AT LAMBING AND ITS INFLUENCE ON LAMB MORTALITY

Dam's weight (Kgs)	Total number of Lambs died				
	Centre 1	Centre 2	Centre 3	Centre 4	Total
20 - 25	7	67	76	-	150
26 - 30	40	54	89	31	214
31 - 35	2	80	92	15	189
36 - 40	-	44	1	-	45
Total	49	245	258	46	598

Records of Dam's body weight at lambing was available only for 4 centres

Centre 1: Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chittoor District.

Centre 2: Network programme on sheep improvement, Palamaner, Chittoor district.

Centre 3: Live Stock Research Station, Chintaladevi, Nellore district

Centre 4: Live Stock Research Station, Garividi, Vizianagaram district.

TABLE 3: LAMB MORTALITY (%) IN RELATION TO AGE IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No	Name of the Centre	Total No. of lambs born	1st Month		2nd Month		3rd Month		4th Month	
			Total No. of lambs died	Lamb Mortality (%)	Total No. of lambs died	Lamb Mortality (%)	Total No. of lambs died	Lamb Mortality (%)	Total No. of lambs died	Lamb Mortality (%)
1.	Sheep unit. Department of Animal Science. College of Veterinary Science. Tirupati Chittoor District.	471	0	0	1	0.21	6	1.27	11	2.34
2.	Net work Programme on sheep improvement Palamaner. Chittoor Dist.	2579	48	1.86	74	2.87	50	1.94	73	2.83
3.	Live Stock Research Station. Chintaladevi. Nellore District	2845	24	0.84	63	2.21	71	2.50	46	1.62
4.	Composite Live Stock Farm. Chintaladevi. Nellore District	2744	15	0.55	31	1.13	18	0.65	9	0.32
5.	Government sheep farm. Pennkonda. Anantapur District	888	31	3.49	7	0.79	6	0.67	1	0.09
6.	Ram Multiplication farm. Siddarampuram. Anantapur District	1149	24	3.66	12	1.04	13	1.13	8	0.69
7.	Live Stock Research Station. Mahaboob Nagar	324	12	3.70	9	2.78	11	3.39	10	3.09
8.	Government Live Stock farm. Mamnoor. Warangal District	1528	24	1.57	22	1.44	20	3.39	23	1.50
9.	Sheep unit. Department of Animal Science. College of Veterinary Science. Rajendra Nagar. Hyderabad	497	10	2.01	9	1.81	7	1.31	10	2.01
10.	Live stock Research Station. Garividi. Vizianagaram District	167	7	4.19	6	3.59	6	3.59	6	3.59
11.	Large scale sheep breeding farm. Mamidipally. Ranga Reddy District	3965	135	3.40	185	4.67	128	3.22	79	1.99
	Total	**17157**	**330**	**1.92**	**419**	**2.44**	**336**	**1.95**	**276**	**1.61**

TABLE 3-A. LAMB MORTALITY (%) AT PRE-WEANING AND POST-WEANING IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total number of lambs died	Pre-weaning Deaths		Post-weaning Deaths	
			Deaths at Pre-weaning	Percentage of Mortality	Deaths at Post-weaning	Percentage of Mortality
1.	Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chitoor District.	51	0	0	51	100.00
2.	Net work Programme on sheep improvement, Palamaner Chittoor Dist.	407	154	37.83	253	62.16
3.	Live Stock Research Station, Chintaladevi, Nellore District	346	115	33.23	231	66.76
4.	Composite Live Stock Farm, Chintaladevi, Nellore District	112	53	47.32	59	52.67
5.	Government sheep farm, Penukonda, Anantapur District	75	67	89.33	8	10.66
6.	Ram Multiplication farm, Siddarampuram, Anantapur District	177	86	48.58	91	51.42
7.	Live Stock Research Station, Mahaboob Nagar	69	29	40.02	40	57.97
8.	Government Live Stock farm, Mannoor, Warangal District	140	53	37.85	87	62.15
9.	Sheep unit, Department of Animal Science, College of Veterinary Science, Rajendra Nagar, Hyderabad	121	29	23.96	92	76.03
10.	Live stock Research Station, Garividi, Vizianagaram District	50	20	40.00	30	60.00
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	718	335	46.65	383	53.35
	Total	**2266**	**941**	**41.52**	**1325**	**58.48**

TABLE 4. LAMB MORTALITY (%) IN RELATION TO SEX IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total Number of Births		Total Number of Deaths		Percentage of Mortality	
		Male	Female	Male	Female	Male	Female
1.	Sheep unit. Department of Animal Science. College of Veterinary Science. Tirupati. Chittoor District.	245	226	29	22	11.84	9.73
2.	Net work Programme on sheep improvement. Palamaner Chittoor Dist.	1297	1282	208	199	16.04	15.52
3.	Live Stock Research Station. Chintaladevi. Nellore District	1200	1645	187	159	15.58	9.67
4.	Composite Live Stock Farm. Chintaladevi. Nellore District	1239	1505	0	112	0	7.44
5.	Government sheep farm. Penukonda. Anantapur District	349	539	31	44	8.88	8.16
6.	Ram Multiplication farm. Siddarampuram. Anantapur District	929	220	91	86	9.80	39.10
7.	Live Stock Research Station. Mahaboob Nagar	162	162	48	21	29.63	12.96
8.	Government Live Stock farm. Mannoor. Warangal District	636	892	60	79	9.43	8.97
9.	Sheep unit. Department of Animal Science. College of Veterinary Science. Rajendra Nagar. Hyderabad	223	274	64	57	28.70	20.80
10.	Live stock Research Station. Garividi. Vizianagaram District	74	93	21	29	28.38	31.18
11.	Large scale sheep breeding farm. Mamidipally, Ranga Reddy District	1888	2077	350	368	18.54	17.72
	Total	**8242**	**8915**	**1089**	**1177**	**13.21**	**13.20**

TABLE 5: DISTRIBUTION OF MORTALITY IN LAMBS IN RELATION TO BREED IN ORGANISED SHEEP FARMS DURING 1985 TO 1994

S.No.	Name of the Centre	Breed	Total Number of Lambs born	Total Number of Lambs died	Percentage of Mortality
1.	Sheep Farm: Department of Animal Science. C.V.Sc., Tirupati	Nellore Brown	471	51	10.82
2.	Net work programme on sheep improvement. Palamaner Chittoor District	Dorset cross x Mandya	184	38	20.65
		Dorset cross x Nellore	235	126	53.61
		Mandya	490	11	2.24
		Nellore Brown	1454	221	15.19
		Nellore Synthetic	126	11	8.73
3.	Livestock Research Station: Chintaladevi: Nellore District	Nellore Jodipi	1328	268	20.18
		Nellore white	938	70	7.46
		Nellore Black	579	8	1.38
4.	Composite livestock farm: Chintaladevi	Nellore Jodipi	1082	98	9.05
		Nellore white	1004	14	1.39
		Nellore Black	648	Nil	Nil
5.	Government sheep farm Penukonda: Anantapur District	Bellary	260	18	6.92
		Corriedale x Bellary	492	55	11.17
		Nellore Brown	136	2	1.47
6.	Ram Multiplication Farm: Sidarampuram Anantapur District	Nellore Brown	1149	117	10.18
7.	Livestock Research Station: Mahaboob Nagar	Deccani	218	50	22.93
		Corriedale x Deccani cross	106	19	17.92
8.	Government Livestock farm: Mamnoor : Warangal District	Deccani	214	1	0.46
		Corriedale x Deccani cross	794	75	9.44
		Nellore Brown	520	64	12.30
9.	Sheep farm: Department of Animal Science, CVSc., Rajendranagar, Hyderabad	Deccani	282	86	30.50
		Nellore Jodipi	205	35	17.07
10.	Livestock Research Station, Garividi, Vizianagaram District	Nellore Jodipi	167	50	29.94
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	Corriedale x Deccani cross	912	176	19.29
		Rambouillet x Deccani cross	435	42	9.65
		Deccani	2618	500	19.10

TABLE 6. PERCENTAGE OF LAMB MORTALITY DURING DIFFERENT SEASONS IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No	Name of the Centre	Total number of lambs died	Summer		Monsoon		Winter	
			Number of lambs died	Percentage of lamb mortality	Number of lambs died	Percentage of lamb mortality	Number of lambs died	Percentage of lamb mortality
1.	Sheep unit. Department of Animal Science. College of Veterinary Science. Tirupati. Chittoor District.	51	15	29.42	31	60.78	5	9.80
2.	Net work Programme on sheep improvement. Palamaner. Chittoor Dist.	407	320	78.62	22	5.40	65	15.98
3.	Livestock Research Station. Chintaladevi. Nellore Dist.	346	182	52.60	64	18.49	100	28.91
4.	Composite Livestock Farm. Chintaladevi. Nellore Dist.	112	70	62.50	17	15.18	25	22.32
5.	Government sheep farm. Penukonda. Anantapur Dist.	75	21	28.00	45	60.00	9	12.00
6.	Ram Multiplication farm. Siddarampuram. Anantapur Dist.	177	24	13.55	91	51.42	62	35.03
7.	Livestock Research Station. Mahaboob Nagar	69	19	27.54	10	14.49	40	57.97
8.	Government Livestock farm. Mamnoor. Warangal Dist.	140	76	54.29	31	22.14	33	23.57
9.	Sheep unit. Department of Animal Science. College of Veterinary Science. Rajendra Nagar. Hyderabad	121	25	20.66	52	42.98	44	36.36
10.	Livestock Research Station. Garividi. Vizianagaram Dist.	50	31	62.00	15	30.00	4	8.00
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	718	320	44.57	117	16.29	281	39.14
	Total	**2266**	**1103**	**48.68**	**495**	**21.84**	**668**	**29.48**

TABLE 7: INCIDENCE OF LAMB MORTALITY DUE TO NON-INFECTIOUS, INFECTIOUS AND MISCELLANEOUS CAUSES IN VARIOUS ORGANISED SHEEI FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total No. of lambs died	Cause of Death			Percentage of Mortality		
			Non-infectious	Infectious	Miscel-laneous	Non infectious	Infectious	Miscel-laneous
1.	Sheep unit. Department of Animal Science., College of Veterinary Science. Tirupati. Chittoor District.	51	12	31	8	23.53	60.78	15.69
2.	Net work Programme on sheep improvement. Palamaner. Chittoor District	407	61	324	22	14.99	79.61	5.40
3.	Live Stock Research Station. Chintaladevi. Nellore District	346	29	298	19	8.38	86.13	5.49
4.	Composite Live Stock Farm. Chintaladevi. Nellore District	112	5	87	10	13.39	77.68	8.93
5.	Government sheep farm. Pemkonda. Anantapur District	75	8	62	5	10.67	82.67	6.66
6.	Ram Multiplication farm. Siddarampuram. Anantapur District	177	22	125	30	12.43	70.62	16.95
7.	Live Stock Research Station. Mahaboob Nagar	69	4	59	6	5.80	85.50	8.70
8.	Government Live Stock farm, Mamnoor, Warangal District	140	14	110	16	10.00	78.57	11.43
9.	Sheep unit. Department of Animal Science. College of Veterinary Science. Rajendra Nagar, Hyderabad	121	18	96	7	14.88	79.34	5.78
10.	Live stock Research Station. Garividi. Vizianagaram District	50	7	39	4	14.00	78.0	8.00
11.	Large scale sheep breeding farm. Mamidipally, Ranga Reddy District	718	59	528	131	8.22	73.54	18.24
	Total	**2266**	**249**	**1759**	**258**	**10.99**	**77.63**	**11.38**

TABLE 7-A: INCIDENCE OF LAMB MORTALITY DUE TO INFECTIOUS CAUSES IN VARIOUS ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total No. of lambs died	Cause of Death					Percentage of Mortality				
			Pneu-monia	Parasitic enteritis	Hepa-titis	Blue Tongue	Sheep pox	Pneu-monia	Parasitic enteritis	Hepa-titis	Blue tongue	Sheep pox
1.	Sheep unit. Department of Animal Science. College of Veterinary Science. Tirupati. Chittoor District.	51	28	17	5	-	-	54.90	33.33	9.80	-	-
2.	Net work Programme on sheep improvement. Palamaner. Chittoor Dist.	407	205	25	17	-	70	50.37	6.14	4.18	-	17.20
3.	Live Stock Research Station. Chintaladevi. Nellore District	346	126	86	10	11	-	36.42	24.86	0.0003	0.00032	-
4.	Composite Live Stock Farm. Chintaladevi. Nellore District	112	97	2	1	-	-	86.61	1.79	0.89	-	-
5.	Government sheep farm. Pennkonda. Anantapur District	75	47	3	4	-	-	62.67	4.00	5.33	-	-
6.	Ram Multiplication farm. Siddarampuram. Anantapur District	177	49	10	20	-	-	27.68	5.65	11.30	-	-
7.	Live Stock Research Station. Mahaboob Nagar	69	36	20	6	3	-	52.17	28.99	8.70	4.35	-
8.	Government Live Stock farm. Mamnoor. Warangal District	140	72	16	6	14	21	51.43	11.43	4.29	10.00	15.00
9.	Sheep unit. Department of Animal Science. College of Veterinary Science. Rajendra Nagar. Hyderabad	121	50	32	1	1	-	41.32	26.45	0.83	0.83	-
10.	Live stock Research Station. Garividi. Vizianagaram District	50	25	2	-	-	-	50.00	4.00	-	-	-
11.	Large scale sheep breeding farm. Mamidipally. Ranga Reddy District	718	365	85	121	9	41	50.84	11.84	16.85	1.25	5.71
	Total	2266*	1170	298	191	38	132	48.54	13.15	8.43	1.68	5.83

TABLE 7-B: INCIDENCE OF LAMB MORTALITY DUE TO NON-INFECTIOUS CAUSES IN VARIOUS ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total No. of lambs died	Cause of Death				Percentage of Mortality			
			Dysto-cia	Hypo-thermia	SME complex	Trem-bling	Dysto-cia	Hypo-thermia	SME complex	Trem-bling
1.	Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chittoor District.	51	-	-	-	1	-	-	-	1.96
2.	Net work Programme on sheep improvement, Palamaner, Chittoor Dist.	407	15	5	22	16	3.69	1.23	5.41	3.93
3.	Live Stock Research Station, Chintaladevi, Nellore District	346	18	8	20	4	5.20	2.31	5.78	1.56
4.	Composite Live Stock Farm, Chintaladevi, Nellore District	112	1	-	2	1	0.89	-	1.78	0.89
5.	Government sheep farm, Penukonda, Anantapur District	75	2	-	5	2	2.67	-	6.67	2.67
6.	Ram Multiplication farm, Siddarampuram, Anantapur District	177	8	2	27	11	4.52	1.13	15.25	6.21
7.	Live Stock Research Station, Mahaboob Nagar	69	-	-	1	-	-	-	1.45	-
8.	Government Live Stock farm, Mamnoor, Warangal District	140	-	-	3	2	-	-	2.14	1.43
9.	Sheep unit, Department of Animal Science, College of Veterinary Science, Rajendra Nagar, Hyderabad	121	2	2	10	8	1.65	1.65	8.26	6.61
10.	Live stock Research Station, Garividi, Vizianagaram District	50	-	-	6	4	-	-	12.00	8.00
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	718	9	11	15	6	1.25	1.53	2.09	0.84
	Total	**2266**	**55**	**28**	**111**	**55**	**2.43**	**1.24**	**4.90**	**2.43**

TABLE 7-C: INCIDENCE OF LAMB MORTALITY DUE TO MISCELLANEOUS CAUSES IN VARIOUS ORGANISED SHEEP FARMS FROM 1985 TO 1994

S.No.	Name of the Centre	Total No. of lambs	Cause of Death					Percentage of Mortality				
			Copper deficiency	Heat stress	Predators	Contaminated drinking water	Poor birth weight	Copper deficiency	Heat stress	Predators	Contaminated drinking water	Poor birth weight
1.	Sheep unit, Department of Animal Science, College of Veterinary Science, Tirupati, Chittoor District.	51	-	-	-	-	-	-	-	-	-	-
2.	Net work Programme on sheep improvement, Palamaner, Chittoor Dist.	407	6	28	7	5	10	1.47	6.88	1.72	1.23	2.46
3.	Live Stock Research Station, Chintaladevi, Nellore District	346	8	32	10	5	8	2.31	9.25	2.89	1.45	2.31
4.	Composite Live Stock Farm, Chintaladevi, Nellore District	112	2	6	-	-	-	1.79	5.36	-	-	-
5.	Government sheep farm, Penukonda, Anantapur District	75	-	4	2	-	6	-	5.33	2.67	-	8.00
6.	Ram Multiplication farm, Siddarampuram, Anantapur District	177	6	18	10	6	10	3.39	10.17	5.65	3.39	5.65
7.	Live Stock Research Station, Mahaboob Nagar	69	-	2	-	-	1	-	2.90	-	-	1.45
8.	Government Live Stock farm, Mamnoor, Warangal District	140	-	2	2	-	2	-	1.43	1.43	-	1.43
9.	Sheep unit, Department of Animal Science, College of Veterinary Science, Rajendra Nagar, Hyderabad	121	4	2	-	-	9	3.31	1.65	-	-	7.44
10.	Live stock Research Station, Garividi, Vizianagaram District	50	-	7	-	-	6	-	14.00	-	-	12.00
11.	Large scale sheep breeding farm, Mamidipally, Ranga Reddy District	718	8	10	6	4	4	1.11	1.39	0.84	0.56	0.56
	Total	**2266**	**34**	**111**	**37**	**20**	**56**	**1.50**	**4.90**	**1.63**	**0.88**	**2.47**

FIG. 1: LAMB MORTALITY (%) IN RELATION TO AGE
IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

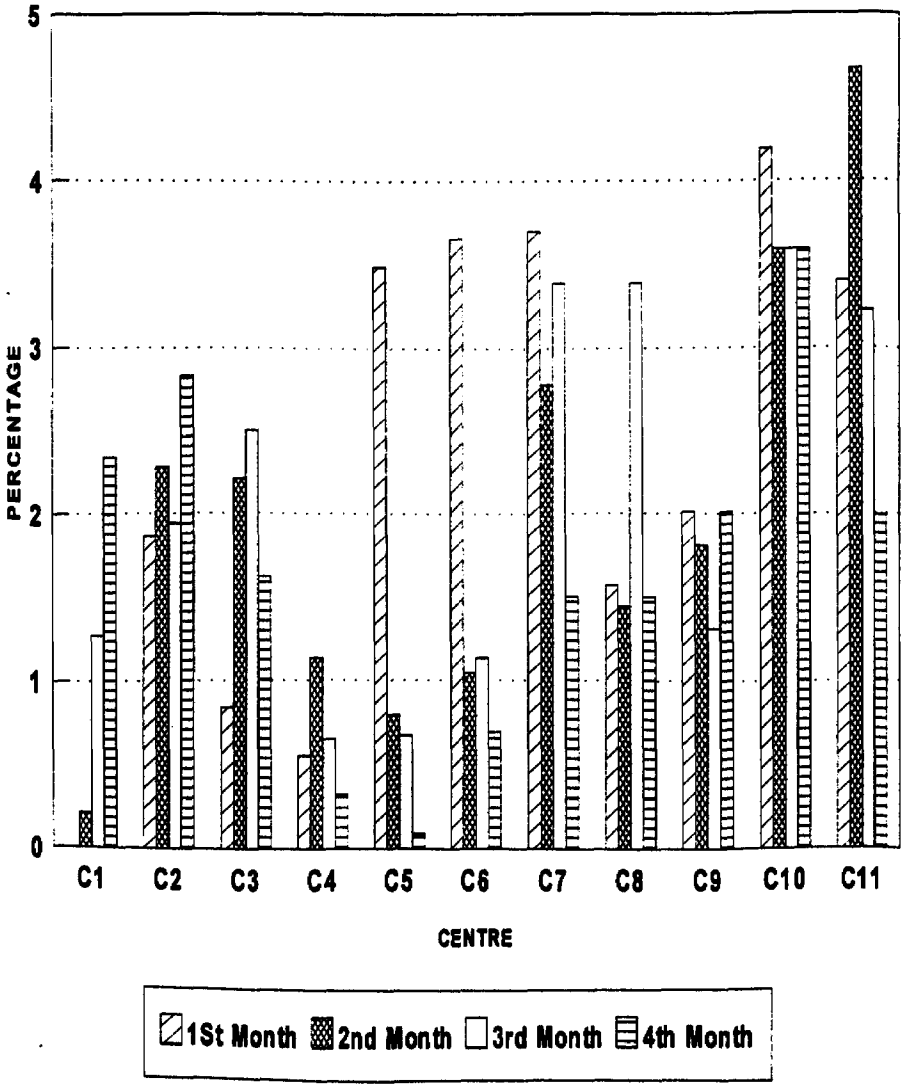


FIG. 1-A:LAMB MORTALITY (%) AT PRE-WEANING AND POST-WEANING IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

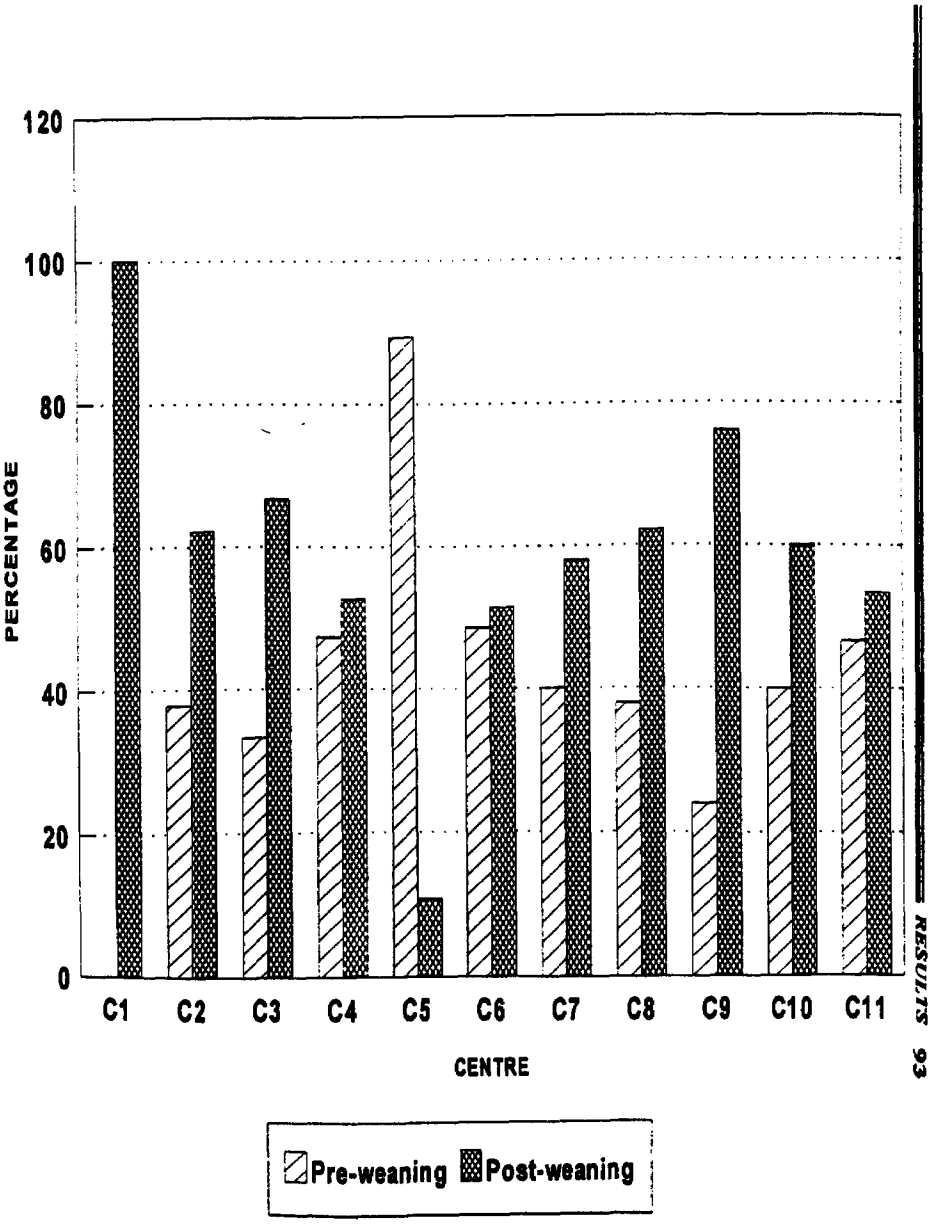


FIG. 2:LAMB MORTALITY (%) IN RELATION TO SEX
IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

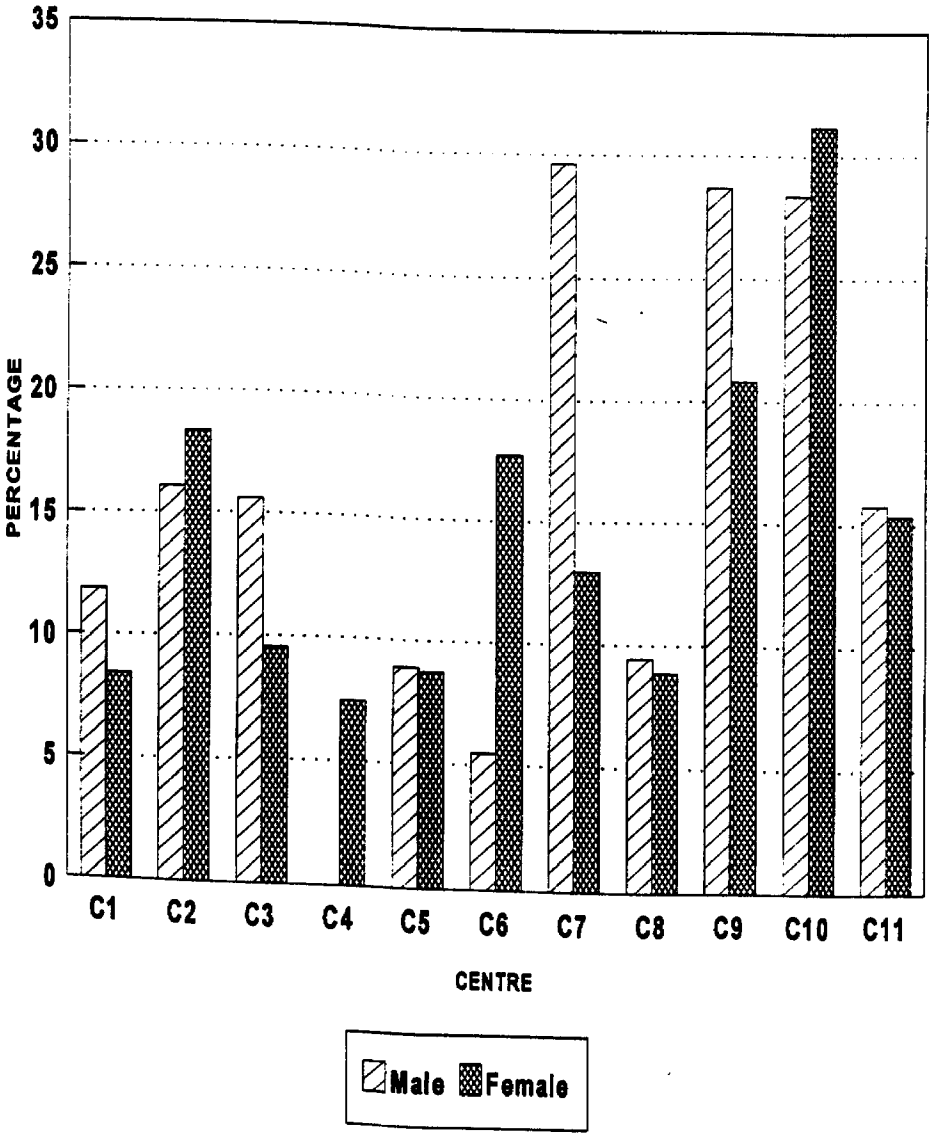


FIG. 3:LAMB MORTALITY (%) IN RELATION TO BREED IN "NET WORK PROGRAMME ON SHEEP IMPROVEMENT" PALAMANER, CHITTOOR DISTRICT, DURING 1985 TO 1994.

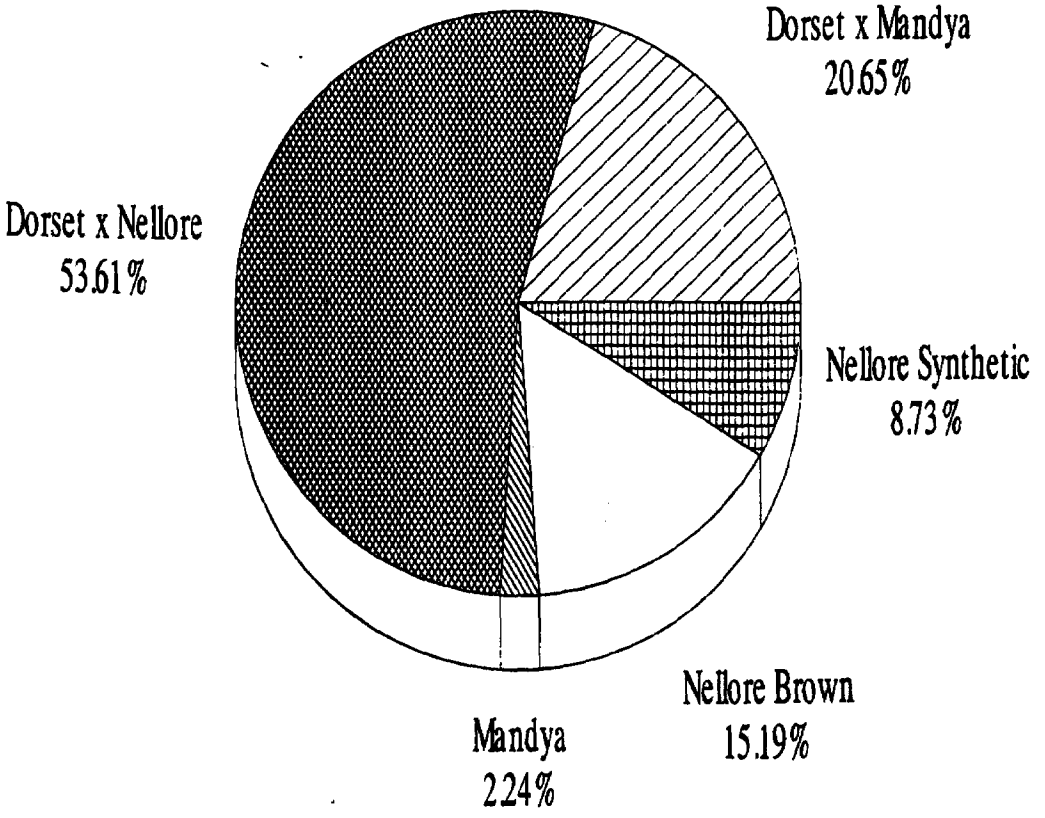


FIG. 4:LAMB MORTALITY (%) IN RELATION TO SEASON
IN ORGANISED SHEEP FARMS FROM 1985 TO 1994

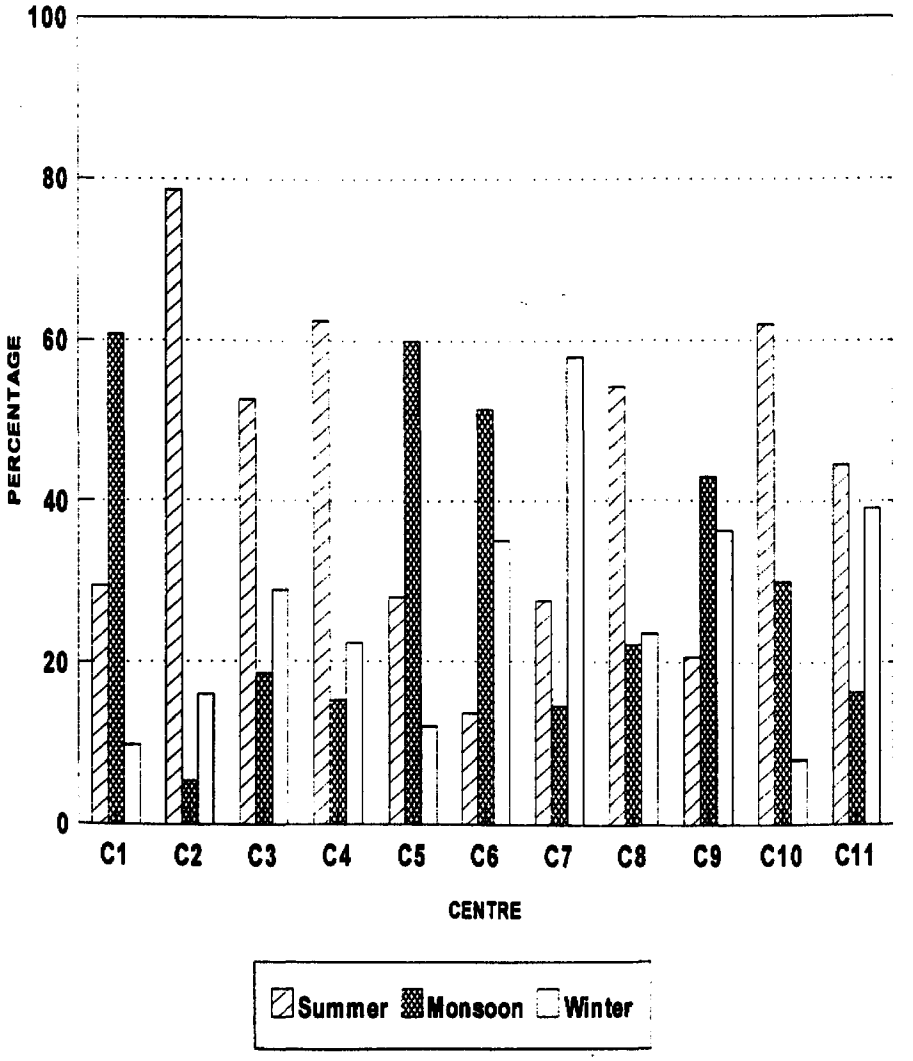
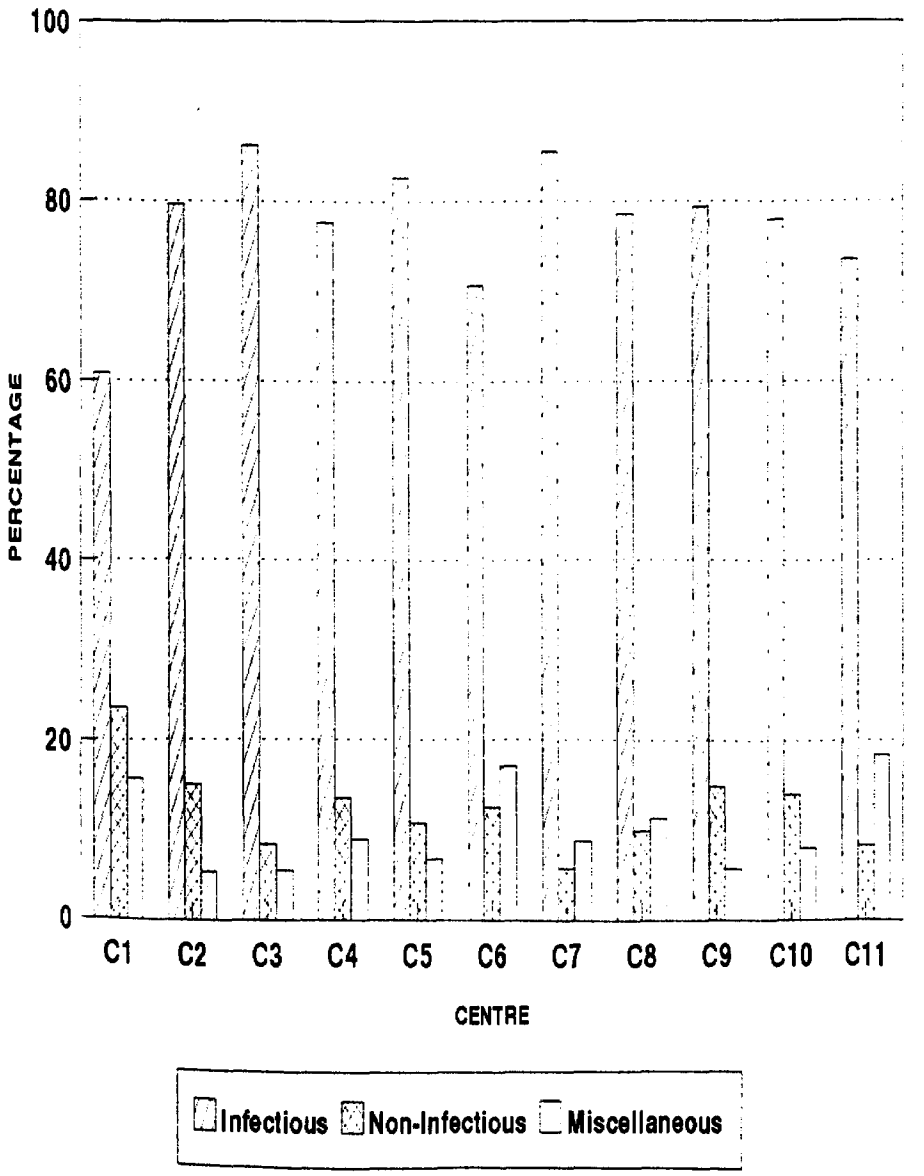


FIG. 5:LAMB MORTALITY (%) DUE TO DIFFERENT CAUSES IN ORGANISED SHEEP FARMS FROM 1985 TO 1994



4.2 HEALTHY CONTROL GROUP (GROUP I)

Detailed clinical observations, EPG, haematological, biochemical observations and their ANOVA treatment pertaining to healthy control (HC) group as well as group II, III, IV and V are summarised below. The 6 lambs of this group did not receive any treatment during the experimental period.

4.2.1 CLINICAL OBSERVATIONS

All the 6 lambs of this group were healthy and active through out the study. Their mean temperature, pulse and respiration rates were 102.33 ± 0.27°F, 82± 2.37/mt and 19.5± 0.34/mt respectively (Table 8-A). The appetite was fair and the consistency of faeces was semisolid to pellety. The visible mucous membranes were light red in colour. The skin was soft and pliable with smooth body coat (Plate 1).

4.2.2 EPG

Faecal examination of all the 6 lambs of this group revealed absence of any helminthic ova through out the study from the 0th day (Table 9).

4.2.3 HAEMATOLOGICAL OBSERVATIONS

Haematological observations in relation to Hb, PCV, TEC, MCV, MCH, MCHC, TLC and DLC and their ANOVA treatment are detailed below.

4.2.3.1 Haemoglobin (g%)

No significant difference was found in between the weekly observations of haemoglobin in lambs of this group. Mean haemoglobin values during this study ranged from 9.94 ± 0.29 and 10.14 ± 0.32 g% (Table 10 and 10-A) (Fig.6).

TABLE 8-A: PRE-TREATMENT CLINICAL MANIFESTATIONS IN LAMBS OF HC (HEALTHY CONTROL) GROUP

Lambs	General appear-rance	Tempa-rature (°F)	Pulse rate/ mm	Respi-ration rate/mm	Appe-tite	Visible mucous membranes	Consist-ency of faeces	Skin	Body coat	Interman-dibular oedema	Neck oedema	Others
1.	Active	101.8	74	20	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
2.	Active	102.4	78	20	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
3.	Active	103.0	86	18	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
4.	Active	101.6	80	19	Fair	Light red	Semisolid	Soft & Pliable	Smooth	-	-	-
5.	Active	103.2	84	20	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
6.	Active	102.0	90	20	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
Mean ± S.E.		102.33 ± 0.27	82 ± 2.37	19.5 ± 0.34								

PLATE 1: HEALTHY LAMB

TABLE 8-B: PRE-TREATMENT CLINICAL MANIFESTATIONS IN LAMBS OF BM (BANMINTH) GROUP

Lambs	General appear-rance	Tempa-rature (°F)	Pulse rate/ min	Respi-ration rate/min	Appe-tite	Visible mucous membranes	Consist-ency of faeces	Skin	Body coat	Interman-dibular oedema	Neck oedema	Others
1.	Dull	103.3	90	20	Poor	Pale	Diarrhoeic	Rough	Coarse	+	+	-
2.	Dull	102.6	84	20	Poor	Pale	Semi solid	Rough	Coarse	-	-	-
3.	Dull	103.5	82	19	Poor	Light red	Diarrhoeic	Rough	Coarse	-	-	-
4.	Dull	103.1	86	18	Fair	Light red	Pellety	Rough	Coarse	-	-	-
5.	Active	102.0	90	20	Fair	Light red	Diarrhoeic	Rough	Coarse	+	-	-
6.	Dull	102.8	84	17	Poor	Pale	Diarrhoeic	Rough	Coarse	+	-	-
Mean ± S.E.		102.88 ± 0.22	86 ± 1.37	19 ± 0.52								

23,14 A

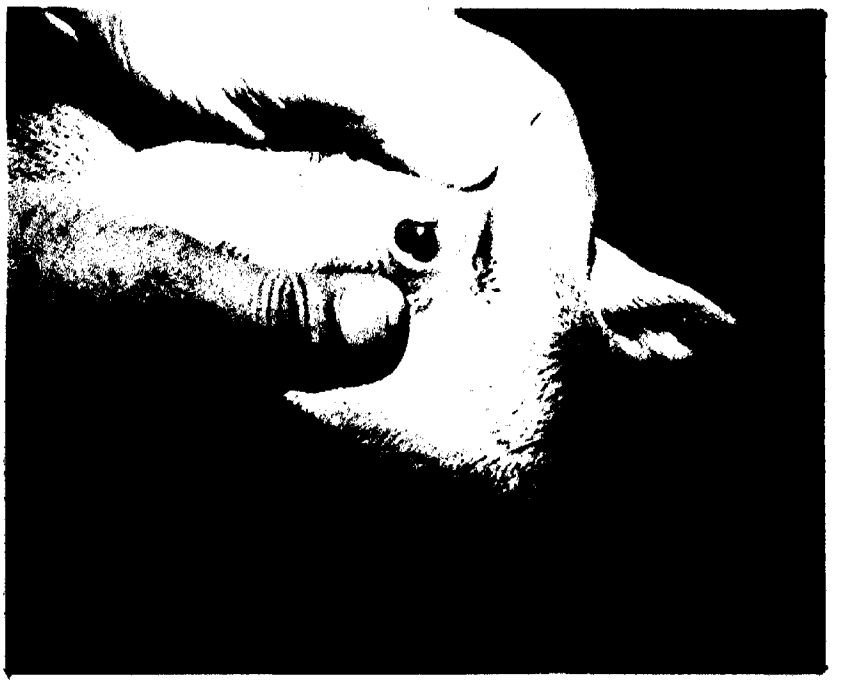


PLATE 2: LAMB INFECTED WITH HAEMONCHOSIS - PALE CONJUNCTIVAL MUCOUS MEMBRANE (ANAEMIC)

TABLE 8-C: PRE-TREATMENT CLINICAL MANIFESTATIONS IN LAMBS OF NX (NICLEX) GROUP

Lambs	General appear-rance	Tempa-rature (°F)	Pulse rate/ min	Respi-ration rate/mn	Appe-tite	Visible mucous membranes	Consist-ency of faeces	Skin	Body coat	Interman-dibular oedema	Neck oedema	Others
1.	Active	102.8	80	20	Fair	Light red	Pellety	Rough	Coarse	-	-	-
2.	Dull	103.5	90	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
3.	Dull	103.0	86	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
4.	Active	102.4	80	19	Fair	Pale	Pellety	Soft & Pliable	Coarse	-	-	-
5.	Dull	103.5	80	20	Poor	Pale	Pellety	Rough	Coarse	-	-	-
6.	Active	101.5	74	18	Fair	Light red	Pellety	Soft & Pliable	Smooth	-	-	-
Mean ± S.E.		102.78 ± 0.31	81.66 ± 2.27	18.83 ± 0.40								

PLATE 3: LAMB INFECTED WITH MONIEZIASIS - ROUGH HAIR COAT AND WEAK IN CONDITION

TABLE 8-D: PRE-TREATMENT CLINICAL MANIFESTATIONS IN LAMBS OF FX (FASINEX) GROUP

Lambs	General appear-rance	Tempa-rature (°F)	Pulse rate/ min	Respi-ration rate/min	Appe-tite	Visible mucous membranes	Consist-ency of faeces	Skin	Body coat	Interman-dibular oedema	Neck oedema	Others
1.	Dull	103.2	90	20	Poor	Pale	Diarrhoeic	Rough	Coarse	+	-	-
2.	Dull	103.1	80	20	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
3.	Dull	102.8	90	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
4.	Dull	101.8	86	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
5.	Dull	102.4	80	20	Poor	Pale	Diarrhoeic	Rough	Coarse	+	-	-
6.	Dull	101.8	78	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
Mean ± S.E.		162.51 ± 0.25	84 ± 2.19	19 ± 0.45								

PLATE 4: LAMB INFECTED WITH FASCIOLIASIS - EMACIATED WITH ROUGH HAIR COAT

TABLE 8-E: PRE-TREATMENT CLINICAL MANIFESTATIONS IN LAMBS OF EX (EXINOT) GROUP

Lambs	General appear-rance	Tempa-rature (°F)	Pulse rate/ min	Respi-ration rate/min	Appe-tite	Visible mucous membranes	Consist-ency of faeces	Skin	Body coat	Interman-dibular oedema	Neck oedema	Others
1.	Dull	103.0	90	20	Poor	Pale	Semi solid	Rough	Coarse	-	-	-
2.	Dull	103.0	86	19	Poor	Pale	Semi solid	Rough	Coarse	-	-	-
3.	Dull	101.4	78	18	Poor	Pale	Semi solid	Rough	Coarse	+	-	-
4.	Dull	102.0	80	20	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
5.	Dull	102.8	90	18	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
6.	Dull	101.5	84	20	Poor	Pale	Diarrhoeic	Rough	Coarse	-	-	-
Mean ± S.E.		102.3 ± 0.30	86.66 ± 2.04	19.16 ± 0.40								

PLATE 5: LAMB INFECTED WITH MIXED INFECTION OF HAEMONCHOSIS AND FASCIOLIASIS - WEAK, DEBILITATED AND POOR BODY COAT WITH ALOPECIA

TABLE 9: WEEKLY OBSERVATIONS ON EPG IN LAMBS OF HEALTHY CONTROL AND TREATED GROUPS

Group	Day	Eggs per gram (EPG)						Mean ± SE
	Lambs	1	2	3	4	5	6	
Healhy control	0th	0	0	0	0	0	0	-
	7th	0	0	0	0	0	0	-
	14th	0	0	0	0	0	0	-
	21st	0	0	0	0	0	0	-
	28th	0	0	0	0	0	0	-
Banminth group	0th	1200	900	1100	1400	1000	1100	1116.67 ± 64.18
	7th	0	0	0	0	0	0	-
	14th	0	0	0	0	0	0	-
	21st	0	0	0	0	0	0	-
	28th	0	100	0	0	0	0	16.67 ± 15.21
Niclex group	0th	900	900	1000	900	900	1100	950 ± 31.17
	7th	0	0	0	0	0	0	-
	14th	0	0	0	0	0	0	-
	21st	0	0	0	0	0	0	-
	28th	100	0	0	100	0	100	50 ± 20.41
Fasinex group	0th	1000	1100	1100	900	1100	1000	1033.33 ± 30.42
	7th	0	0	0	0	0	0	-
	14th	0	0	0	0	0	0	-
	21st	0	0	0	0	0	0	-
	28th	0	0	0	0	0	0	-
Exinot group	0th	1400 *(H:800 & F:600)	1200 (H:700&F:500)	1200 (H:750&F:450)	1400 (H:900&F:500)	1400 (H:850&F:550)	1200 (H:700&F:500)	1300 ± 30.42 (H:783.33 ± 33.40 and F:516.67 ±19.38)
	7th	0	0	0	0.	0	0	-
	14th	0	0	0	0	0	0	-
	21st	0	0	0	0	0	0	-
	28th	0	0	0	0	0	0	-

*H: Haemonchus
F: Fasciola

4.2.3.2 Packed Cell Volume (%)

The mean PCV values ranged from 32.33 ± 1.46 to 34.17 ± 1.75. There was no significant difference between the weekly observations (Table 10 and 10-B) (Fig.7).

4.2.3.3 Total Erythrocyte Count (millions/cmm)

The mean TEC values ranged from 9.77 ± 0.21 to 10.57 ± 0.23. There was no significant difference between the weekly observations (Table 10 and 10-C) (Fig.8).

4.2.3.4 Mean Corpuscular Volume (fl)

The MCV values ranged from 32.11 ± 1.15 to 33.13 ± 0.85. There was no significant difference between the weekly observations (Table 11 and 11-A) (Fig.9).

4.2.3.5 Mean Corpuscular Haemoglobin (pg)

No significant difference was noticed among the weekly findings. The mean MCH values ranged from 9.58 ± 0.11 to 10.02 ± 0.10 (Table 11 and 11-B) (Fig.10).

4.2.3.6 Mean Corpuscular Heamoglobin Concentration (%)

The mean MCHC values ranged between 29.85 ± 0.62 and 30.88 ± 0.65. There was no significant difference at any weekly interval (Table 11 and 11-C) (Fig.11).

4.2.3.7 Total Leukocyte Count (thousands/cmm)

There was no significant difference in TLC values among weekly observations. The mean TLC values ranged from 9.96 ± 0.31 to 10.28 ± 0.26 (Table 11 and 11-A) (Fig.12).

4.2.3.8 Differential Leukocyte Counts (%)

Weekly observations of DLC in this group and statistical comparison are presented in Table 12 and 12-A, 12-B, 12-C, 12-D and 12-E. The weekly means of neutrophils during this study varied between 35.00 ± 1.67 and 36.83 ± 1.67, whereas lymphocytes, eosinophils, basophils and monocytes varied between 55.17 ± 1.57 and 57.50 ± 1.64; 4.17 ± 0.44 and 5.17 ± 0.28; 0.50 ± 0.31 and 1.00 ± 0.33 and 1.83 ± 0.37 and 2.25 ± 0.34 respectively. There was no significant difference between the weekly observations (Fig.13).

4.2.4 BIOCHEMICAL OBSERVATIONS

4.2.4.1 Total Serum Protein (g/dl) and A/G Ratio

The total serum protein, albumin and globulin values remained fairly constant throughout the study, ranging between 5.82 ± 0.04 and 6.42 ± 0.20, 2.58 ± 0.13 and 3.13 ± 0.03 and 2.68 ± 0.07 and 3.84 ± 0.11 respectively (Table 13, 13-A, 13-B and 13-C) whereas, serum albumin and globulin ratio ranged between 0.72 ± 0.03 and 1.17 ± 0.04 (Table 13 and 13-C) (Fig.20,21,22 and 23). The variation between weekly observations of total serum protein, serum albumin, serum globulin and albumin and globulin ratio was statistically non significant.

4.2.4.2 Serum Amino Transferases (units/ml)

The mean AST and ALT values during the study were ranged from 76.11 ± 0.15 to 78.19 ± 1.03 and 17.49 ± 0.08 to 17.93 ± 0.16 (Table 14, 14-A and 14-B)

(Fig.24 and 25) respectively. There was no significant difference among weekly observations.

4.3 THERAPEUTIC TRIALS

4.3.1 BANMINTH GROUP (GROUP II)

4.3.1.1 CLINICAL OBSERVATIONS

Out of 6 lambs in this group 4 lambs have shown poor appetite with pale visible mucous membranes and diarrhoea. The remaining 2 lambs exhibited fair appetite and light red mucous membranes with semisolid and pellety faeces. Their skin was rough with a coarse body coat. 3 lambs have shown inter mandibular oedema whereas 2 lambs exhibited neck oedema. One lamb exhibited oedema of both neck and inter mandibular space (Table 8-B). However the general symptoms like weakness, unthriftiness, anaemia and emaciation also observed (Plate 2). The mean temperature, pulse and respiration rates were 102.88 ± 0.22°F, 86 ± 1.37/mt and 19 ± 0.52/mt respectively (Table 8-B). By 7th day after treatment there was a great improvement in the clinical condition of the lambs and by 14th the clinical signs that were noticed initially disappeared and the general condition of all the lambs of this group after treatment was apparently normal.

4.3.1.2 EPG

The pre-treatment mean EPG value was 1116.67±64.18. On 7th, 14th and 21st days of post treatment no eggs could be detected in the faeces of all 6 lambs while on

28th day in one lamb re-infection was noticed with a mean EPG of 16.67 ± 15.21 (Table 9).

4.3.1.3 HAEMATOLOGICAL OBSERVATIONS

4.3.1.3.1 Haemoglobin (g%)

The pre-treatment mean value was 7.67±0.17 and it was found to be significantly (P<0.01) lower than the healthy control group value. From 7th day onwards an increasing trend was observed upto 28th day. A significant difference (P<0.01) was noticed when compared to healthy control group at any interval whereas on 28th day the difference was significant at 5% level (Table 10 and 10-A) (Fig.6). No significant difference was observed at any interval when compared to Group V. The mean values were almost similar in both the groups (Table 15 and 15-A) (Fig.6-A).

4.3.1.3.2 Packed Cell Volume (%)

The pre-treatment mean value was 24.33 ± 0.96 which was significantly lower (P<0.01) than that of healthy control group value. A gradual increase in PCV value was observed upto 21st day. The mean PCV value decreased to 31.17 ± 0.98 with a significant difference (P<0.05) on 28th day from healthy control group (Table 10 and 10-B) (Fig.7).

A significant difference (P<0.05) was noticed only on 21st day when compared to Group V (Table 15 and 15-B) (Fig.7-A).

4.3.1.3.3 Total Erythrocyte Count (millions/cmm)

The mean pre-treatment value was 7.83 ± 0.38 which was significantly lower ($P<0.01$) than that of healthy control group value. A gradual increase in TEC value was noticed upto 28th day with a significant decrease ($P<0.01$) when compared to healthy control group at any weekly observations (Table 10 and 10-C) (Fig.8).

No significant difference was observed at any weekly observations when compared to Group V lambs (Table 15 and 15-C) (Fig.8-A).

4.3.1.3.4 Mean Corpuscular Volume (fl)

The mean pre-treatment value was 31.32 ± 1.44 which was did not differ significantly when compared to healthy control group value. An increased trend was observed upto 28th day at any weekly observations (Table 11 and 11-A) (Fig.9) while no significant difference was observed when compared to Group V (Table 16 and 16-A) (Fig.9-A).

4.3.1.3.5 Mean Corpuscular Haemoglobin (pg)

The mean pre-treatment value 9.90 ± 0.46 was found non-significant when compared to healthy control group value. The value was 9.88 ± 0.16 at 28th day, indicating the MCH values were almost similar at any weekly observations (Table 11 and 11-B) (Fig.10), whereas no significant difference was observed when compared to Group V (Table 16 and 16-B) (Fig.10-A).

4.3.1.3.6 Mean Corpuscular Haemoglobin Concentration (%)

The mean MCHC values ranged from 31.68 ± 0.74 to 31.07 ± 1.45. There was no significant difference at any weekly interval when compared to healthy control group and group V. (Table 11, 11-C, 16 and 16-C) (Fig.11 and 11-A).

4.3.1.3.7 Total Leukocyte Count (thousands/cmm)

The mean pre-treatment value was 7.33 ± 0.22 which differed significantly with that of healthy control lambs. The TLC value was gradually increased to 9.23 ± 0.14 by 28th day, indicating an increased trend at any weekly interval (Table 11 and 11-D) (Fig.12). A non significant difference was observed when compared to Group V (Table 11 and 11-B) (Fig.12-A).

4.3.1.3.8 Differential Leukocyte Count (%)

The mean pre-treatment neutrophils, lymphocytes, eosinophils, basophils and monocytes values were 55.33 ± 2.72, 35.83 ± 2.17, 6.33 ± 0.80, 0.65 ± 0.30 and 1.83 ± 0.60 respectively. A significant increase ($P<0.01$) in neutrophils and eosinophils and significant decrease in lymphocytes ($P<0.01$) was observed when compared to healthy control lambs whereas the basophils and monocytes values were non-significant. The neutrophils and eosinophils tended to lower upto 28th day, by which time they reached very closer to those of HC group. The lymphocytes have progressively improved upto 28th day by which time the difference was significant ($P<0.05$) with HC group. At any of the weekly observations, there was no significant difference in the count of basophils and monocytes between group II and HC group (Tables 12, 12-A, 12-B, 12-C, 12-D and 12-E). There was no significant difference between any of the DLC fractions

owing any weekly intervals between group II and group V (Tables 17, 17-A, 17-B, 17-C, 17-D and 17-E) (Fig.17).

4.3.1.4 BIOCHEMICAL OBSERVATIONS

4.3.1.4.1 Total Serum Protein (g/dl) and A/G ratio

The mean pre-treatment serum total protein, albumin and globulin values was 5.76 ± 0.21, 2.20 ± 0.15 and 3.83 ± 0.36 respectively whereas serum albumin and globulin ratio was 0.62 ± 0.09. A significant difference ($P<0.01$) in serum total protein and albumin values and a non significant difference in globulin and A/G ratio values were observed when compared to healthy control lambs. On the 7th day the serum globulin and A/G ratio values showed a significant difference ($P<0.01$) whereas the other values were non significant at any weekly interval (Table 13, 13-A, 13-B, 13-C and 13-D) (Figs.20, 21, 22 and 23).

A non-significant difference in serum globulin and A/G ratio values on 0th day and serum total protein on 7th day were observed. A significant difference ($P<0.01$) in all the values at any weekly interval when compared to Group V were observed (Table 18, 18-A, 18-B, 18-C and 18-D) (Fig.20-A, 21-A, 22-A and 23-A).

4.3.1.4.2 Serum Amino Transferases (units/ml)

The mean pre-treatment AST and ALT values were 132.08 ± 9.01 and 24.78 ± 3.83 respectively. A significant difference ($P<0.01$) in both the values and also in AST value on 7th day was observed when compared to healthy control lambs.

However the values gradually returned to almost normal on 28th day (Table 14, 14-A and 14-B) (Fig.24 and 25).

A significant increase ($P<0.01$) in AST values on 0th and 7th day was noticed, while the difference in the values at other weekly intervals was observed to be non-significant compared to Group V. The values of ALT did not differ significantly at any weekly interval between group II and group V. (Table 19, 19-A and 19-B) (Fig.24-A and 25-B).

4.3.2 NICLEX GROUP (GROUP III)

4.3.2.1 CLINICAL OBSERVATIONS

In this group, 3 lambs have shown poor appetite and the remaining 3 lambs had fair appetite. The colour of visible mucous membranes was pale in 4 lambs, whereas it was light red in 2 lambs. The consistency of faeces was pellety in 4 lambs and the other lambs were diarrhoeic. The skin was rough in 4 lambs, whereas it was soft and pliable with a smooth body coat in 2 lambs. The mean temperature, pulse and respiration rates were 102.78 ± 0.31°F, 81.66 ± 2.27/mt and 18.83 ± 0.40/mt respectively (Table 8-C). In general, all the lambs of this group were depressed and unthrifty (Plate 3). From 7th day after treatment, there was a remarkable improvement in the clinical condition of the lambs and by 14th day all the clinical signs that were noticed initially disappeared and the general condition of all the lambs of this group was apparently normal.

4.3.2.2 EPG

The pre-treatment mean EPG value was 950 ± 31.17. No egg could be detected on 7th, 14th and 21st day while on 28th day 3 lambs revealed re-infection with a mean EPG of 50 ± 2.41 (Table 9).

4.3.2.3 HAEMATOLOGICAL OBSERVATIONS

4.3.2.3.1 Haemoglobin (g%)

The pre-treatment mean haemoglobin value was 8.43 ± 0.15 and it was found to be significantly lower ($P<0.01$) than healthy control group value. From 7th day onwards an increasing trend was observed upto 28th day. A significant difference ($P<0.01$) was noticed on 7th and 14th day when compared to healthy control group while the values on 21st and 28th day were non significant (Table 10 and 10-A) (Fig.6).

A significant difference ($P<0.01$) was observed with a gradual increasing trend at any weekly interval when compared to Group V (Table 15 and 15-A) (Fig.6-A).

4.3.2.3.2 Packed Cell Volume (%)

The mean pre-treatment value was 25.33 ± 0.96 which was significantly lower ($P<0.01$) than healthy control group value. From 7th day an increasing trend was observed upto 28th day. A significant difference ($P<0.01$) was noticed on 7th and 14th day when compared to healthy control group whereas the values on 21st and 28th day were non significant (Table 10 and 10-B) (Fig.7).

A significant difference (P<0.05) was observed 21st day when compared to Group V (Table 15 and 15-B) (Fig.7-A).

4.3.2.3.3 Total Erythrocyte Count (millions/cmm)

Highly significant decrease (P<0.01) of the pre-treatment TEC mean value 8.20 ± 0.35 was observed in the lambs of this group when compared to healthy control group. On 7th and 14th day the levels increased significantly (P<0.01). The mean TEC values on 7th and 14th day were 8.58 ± 0.27 and 9.03 ± 0.27 respectively while the values on 21st and 28th day were significant at 5% level. From 7th day onwards an increasing trend was observed upto 28th day (Table 10 and 10-C) (Fig.8).

The pre-treatment mean values of group III were slightly higher than those of group V but did not differ significantly. There was an increasing trend in the mean TEC values at any interval of weekly observations except that a significant difference (P<0.05) was observed on 7th day when compared to Group V (Table 15 and 15-C) (Fig.8-A).

4.3.2.3.4 Mean Corpuscular Volume (fl)

The mean MCV value on 0th day was 31.14 ± 1.53 which was lower and not significant when compared to healthy control group value. The mean MCV values from 7th day upto 28th day were non significant when compared to healthy control group (Table 11 and 11-A) (Fig.9). No significant difference was observed during any weekly intervals when compared to group V (Table 16 and 16-A) (Fig.9-A).

4.3.2.3.5 Mean Corpuscular Haemoglobin (pg)

The mean pre-treatment MCH value was 10.35 ± 0.30 which was higher but not significant when compared to healthy control group. The mean MCH values on 7th day and 14th day 10.35 ± 0.24 and 10.39 ± 0.36 respectively and were non significant when compared to healthy control group. On 21st day the value was significant ($P<0.05$) and on 28th day it was highly significant ($P<0.01$). An increasing trend was observed from 7th day to 28th day (Table 11 and 11-B) (Fig.10).

The mean MCH value was non significant and higher when compared to Group V. From 7th day upto 28th day the values were highly significant ($P<0.01$) at any weekly observations (Table 16 and 16-B) (Fig.10-A).

4.3.2.3.6 Mean Corpuscular Haemoglobin Concentration (%)

The mean MCHC values of this group ranged between 33.48 ± 0.92 and 33.08 ± 1.23. The mean pre-treatment MCHC value was significantly higher than that of HC group. A significant decrease ($P<0.05$) on 7th and 28th day was noticed when compared to healthy control group. Whereas a non-significant increase was observed when compared to group V during any weekly observations (Table 11, 11-C, 16 and 16-C) (Fig. 11 and 11-A).

4.3.2.3.7 Total Leukocyte Count (thousands/cmm)

The mean pre-treatment TLC value was 7.50 ± 0.13 which was significantly lower than that of healthy control group. There was a gradual increasing trend noticed in weekly observations from 7th to 28th day with a significant difference found only on 7th day (Table 11 and 11-D) (Fig.12).

The mean TLC value on 0th day was 7.50 ± 0.13 which was higher but not significant when compared to Group V. However, an increasing trend was observed from 7th to 18th day (Table 16 and 16-D) (Fig.12-A).

4.3.2.3.8 Differential Leukocyte Count (%)

The mean pre-treatment neutrophils, lymphocytes, eosinophils, basophils and monocytes values were 53.50 ± 2.54, 39.33 ± 1.94, 5.83 ± 0.72, 0.50 ± 0.20 and 1.83 ± 0.55 respectively. A highly significant increase ($P<0.01$) in neutrophils and highly significant decrease in lymphocytes and a significant increase ($P<0.05$) in eosinophils and non significant difference in basophils and monocytes were observed when compared to healthy control group. After the treatment the neutrophils count decreased steadily with a proportionate increase in lymphocytes from 7th to 28th day. Eosinophils count also decreased progressively at any weekly observations, whereas basophils and monocytes counts did not vary throughout the experimental period between group III and HC group. On 7th day neutrophils and lymphocytes counts were highly significant ($P<0.01$), whereas on 14th day the values were significant at 5% level (Table 12, 12-A, 12-B, 12-C, 12-D and 12-E) (Fig.14).

The mean pre-treatment values of neutrophils, lymphocytes, eosinophils, basophils and monocytes were 53.50 ± 2.54; 39.33 ± 1.94; 5.83 ± 0.72; 0.50 ± 0.20 and 1.83 ± 0.55 respectively (Table 17, 17-A, 17-B, 17-C, 17-D and 17-E) (Fig.18). None of the DLC fractions differed significantly during any weekly interval when compared to Group V.

4.3.2.4 BIOCHEMICAL OBSERVATIONS

4.3.2.4.1 Total Serum Protein (g/dl) and A/G ratio

The mean pre-treatment values of serum total protein, albumin and globulin of this group were 5.72 ± 0.22, 2.07 ± 0.14 and 3.73 ± 015 respectively whereas albumin and globulin ratio was 0.57 ± 0.05. A significant difference ($P<0.01$) in serum total protein and albumin values and a non significant difference in globulin and A/G ratio values were observed when compared to healthy control group. On 7th day, the serum globulin values were significant ($P<0.05$) and the A/G ratio values were highly significant ($P<0.01$) whereas the other values were non significant at any weekly interval (Table 13, 13-A, 13-B, 13-C and 13-D) (Fig.20, 21, 22 and 23).

The mean serum albumin values were highly significant ($P<0.01$) while the serum total protein, serum globulin and serum albumin and globulin ratio were non significant on 0th day before treatment when compared to Group V. After treatment, on 7th day, serum total protein value was non significant, whereas the remaining values were highly significant ($P<0.01$) throughout the experiment upto 28th day when compared with Group V (Table 18, 18-A, 18-B, 18-C and 18-D) (Fig.20-A, 21-A, 22-A and 23-A).

4.3.2.4.2 Serum Amino Transferases (unit/ml)

Highly significant ($P<0.01$) increase of the mean pre-treatment AST value and a significant increase ($P<0.05$) of pre treatment ALT value were observed in this group when compared to healthy control group. The mean AST and ALT values before treatment were 112.77 ± 3.44 and 21.04 ± 1.98 respectively. No significant difference

was observed from 7th to 28th day in both AST and ALT values when compared to healthy control group (Table 13, 14-A and 14-B) (Fig.24 and 25).

No significant difference was observed in the pre treatment AST and ALT values when compared to Group V. After treatment on 7th day, highly significant difference ($P<0.01$) was observed in AST values while no significant difference was observed in the ALT value. The values of AST and ALT did not differ significantly upto 28th day when compared to Group V (Table 19, 19-A and 19-B) (Fig.24-A and 25-A).

4.3.3 FASINEX GROUP (GROUP IV)

4.3.3.1 CLINICAL OBSERVATIONS

In this group all the 6 lambs have shown poor appetite with pale mucous membranes and dull in general appearance. The consistency of faeces was diarrhoeic in all the lambs. The skin was rough and body coat was coarse in all the 6 lambs. One lamb exhibited oedema of both neck and inter mandibular space and in one lamb only intermandibular oedema (Bottle-Jaw) was observed, while the other 4 lambs did not exhibit oedema. However the other clinical symptoms like lack of vigour, debility, emaciation and depression were also observed (Plate 4). The mean temperature, pulse and respiration rates were 102.51 ± 0.25°F; 84 ± 2.19/mt and 19 ± 0.45/mt respectively prior to the therapeutic trial (Table 8-D).

7th day after treatment, there was a great improvement in the clinical condition of the lambs and by 14th day all the clinical signs noticed prior to the treatment were disappeared and the general condition of all the lambs was apparently normal.

4.3.3.2 EPG

The mean EPG value was 1033.33 ± 30.42 prior to the treatment. From 7th to 28th day after treatment no eggs could be detected in the faeces of all 6 lambs of this group (Table 9).

4.3.3.3 HAEMATOLOGICAL OBSERVATIONS

4.3.3.3.1 Haemoglobin (g%)

The mean pre-treatment haemoglobin value was 8.22 ± 0.16 and it was found to be significantly ($P<0.01$) lower than that of the healthy control group value. From the 7th day onwards an increasing trend was observed upto 28th day. A significant decrease ($P<0.01$) was noticed on 7th and 14th day when compared to healthy control group. whereas the values on 21st and 28th day were non significant and showed almost similar values that of healthy control (Table 10 and 10-A) (Fig.6).

A highly significant increase ($P<0.01$) upto 14th day and a significant increase ($P<0.05$) on 21st day and a non significant increase on 28th day were observed when compared to Group V (Table 15 and 15-A) (Fig.6-A).

4.3.3.3.2 Packed Cell Volume (%)

The mean pre-treatment value was 24.33 ± 0.96 which was significantly ($P<0.01$) lower than that of healthy control group value. From 7th day onwards, an increasing trend was observed upto 28th day. However the values were significantly lower ($P<0.01$) upto 21st day when compared to healthy control group (Table 10 and 10-B) (Fig.7).

On 21st day only, the values in this group showed a significant increase ($P<0.01$) when compared to Group V (Table 15 and 15-B) (Fig.7-A).

4.3.3.3.3 Total Erythrocyte Count (millions/cmm)

A highly significant decrease of the pre-treatment TEC mean value 8.13 ± 0.25 was observed in this group when compared to healthy control group value. On 7th and 14th day the values were significantly decreased ($P<0.01$) whereas on 21st day the value was 9.70 ± 0.16 which was significantly lower ($P<0.05$) when compared to healthy control value. On 28th day the value showed almost similar to that of healthy control value (Table 10 and 10-C) (Fig.8).

There was an increasing trend in the mean TEC values at any interval of weekly observations. A significant increase ($P<0.01$) on 7th day was noticed when compared to Group V while the difference was non significant during the remaining period upto 28th day (Table 15 and 15-C) (Fig.8-A).

4.3.3.3.4 Mean Corpuscular Volume (fl)

The mean MCV values on 0th day was 29.74 ± 1.39 which was lower but non significant when compared to healthy control group value. A non significant increase in these values from 7th day to 28th day were noticed (Table 11 and 11-A) (Fig.9). The values of MCV did not differ significantly with group V during any period of observation (Table 16 and 16-A) (Fig.9-A).

4.3.3.3.5 Mean Corpuscular Haemoglobin (pg)

The mean pre-treatment MCH value was 10.23 ± 0.40 which was non significant and higher than that of healthy control group value. A decrease in these values was noticed upto 28th day which was non significant at any weekly observations (Table 11 and 11-B) (Fig.10).

The pre-treatment mean MCH value was slightly higher but the difference was non significant when compared to Group V. From 7th day onwards also the values showed a non significant difference upto 28th day (Table 16 and 16-B) (Fig.10-A).

4.3.3.3.6 Mean Corpuscular Haemoglobin Concentration (%)

The mean MCHC values showed a non significant difference at any weekly interval when compared to healthy control group as well as group V. The values ranged between 34.20 ± 1.59 and 28.83 ± 0.92 (Table 11, 11-C, 16 and 16-C) (Fig. 11 and 11-A).

4.3.3.3.7 Total Leukocyte Count (thousands/cmm)

The mean pre-treatment TLC value was 7.58 ± 0.14 which was significantly lower when compared to healthy control group. A gradual increasing trend only was noticed upto 28th day with a significant difference ($P<0.05$) only on 7th day (Table 11 and 11-D) (Fig.12).

The mean TLC value on 0th day was 7.58 ± 0.14 which was higher but non significant when compared to Group V. However an increasing trend was noticed at any weekly observations upto 28th day without any significant difference with group V (Table 16 and 16-D) (Fig.12-A).

4.3.3.3.8 Differential Leukocyte Count (%)

The pre-treatment mean values of neutrophils, lymphocytes, eosinophils, basophils and monocytes were 55.50 ± 2.55; 38.33 ± 2.01; 5.17 ± 0.28; 0.17 ± 0.15 and 1.78 ± 0.33 respectively. Highly significant increase ($P<0.01$) in neutrophils and a significant decrease ($P<0.05$) in lymphocytes was observed when compared to healthy control group. After the treatment, from 7th day upto 28th day the neutrophils count decreased steadily with a proportionate increase in lymphocytes was observed (Table 12, 12-A and 12-B) (Fig.13). The eosinophils values decreased progressively at any weekly observations, but without any significant difference (Table 12 and 12-C) (Fig.15). No significant difference was noticed in the values of basophils ad monocytes through out the experimental period when compared to healthy control group (Table 12, 12-D and 12-E) (Fig.15).

The mean pre-treatment values of neutrophils, lymphocytes, eosinophils, basophils and monocytes were 55.50 ± 2.55; 38.33 ± 2.01; 5.17 ± 0.28; 0.17 ± 0.15 and 1.78 ± 0.33 respectively. After treatment from 7th to 28th day all the values of different DLC fractions were non significant when compared to Group V (Table 17, 17-A, 17-B, 17-C, 17-D and 17-E) (Fig.19).

4.3.3.4 BIOCHEMICAL OBSERVATIONS

4.3.3.4.1 Total Serum Protein (g/dl) and A/G ratio

The mean pre-treatment values of serum total protein, albumin and globulin of this group were 5.98 ± 0.21, 2.75 ± 0.22 and 3.08 ± 0.19 respectively whereas albumin and globulin ratio was 0.94 ± 0.15. A significant decrease ($P<0.05$) in serum total protein was noticed when compared to healthy control. The serum albumin and globulin ratio showed a highly significant difference ($P<0.01$) on 7th day and a significant difference ($P<0.05$) on 14th day while all the other values were non significant at any weekly observations (Table 13, 13-A, 13-B and 13-C) (Fig.20, 21, 22 and 23).

The mean serum albumin and serum albumin and globulin ratio values were highly significant ($P<0.01$) at any weekly observation from 0th day, 28th day when compared to group V. The serum total protein value die not differ significantly on 0th and 7th day but differed significantly ($P<0.05$) on 14th day and ($P<0.01$) 21st to 28th day, when compared to group V. The serum globulin value differed significantly (at 5% level on 0th day and 1% level from 7th to 28th day) when compared to group V. (Table 18, 18-A, 18-B, 18-C and 18-D) (Fig.20-A, 21-A, 22-A and 23-A).

4.3.3.4.2 Serum Amino Transferases (units/ml)

The pre-treatment mean values of AST and ALT were 128.61 ± 6.10 and 21.81 ± 2.16 respectively. A significant increase ($P<0.01$) in AST values on 7th and 14th day and non significant difference in the remaining weekly intervals were noticed when compared to healthy control whereas the ALT values showed a non significant

difference from 7th day to 28th day with significant difference ($P<0.05$) on 0th day when compared to HC group (Table 14, 14-A and 14-B) (Fig.24 and 25).

The AST and ALT values showed a non significant variation at any weekly interval upto 28th day except that the mean pre-treatment AST value showed a significant increase when compared to HC group ($P<0.05$) (Table 19, 19-A and 19-B) (Fig.24-A and 25-A).

4.3.4 EXINOT GROUP (GROUP V)

4.3.4.1 CLINICAL OBSERVATIONS

All the 6 lambs of this group have shown poor appetite with pale mucous membranes and dull in general appearance. The consistency of faeces was diarrhoeic in 3 lambs and semisolid in the other lambs. The skin was rough and body coat was coarse in all the 6 lambs. One lamb exhibited intermandibular oedema and in one lamb only oedema of neck was observed. The other clinical symptoms observed were weakness, anaemia, emaciation and depression. The mean temperature, pulse and respiration rates were 102.3 ± 0.30°F, 84.66 ±2.04/mt and 19.16 ± 0.40/mt respectively prior to the therapeutic trial (Table 8-E).

By 7th day after treatment, there was a great improvement in the clinical condition of the lambs and by 14th day all the clinical symptoms noticed prior to the treatment were disapppeared and the general condition of all the lambs was apparently normal.

4.3.4.2 EPG

The mean EPG value was 1300 ± 30.42 (Haemonchus 788.33 ± 33.40 and Fasciola 516.67 ± 19.38) prior to the treatment. From 7th to 28th day after treatment no eggs could be detected in the faeces of all lambs of this group (Table 9).

4.3.4.3 HAEMATOLOGICAL OBSERVATIONS

4.3.4.3.1 Haemoglobin (g%)

The mean pre-treatment haemoglobin was 7.22 ± 0.19 and it was found to be significantly lower ($P<0.01$) than that of the healthy control group. After treatment the values ranged from 7.92 ± 0.19 to 9.54 ± 0.20. A significant decrease was noticed ($P<0.01$) upto 21st day, while there was a significant decrease on 28th day at 5% level when compared to healthy control group (Table 10 and 10-A) (Fig.6).

4.3.4.3.2 Packed Cell Volume (%)

The mean value ranged from 23.67 ± 1.17 to 32.50 ± 1.26. There was a sigificant decrease ($P<0.01$) in these values upto 21st day when compared to healthy control group. However on 28th day the values showed a non significant difference with HC group (Table 10 and 10-B) (Fig.7).

4.3.4.3.3 Total Erythrocyte Count (millions/cmm)

The mean TEC value ranged from 7.47 ± 0.23 to 10.25 ± 0.09. A significant decrease ($P<0.01$) in these values was observed upto 21st day whereas on 28th day

these values showed a non significant decrease when compared to HC group (Table 10 and 10-C) (Fig.8).

4.3.4.3.4 Mean Corpuscular Volume (fl)

The mean MCV values ranged from 31.63 ± 0.86 to 31.64 ± 0.97. These values did not show any significant difference at any weekly interval when compared to healthy control group (Table 11 and 11-A) (Fig.9).

4.3.4.3.5 Mean Corpuscular Haemoglobin (pg)

A non significant decrease in MCH values was observed at any weekly interval, except on 7th day, when the values showed a significant decrease ($P<0.05$) when compared to healthy control group, the values ranged from 9.72 ± 0.37 to 9.30 ± 0.18 (Table 11 and 11-B) (Fig.10).

4.3.4.3.6 Mean Corpuscular Haemoglobin Concentration (%)

The mean MCHC values ranged from 31.01 ± 1.91 to 29.52 ± 0.88. These values showed a non significant difference at any weekly interval when compared to healthy control group (Table 11 and 11-C) (Fig.11).

4.3.4.3.7 Total Leukocyte Count (thousands/cmm)

The mean TLC values ranged between 7.07 ± 0.30 and 9.37 ± 0.16. The mean pre treatment value was significantly lower than HC group. The tLC values gradually increased from 7th to 28th day, with a significant difference was noticed only on 7th day, when compared to HC group (Table 11 and 11-D) (Fig.12).

4.3.4.3.8 Differential Leukocyte Count (%)

The mean neutrophils, lymphocytes, eosinophils, basophils and monocytes were ranged from 51.50 ± 2.99 to 32.00 ± 0.88; 40.50 ± 2.95 to 62.00 ± 0.88; 5.83 ± 0.28 to 3.00 ± 0.00; 0.33 ± 0.19 to 0.67 ± 0.19 and 1.83 ± 0.28 to 2.33 ± 0.30 respectively. The neutrophils and lymphocytes showed a significant difference ($P<0.01$) on 0th day and 7th day, while these values showed a significant difference ($P<0.05$) on 14th day. The remaining values showed a non significant difference at any weekly interval. The eosinophils, basophils and monocytes values showed a non significant difference at any weekly interval except tht the pre treatment eosinophils differed significantly when compared to healthy control group (Table 12, 12-A, 12-B, 12-C, 12-D and 12-E) (Fig.19).

4.3.4.4 BIOCHEMICAL OBSERVATIONS

4.3.4.4.1 Total Serum Protein (g/dl) and A/G ratio

The mean total serum protein, albumin and globulin values ranged from 5.12 ± 0.34 to 6.74 ± 0.17, 1.63 ± 0.16 to 2.56 ± 0.07 and 3.48 ± 0.22 to 4.17 ± 0.12 respectively while the serum albumin and globulin retio ranged 0.47 ± 0.04 to 0.61 ± 0.02. The mean pre-treatment values of serum total protein, serum albumin and serum albumin and globulin ratio were significantly ($P<0.01$) lower than those of HC group. The pre treatment serum globulin did not differ significantly with that of HC group. All the four serum biochemical parameters tended to increase progressively upt 28th day with a significant difference ($P<0.01$) with those of HC group during any of the post treatment weekly observations (Table 13, 13-A, 13-B, 13-C and 13-D) (Fig.20, 21, 22 and 23).

4.3.4.4.2 Serum Amino Transferases (units/ml)

The mean AST and ALT values ranged from 118.80 ± 6.19 to 74.72 ± 0.67 and 23.39 ± 1.63 to 17.17 ± 0.18. The AST values showed a significant increase ($P<0.01$) on 7th day and 14th day when compared to healthy control while the remaining values showed a non significant difference at the remaining weekly intervals. The mean pre treatment ALT value was significantly ($P<0.01$) higher than that of HC group, while the values did not differ significantly with HC group during any weekly interval after commencing the treatment with closantel (Table 14, 14-A and 14-B) (Fig.24 and 25).

Table 10: Comparison of heamatological means of treated groups with HC group

Group	Day	Mean values		
		Haemoglobin (g%)	PCV (%)	TEC (millions/cmm)
HC	0th	9.98 ± 0.30	33.17 ± 1.36	10.16 ± 0.25
	7th	9.94 ± 0.29	32.33 ± 1.46	9.77 ± 0.21
	14th	10.08 ± 0.30	33.83 ± 1.62	10.18 ± 0.25
	21st	10.05 ± 0.31	33.33 ± 1.74	10.37 ± 0.22
	28th	10.14 ± 0.32	34.17 ± 1.75	10.57 ± 0.23
BM	0th	7.67 ± 0.17**	24.33 ± 0.96**	7.83 ± 0.38**
	7th	8.21 ± 0.14**	27.50 ± 1.52**	8.37 ± 0.30**
	14th	8.64 ± 0.10**	27.42 ± 1.69**	8.80 ± 0.23**
	21st	9.23 ± 0.15**	32.00 ± 1.35	9.56 ± 0.25**
	28th	9.61 ± 0.23*	31.17 ± 0.98*	9.75 ± 0.21**
NX	0th	8.43 ± 0.15**	25.33 ± 0.96**	8.20 ± 0.35**
	7th	8.87 ± 0.10**	26.83 ± 1.14**	8.58 ± 0.27**
	14th	9.33 ± 0.06**	26.67 ± 1.04**	9.03 ± 0.27**
	21st	9.97 ± 0.11	32.00 ± 1.18	9.62 ± 0.21*
	28th	10.55 ± 0.05	32.17 ± 1.26	9.96 ± 0.19*
FX	0th	8.22 ± 0.16**	24.33 ± 0.96**	8.13 ± 0.25**
	7th	8.68 ± 0.19**	27.33 ± 0.69**	8.82 ± 0.26**
	14th	9.20 ± 0.20**	30.17 ± 0.89**	9.26 ± 0.18**
	21st	9.67 ± 0.23	32.83 ± 1.21	9.70 ± 0.16*
	28th	9.98 ± 0.27	34.83 ± 1.40	10.31 ± 0.05
EX	0th	7.22 ± 0.19**	23.67 ± 1.17**	7.47 ± 0.23**
	7th	7.92 ± 0.19**	25.50 ± 1.07**	7.90 ± 0.26**
	14th	8.47 ± 0.20**	28.83 ± 1.09**	8.99 ± 0.09**
	21st	9.05 ± 0.21**	29.17 ± 1.04**	9.63 ± 0.07*
	28th	9.54 ± 0.20*	32.50 ± 1.26	10.25 ± 0.09

**Significant at P<0.01
*Significant at P<0.05

Table 10-A: Abstracts of ANOVA - Haematological observations: Haemoglobin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.95	1.90
Among groups	4	25.98**	3.07*
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.68

Group	NX	HC	FX	BM	EX
Mean	10.55	10.14	9.98	9.61	9.54

Pre-treatment : CD : 0.60

Group	HC	NX	FX	BM	EX
Mean	9.98	8.43	8.22	7.67	7.22

** Significant at $P < 0.01$
* Significant at $P < 0.05$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 10-B: Abstracts of ANOVA - Haematological observations: PCV

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	7.56	8.94
Among groups	4	25.13**	2.65^{NS}
Error	20		

Means of pre-treatment are arranged in descending order

Pre-treatment : CD : 0.60

Group	HC	NX	FX	BM	EX
Mean	33.17	25.33	24.33	24.33	23.67

NS : Non-significant
** Significant at P < 0.01

Mean values grouped together by a common under line do not differ significantly among themselves

Table 10-C: Abstracts of ANOVA - Haematological observations: TEC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	3.63	0.98
Among groups	4	15.44**	2.99*
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.55

Group	HC	FX	EX	NX	BM
Mean	10.57	10.31	10.25	9.96	9.72

Pre-treatment : CD : 0.78

Group	HC	NX	FX	BM	EX
Mean	10.16	8.20	8.13	7.83	7.47

** Significant at $P < 0.01$
* Significant at $P < 0.05$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 11: Comparison of heamatological means of treated groups with HC group

Group	Day	Mean values			
		MCV (fl)	MCH (pg)	MCHC (%)	TLC (thousands/cmm)
HC	0th	32.56 ± 0.66	9.85 ± 0.09	30.20 ± 0.52	10.03 ± 0.27
	7th	32.82 ± 0.89	10.02 ± 0.10	30.88 ± 0.65	10.28 ± 0.26
	14th	33.13 ± 0.85	9.89 ± 0.07	29.96 ± 0.63	10.00 ± 0.25
	21st	32.11 ± 1.15	9.68 ± 0.14	30.32 ± 0.64	10.06 ± 0.19
	28th	32.23 ± 1.02	9.58 ± 0.11	29.85 ± 0.62	9.96 ± 0.31
BM	0th	31.32 ± 1.44	9.90 ± 0.46	31.68 ± 0.74	7.33 ± 0.22
	7th	33.28 ± 2.58	9.88 ± 0.40	30.31 ± 1.46	7.69 ± 0.23
	14th	32.54 ± 1.06	9.84 ± 0.25	30.81 ± 1.21	8.28 ± 0.24
	21st	33.30 ± 0.72	9.64 ± 0.19	31.09 ± 0.85	8.95 ± 0.19
	28th	32.11 ± 1.12	9.88 ± 0.16	31.07 ± 1.45	9.23 ± 0.14
NX	0th	31.14 ± 1.53	10.35 ± 0.30	33.48 ± 0.92*	7.50 ± 0.13
	7th	31.48 ± 1.92	10.35 ± 0.24	33.42 ± 1.53*	7.93 ± 0.11
	14th	30.36 ± 1.02	10.39 ± 0.36	31.10 ± 1.48	8.35 ± 0.08
	21st	33.39 ± 1.52	10.39 ± 0.22*	30.60 ± 1.53	8.97 ± 0.05
	28th	32.42 ± 1.62	10.61 ± 0.17**	33.08 ± 1.23*	9.32 ± 0.06
FX	0th	29.74 ± 1.39	10.23 ± 0.40	34.20 ± 1.57*	7.58 ± 0.14
	7th	31.55 ± 0.81	9.86 ± 0.38	32.22 ± 0.82	7.98 ± 0.09
	14th	32.81 ± 0.88	9.96 ± 0.32	30.60 ± 0.80	8.40 ± 0.08
	21st	33.98 ± 1.21	9.37 ± 0.27	29.62 ± 0.96	9.03 ± 0.05
	28th	34.94 ± 1.21	9.68 ± 0.31	28.83 ± 0.92	9.42 ± 0.05
EX	0th	31.63 ± 0.86	9.72 ± 0.37	31.01 ± 1.91	7.07 ± 0.30
	7th	30.53 ± 0.83	9.34 ± 0.18*	31.38 ± 1.57	7.68 ± 0.21
	14th	32.06 ± 1.17	9.42 ± 0.28	29.73 ± 1.13	8.33 ± 0.11
	21st	31.31 ± 1.12	9.40 ± 0.24	28.75 ± 1.26	9.05 ± 0.20
	28th	31.64 ± 0.97	9.30 ± 0.18	29.52 ± 0.88	9.73 ± 0.16

**Significant at P<0.01

*Significant at P<0.05

Table 11-A: Abstracts of ANOVA - Haematological observations: MCV

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.29	3.50
Among groups	4	0.72^{NS}	1.50^{NS}
Error	20		

NS : Non-significant

Table 11-B: Abstracts of ANOVA - Haematological observations: MCH

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	6.62	3.20
Among groups	4	1.08^{NS}	7.52**
Error	20		

Means post-treatment are arranged in descending order

Post-treatment : CD : 0.52

Group	NX	BM	FX	HC	EX
Mean	10.61	9.88	9.68	9.58	9.30

** Significant at $P < 0.01$
NS - Non-significant

Mean values grouped together by a common under line do not differ significantly among themselves

Table 11-C: Abstracts of ANOVA - Haematological observations: MCHC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	3.69	3.15
Among groups	3	2.33^{NS}	3.64^{*}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 1.58

Group	NX	BM	FX	HC	EX
Mean	32.05	30.82	30.32	30.25	29.85

NS - Non Significant

*Significant at P<0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 11-D: Abstracts of ANOVA - Haematological observations: TLC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.06	0.84
Among groups	4	24.69**	2.57
Error	20		

Means of pre-treatment are arranged in descending order

Pre - treatment : CD : 0 71

Group	HC	FX	NX	BM	EX
Mean	10.03	7.58	7.50	7.33	7.07

NS - Non-significant

** Significant at P < 0.01

Mean values grouped together by a common under line do not differ significantly among themselves

Table 12: Comparison of heamatological means of treated groups with HC group : DLC

Group	Day	Mean values				
		Neutrophils (%)	Lymphocytes (%)	Eosinophils (%)	Basophils (%)	Monocytes (%)
HC	0th	36.67 ± 1.68	55.67 ± 1.52	4.33 ± 0.30	0.50 ± 0.20	2.00 ± 0.41
	7th	36.83 ± 1.67	55.17 ± 1.57	4.67 ± 0.45	0.83 ± 0.37	2.25 ± 0.34
	14th	35.33 ± 2.24	56.33 ± 1.79	5.17 ± 0.28	1.00 ± 0.33	2.17 ± 0.28
	21st	35.00 ± 1.67	57.50 ± 1.64	4.83 ± 0.28	0.50 ± 0.20	2.17 ± 0.28
	28th	36.50 ± 1.50	57.00 ± 1.37	4.17 ± 0.44	0.50 ± 0.31	1.83 ± 0.37
BM	0th	55.33 ± 2.72**	35.83 ± 2.71**	6.33 ± 0.80	0.67 ± 0.30	1.83 ± 0.60
	7th	49.83 ± 2.70**	42.50 ± 2.65**	5.00 ± 0.47	0.83 ± 0.37	1.83 ± 0.28
	14th	38.17 ± 2.30	53.67 ± 2.24	5.67 ± 0.73	0.83 ± 0.28	1.67 ± 0.19
	21st	33.50 ± 0.66	59.50 ± 0.99	5.33 ± 0.80	0.33 ± 0.28	1.67 ± 0.19
	28th	33.50 ± 0.70	58.50 ± 0.70*	5.83 ± 0.60*	0.50 ± 0.20	1.67 ± 0.30
NX	0th	53.50 ± 2.54**	39.33 ± 1.94**	5.83 ± 0.72*	0.50 ± 0.20	1.83 ± 0.55
	7th	49.50 ± 2.64**	42.50 ± 2.34**	4.83 ± 0.68	1.25 ± 0.18	2.00 ± 0.62
	14th	42.67 ± 2.45*	50.00 ± 2.36*	4.67 ± 0.61	0.50 ± 0.31	2.33 ± 0.56
	21st	37.67 ± 1.45	55.17 ± 1.44	4.00 ± 0.24	0.83 ± 0.28	2.17 ± 0.28
	28th	36.75 ± 1.27	58.17 ± 1.61*	3.67 ± 0.30	0.67 ± 0.30	1.67 ± 0.38
FX	0th	55.50 ± 2.55**	38.33 ± 2.01**	5.17 ± 0.28	0.17 ± 0.15	1.78 ± 0.33
	7th	49.33 ± 1.99**	44.33 ± 2.13**	4.00 ± 0.33	0.50 ± 0.20	2.01 ± 0.18
	14th	40.83 ± 0.72	53.83 ± 0.95	3.33 ± 0.30*	0.67 ± 0.19	2.32 ± 0.42
	21st	37.17 ± 1.46	57.33 ± 1.28	3.17 ± 0.15*	0.67 ± 0.30	2.18 ± 0.19
	28th	33.83 ± 0.80	61.50 ± 0.51	3.00 ± 0.00	0.17 ± 0.15	2.08 ± 0.36
EX	0th	51.50 ± 2.99**	40.50 ± 2.95**	5.83 ± 0.28*	0.33 ± 0.19	1.83 ± 0.28
	7th	47.83 ± 3.04**	44.83 ± 2.25**	5.33 ± 0.45	0.67 ± 0.30	1.33 ± 0.45
	14th	42.83 ± 2.57*	49.17 ± 2.24*	4.67 ± 0.30	1.17 ± 0.15	2.17 ± 0.44
	21st	36.50 ± 1.47	56.00 ± 1.13	4.00 ± 0.24	1.17 ± 0.28	2.33 ± 0.38
	28th	32.00 ± 0.88	62.00 ± 0.88	3.00 ± 0.00	0.67 ± 0.19	2.33 ± 0.30

**Significant at P<0.01

*Significant at P<0.05

Table 12-A: Abstracts of ANOVA - Haematological observations: DLC: Neutrophils

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.31	0.87
Among groups	4	8.93**	2.69^{NS}
Error	20		

Means of pre-treatment are arranged in descending order

Pre-treatment : CD : 7.21

Group	FX	BM	NX	EX	HC
Mean	55.50	55.33	52.50	51.50	37.67

NS : Non-significant
** Significant at P < 0.01

Mean values grouped together by a common under line do not differ significantly among themselves

Table 12-B: Abstracts of ANOVA - Haematological observations - DLC: Lymphocytes

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.72	0.71
Among groups	4	13.23**	3.15*
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 3.61

Group	EX	FX	BM	NX	HC
Mean	62.00	61.50	58.50	58.17	57.00

Pre-treatment : CD : 6.31

Group	HC	EX	NX	FX	BM
Mean	55.67	40.50	39.33	38.33	35.83

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 12-C: Abstracts of ANOVA - Haematological observations - DLC: Eosinophils

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.48	1.50
Among groups	4	1.57^{NS}	9.82**
Error	20		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 1.09

Group	BM	HC	NX	FX	EX
Mean	5.83	4.17	3.67	3.00	3.00

NS : Non-significant

** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 12-D: Abstracts of ANOVA - Haematological observations - DLC: Basophils

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.05	0.28
Among groups	4	0.64^{NS}	0.51^{NS}
Error	20		

NS - Non-significant

Table 12-E: Abstracts of ANOVA - Haematological observations: DLC : Monocytes

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.32	0.59
Among groups	4	2.82^{NS}	2.13^{NS}
Error	20		

NS - Non-significant

Table 13: Comparison of serum biochemical means of treated groups with HC group

Group	Day	Mean values			
		Serum total protein (g/dl)	Serum Albumin (g/dl)	Serum Globulin (g/dl)	Serum Albumin and Globulin ratio
HC	0th	6.42 ± 0.20	2.58 ± 0.13	3.84 ± 0.11	0.73 ± 0.06
	7th	6.16 ± 0.15	2.79 ± 0.07	3.38 ± 0.09	0.72 ± 0.03
	14th	5.86 ± 0.03	2.74 ± 0.06	3.12 ± 0.07	0.88 ± 0.04
	21st	5.82 ± 0.04	3.13 ± 0.03	2.68 ± 0.07	1.17 ± 0.04
	28th	5.86 ± 0.03	3.10 ± 0.04	2.76 ± 0.03	1.12 ± 0.02
BM	0th	5.76 ± 0.21**	2.20 ± 0.15**	3.83 ± 0.36	0.62 ± 0.09
	7th	5.84 ± 0.13	2.96 ± 0.02	2.88 ± 0.12**	1.04 ± 0.04**
	14th	5.86 ± 0.02	2.95 ± 0.01	2.91 ± 0.02	1.01 ± 0.01
	21st	5.78 ± 0.02	2.94 ± 0.02	2.84 ± 0.03	1.04 ± 0.02
	28th	5.78 ± 0.02	2.92 ± 0.02	2.86 ± 0.03	1.02 ± 0.01
NX	0th	5.72 ± 0.22**	2.07 ± 0.14**	3.73 ± 0.15	0.57 ± 0.05
	7th	5.78 ± 0.02	2.96 ± 0.02	2.83 ± 0.02*	1.05 ± 0.01**
	14th	5.81 ± 0.02	2.95 ± 0.01	2.86 ± 0.02	1.03 ± 0.01
	21st	5.79 ± 0.03	2.94 ± 0.02	2.86 ± 0.03	1.03 ± 0.01
	28th	5.79 ± 0.03	2.92 ± 0.02	2.85 ± 0.02	1.03 ± 0.01
FX	0th	5.98 ± 0.21*	2.75 ± 0.22	3.08 ± 0.19	0.94 ± 0.15*
	7th	5.78 ± 0.08	2.94 ± 0.02	2.84 ± 0.08	1.07 ± 0.08**
	14th	5.85 ± 0.02	2.95 ± 0.01	2.90 ± 0.02	1.02 ± 0.01
	21st	5.83 ± 0.01	2.95 ± 0.01	2.88 ± 0.01	1.03 ± 0.01
	28th	5.82 ± 0.01	2.95 ± 0.01	2.88 ± 0.01	1.02 ± 0.01
EX	0th	5.12 ± 0.34**	1.63 ± 0.16**	3.48 ± 0.22	0.47 ± 0.04**
	7th	5.64 ± 0.23**	2.01 ± 0.10**	3.63 ± 0.15**	0.56 ± 0.02**
	14th	6.31 ± 0.15**	2.34 ± 0.11**	3.98 ± 0.05**	0.59 ± 0.02**
	21st	6.58 ± 0.18**	2.50 ± 0.10**	4.08 ± 0.09**	0.61 ± 0.02**
	28th	6.74 ± 0.17**	2.56 ± 0.07**	4.17 ± 0.12**	0.61 ± 0.01**

**Significant at P<0.01
*Significant at P<0.05

Table 13-A: Abstracts of ANOVA - Biochemical observations: Serum total protein

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.03	1.05
Among groups	4	4.17*	22.26**
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.25

Group	EX	HC	FX	NX	BM
Mean	6.74	5.86	5.82	5.79	5.78

Pre-treatment : CD : 0.68

Group	HC	FX	BM	NX	EX
Mean	6.46	5.83	5.76	5.72	5.12

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 13-B: Abstracts of ANOVA - Biochemical observations: Serum albumin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.39	0.94
Among groups	4	5.40**	20.59**
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.13

Group	HC	FX	BM	NX	EX
Mean	3.10	2.95	2.92	2.92	2.56

Pre-treatment : CD : 0.55

Group	FX	HC	BM	NX	EX
Mean	2.75	2.58	2.20	2.07	1.63

** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 13-C: Abstracts of ANOVA - Biochemical observations: Serum globulin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.27	1.18
Among groups	4	1.70^{NS}	98.97**
Error	20		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 0.17

Group	EX	FX	BM	NX	HC
Mean	4.17	2.88	2.86	2.85	2.76

NS - Non-significant
**Significant at P<0.01

Mean values grouped together by a common under line do not differ significantly among themselves

Table 13-D: Abstracts of ANOVA - Biochemical observations: Serum albumin and globulin ratio

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.22	0.76
Among groups	4	3.08*	143.28**
Error	20		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.048

Group	HC	NX	FX	BM	EX
Mean	1.122	1.026	1.024	1.023	0.614

Pre - treatment : CD : 0.29

Group	FX	HC	BM	NX	EX
Mean	0.94	0.67	0.62	0.57	0.47

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

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Table 14: Comparison of serum biochemical means of treated groups with HC group

Group	Day	Mean values	
		Aspartate amino transferase (units/ml)	Alanine amino transferase (units/ml)
HC	0th	78.19 ± 1.03	17.93 ± 0.16
	7th	78.05 ± 1.07	17.71 ± 0.19
	14th	77.91 ± 1.11	17.49 ± 0.08
	21st	76.11 ± 0.15	17.65 ± 0.20
	28th	77.22 ± 0.67	17.65 ± 0.20
BM	0th	132.08 ± 9.01**	24.78 ± 3.83**
	7th	103.60 ± 1.70**	18.53 ± 1.06
	14th	79.58 ± 1.16	19.47 ± 0.64
	21st	79.30 ± 1.23	18.15 ± 0.16
	28th	79.30 ± 1.23	18.02 ± 0.13
NX	0th	112.77 ± 3.44**	21.04 ± 1.98*
	7th	77.77 ± 0.67	17.87 ± 0.05
	14th	77.77 ± 0.67	17.87 ± 0.04
	21st	77.44 ± 0.74	17.84 ± 0.04
	28th	77.50 ± 0.34	17.85 ± 0.04
FX	0th	128.61 ± 6.10**	21.81 ± 2.16*
	7th	90.41 ± 3.04**	18.44 ± 0.32
	14th	78.05 ± 0.87	18.18 ± 0.33
	21st	76.11 ± 0.61	17.80 ± 0.05
	28th	76.24 ± 0.17	17.69 ± 0.03
EX	0th	118.80 ± 6.19**	23.39 ± 1.63**
	7th	89.16 ± 4.02**	17.76 ± 0.40
	14th	76.11 ± 0.91	17.32 ± 0.31
	21st	75.27 ± 0.75	17.06 ± 0.11
	28th	74.72 ± 0.67	17.17 ± 0.18

**Significant at P<0.01
*Significant at P<0.05

Table 14-A: Abstracts of ANOVA - Biochemical observations: AST

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	8.02	0.63
Among groups	4	27.31**	2.27^{NS}
Error	20		

Means of pre-treatment are arranged in descending order

Pre - treatment : CD : 12.00

Group	BM	FX	EX	NX	HC
Mean	132.08	128.61	118.80	112.77	78.19

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 14-B: Abstracts of ANOVA - Biochemical observations: ALT

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	4.76	3.60
Among groups	4	11.90^{NS}	7.19**
Error	20		

Means of pre-treatment are arranged in descending order

Pre-treatment : CD : 2.52

Group	BM	EX	FX	EX	HC
Mean	24.78	23.39	21.81	21.04	17.93

** Significant at $P < 0.01$
NS - Non significant

Mean values grouped together by a common under line do not differ significantly among themselves

Table 15: Comparison of haematological means of specific anthelmintic treated groups (BM, NX, FX) with Broad spectrum anthelmintic (EX) group

Group	Day	Mean Values		
		Haemoglobin (g%)	PCV (%)	TEC (millions/cmm)
EX	0th	7.22 ± 0.19	23.67 ± 1.17	7.47 ± 0.23
	7th	7.92 ± 0.19	25.50 ± 1.07	7.90 ± 0.26
	14th	8.47 ± 0.20	28.83 ± 1.09	8.99 ± 0.09
	21st	9.05 ± 0.21	29.17 ± 1.04	9.63 ± 0.07
	28th	9.54 ± 0.20	32.50 ± 1.26	10.25 ± 0.09
BM	0th	7.67 ± 0.17	24.33 ± 0.96	7.83 ± 0.38
	7th	8.21 ± 0.14	27.50 ± 1.52	8.37 ± 0.30
	14th	8.64 ± 0.10	27.42 ± 1.69	8.80 ± 0.23
	21st	9.23 ± 0.15	32.00 ± 1.35*	9.56 ± 0.25
	28th	9.61 ± 0.23	31.17 ± 0.98	9.75 ± 0.21
NX	0th	8.43 ± 0.15**	25.33 ± 0.96	8.20 ± 0.35
	7th	8.87 ± 0.10**	26.83 ± 1.14	8.58 ± 0.27*
	14th	9.93 ± 0.06**	26.67 ± 1.04	9.03 ± 0.27
	21st	9.97 ± 0.11**	32.00 ± 1.18*	9.62 ± 0.21
	28th	10.55 ± 0.05**	32.17 ± 1.26	9.96 ± 0.19
FX	0th	8.22 ± 0.16**	24.33 ± 0.96	8.13 ± 0.25
	7th	8.68 ± 0.19**	27.33 ± 0.69	8.82 ± 0.26**
	14th	9.20 ± 0.20**	30.17 ± 0.89	9.26 ± 0.18
	21st	9.67 ± 0.23*	32.83 ± 1.21**	9.70 ± 0.16
	28th	9.98 ± 0.27	34.83 ± 1.40	10.31 ± 0.05

**Significant at P<0.01

*Significant at P<0.05

Table 15-A: Abstracts of ANOVA - Haematological observations: Haemoglobin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.00	0.77
Among groups	3	8.47**	3.94*
Error	15		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.70

Group	NX	FX	BM	EX
Mean	10.55	9.97	9.61	9.54

Pre-treatment : CD : 0.57

Group	NX	FX	BM	EX
Mean	8.43	8.22	7.67	7.22

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 15-B: Abstracts of ANOVA - Haematological observations: PCV

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	16.91	12.29
Among groups	3	1.89^{NS}	5.02*
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 2.09

Group	FX	EX	NX	BM
Mean	34.83	32.50	32.17	31.17

NS : Non-significant
* Significant at $P < 0.05$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 15-C: Abstracts of ANOVA - Haematological observations: TEC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	9.58	2.75
Among groups	3	3.03^{NS}	3.75^{*}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 0.42

Group	FX	EX	NX	BM
Mean	10.31	10.25	9.95	9.72

NS : Non-significant
* Significant at $P < 0.05$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 16: Comparison of haematological means of specific anthelmintic treated groups (BM, NX, FX) with Broad spectrum anthelmintic (EX) group

Group	Day	Mean Values			
		MCV (fl)	MCH (pg)	MCHC (%)	TLC (thousands/cmm)
EX	0th	31.63 ± 0.86	9.72 ± 0.37	31.01 ± 1.91	7.07 ± 0.30
	7th	30.53 ± 0.83	9.34 ± 0.18	31.38 ± 1.57	7.68 ± 0.21
	14th	32.06 ± 1.17	9.42 ± 0.28	29.73 ± 1.13	8.33 ± 0.11
	21st	31.31 ± 1.12	9.40 ± 0.24	28.75 ± 1.26	9.05 ± 0.20
	28th	31.64 ± 0.97	9.30 ± 0.18	29.52 ± 0.88	9.73 ± 0.16
BM	0th	31.32 ± 1.44	9.90 ± 0.46	31.68 ± 0.74	7.33 ± 0.22
	7th	33.28 ± 2.58	9.88 ± 0.40	30.31 ± 1.46	7.69 ± 0.23
	14th	32.54 ± 1.06	9.84 ± 0.25	30.81 ± 1.21	8.28 ± 0.24
	21st	33.30 ± 0.72	9.64 ± 0.19	31.09 ± 0.85	8.95 ± 0.19
	28th	32.11 ± 1.12	9.88 ± 0.16	31.07 ± 1.45	9.23 ± 0.14
NX	0th	31.14 ± 1.53	10.35 ± 0.30	33.48 ± 0.92	7.50 ± 0.13
	7th	31.48 ± 1.92	10.35 ± 0.24**	33.42 ± 1.53	7.93 ± 0.11
	14th	30.36 ± 1.02	10.39 ± 0.36**	31.10 ± 1.48	8.35 ± 0.08
	21st	33.39 ± 1.52	10.39 ± 0.22**	30.60 ± 1.53	8.97 ± 0.05
	28th	32.42 ± 1.62	10.61 ± 0.17**	30.08 ± 1.23	9.32 ± 0.06
FX	0th	29.74 ± 1.39	10.23 ± 0.40	34.20 ± 1.57	7.58 ± 0.14
	7th	31.55 ± 0.81	9.86 ± 0.38	32.22 ± 0.82	7.98 ± 0.09
	14th	32.81 ± 0.88	9.96 ± 0.32	30.60 ± 0.80	8.40 ± 0.08
	21st	33.98 ± 1.21	9.37 ± 0.27	29.62 ± 0.96	9.03 ± 0.05
	28th	34.94 ± 1.21	9.68 ± 0.31	28.83 ± 0.92	9.42 ± 0.05

**Significant at P<0.01

*Significant at P<0.05

Table 16-A: Abstracts of ANOVA - Haematological observations: MCV

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.77	2.88
Among groups	3	0.39^{NS}	1.78^{NS}
Error	15		

NS : Non-significant

Table 16-B: Abstracts of ANOVA - Haematological observations: MCH

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	11.08	3.37
Among groups	3	1.65^{NS}	8.81^{**}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 0.68

Group	NX	BM	FX	EX
Mean	10.61	9.88	9.67	9.30

NS : Non-significant
** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 16-C: Abstracts of ANOVA - Haematological observations: MCHC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	4.52	1.88
Among groups	3	1.87^{NS}	2.69^{NS}
Error	15		

NS:Non significant

Table 16-D: Abstracts of ANOVA - Haematological observations: TLC

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.57	0.31
Among groups	3	1.38^{NS}	2.54^{NS}
Error	15		

NS - Non Significant

Table 17: Comparison of haematological means of specific anthelmintic treated groups (BM, NX, FX) with Broad spectrum anthelmintic (EX) group : DLC

Group	Day	Mean Values				
		Neutrophils (%)	Lymphocytes (%)	Eosinophils (%)	Basophils (%)	Monocytes (%)
EX	0th	51.50 ± 2.99	40.50 ± 2.95	5.83 ± 0.28	0.33 ± 0.19	1.83 ± 0.28
	7th	47.83 + 3.04	44.83 ± 2.25	5.33 ± 0.45	0.67 ± 0.30	1.33 ± 0.45
	14th	42.83 ± 2.57	49.17 ± 2.24	4.67 ± 0.30	1.17 ± 0.15	2.17 ± 0.44
	21st	36.50 ± 1.47	56.00 + 1.13	4.00 ± 0.24	1.17 ± 0.28	2.33 ± 0.38
	28th	32.00 ± 0.88	62.00 ± 0.88	3.00 ± 0.00	0.67 ± 0.19	2.33 ± 0.30
BM	0th	55.33 ± 2.72	35.83 ± 2.71	6.33 ± 0.80	0.67 ± 0.30	1.83 ± 0.60
	7th	49.83 ± 2.70	42.50 ± 2.65	5.00 ± 0.47	0.83 ± 0.37	1.83 ± 0.28
	14th	38.17 ± 2.30	53.67 ± 2.24	5.67 ± 0.73	0.83 ± 0.28	1.67 ± 0.19
	21st	33.50 ± 0.66	59.50 + 0.99	5.33 + 0.80	0.33 ± 0.28	1.67 ± 0.19
	28th	33.50 ± 0.70	58.50 + 0.70	5.83 ± 0.60**	0.50 ± 0.20	1.67 ± 0.30
NX	0th	53.50 ± 2.54	39.33 ± 1.94	5.83 ± 0.72	0.50 ± 0.20	1.83 ± 0.55
	7th	49.50 ± 2.64	42.50 ± 2.34	4.83 + 0.68	1.25 ± 0.18	2.00 ± 0.62
	14th	42.67 ± 2.45	50.00 ± 3.6	4.67 ± 0.61	0.50 ± 0.31	2.33 ± 0.56
	21st	37.67 ± 1.45	55.17 ± 1.44	4.00 ± 0.24	0.83 ± 0.28	2.17 ± 0.28
	28th	36.75 ± 1.27	58.17 ± 1.61	3.67 ± 0.30	0.67 ± 0.30	1.67 ± 0.38
FX	0th	55.50 ± 2.55	38.33 ± 2.01	5.17 ± 0.28	0.17 ± 0.15	1.78 ± 0.33
	7th	49.33 ± 1.99	44.33 ± 2.13	4.00 ± 0.33	0.50 ± 0.20	2.01 ± 0.18
	14th	40.83 ± 0.72	53.83 ± 0.95	3.33 ± 0.30	0.67 ± 0.19	2.32 ± 0.42
	21st	37.17 ± 1.46	57.33 ± 1.28	3.17 ± 0.15	0.67 ± 0.30	2.18 ± 0.19
	28th	33.83 ± 0.80	61.50 ± 0.51	3.00 ± 0.00	0.17 ± 0.15	2.08 ± 0.36

**Significant at P<0.01

Table 17-A: Abstracts of ANOVA - Haematological observations: DLC: Neutrophills

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	2.73	0.46
Among groups	3	0.66^{NS}	2.61^{NS}
Error	15		

NS - Non Signiificant

Table 17-B: Abstracts of ANOVA - Haematological observations: DLC : Lymphocytes

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	3.13	0.85
Among groups	3	0.84^{NS}	3.09^{NS}
Error	15		

NS - Non-Significant

Table 17-C: Abstracts of ANOVA - Haematological observations: DLC: Eosinophills

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.86	0.94
Among groups	3	0.55^{NS}	13.20^{**}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 1.11

Group	BM	NX	FX	EX
Mean	5.83	3.67	3.00	3.00

NS : Non-significant

** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 17-D: Abstracts of ANOVA - Haematological observations: DLC: Basophils

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.06	0.50
Among groups	3	0.81^{NS}	0.83^{NS}
Error	15		

NS - Non Significant

Table 17-E: Abstracts of ANOVA - Haematological observations: DLC: Monocytes

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.00	0.80
Among groups	3	3.05^{NS}	2.47^{NS}
Error	15		

NS - Non significant

Table 18: Comparison of serum biochemical means of specific anthelmintic treated groups (BM, NX, FX) with Broad spectrum anthelmintic (EX) group

Group	Day	Mean Values			
		Serum Total protein (g/dl)	Serum albumin (g/dl)	Serum globulin (g/dl)	Serum albumin and globulin ratio
EX	0th	5.12 ± 0.34	1.63 ± 0.16	3.48 ± 0.22	0.47 ± 0.04
	7th	5.64 ± 0.23	2.01 ± 0.10	3.63 ± 0.15	0.56 ± 0.02
	14th	6.31 ± 0.15	2.34 ± 0.11	3.98 ± 0.05	0.59 ± 0.02
	21st	6.58 ± 0.18	2.50 ± 0.10	4.08 ± 0.09	0.61 ± 0.02
	28th	6.74 ± 0.17	2.56 ± 0.07	4.17 ± 0.12	0.61 ± 0.01
BM	0th	5.76 ± 0.21	2.20 ± 0.15**	3.83 ± 0.36	0.62 ± 0.09
	7th	5.84 ± 0.13	2.96 ± 0.02**	2.88 ± 0.12**	1.04 ± 0.04**
	14th	5.86 ± 0.02**	2.95 ± 0.01**	2.91 ± 0.02**	1.01 ± 0.01**
	21st	5.78 ± 0.02**	2.94 ± 0.02**	2.84 ± 0.03**	1.04 ± 0.02**
	28th	5.78 ± 0.02**	2.92 ± 0.02**	2.86 ± 0.03**	1.02 ± 0.01**
NX	0th	5.72 ± 0.22	2.07 ± 0.14**	3.73 ± 0.15	0.57 ± 0.05
	7th	5.78 ± 0.02	2.96 ± 0.02**	2.83 ± 0.02**	1.05 ± 0.01**
	14th	5.81 ± 0.02**	2.95 ± 0.01**	2.86 ± 0.02**	1.03 ± 0.01**
	21st	5.79 ± 0.03**	2.94 ± 0.02**	2.86 ± 0.03**	1.03 ± 0.01**
	28th	5.79 ± 0.03**	2.92 ± 0.02**	2.85 ± 0.02**	1.03 ± 0.01**
FX	0th	5.98 ± 0.21	2.75 ± 0.22**	3.08 ± 0.19	0.94 ± 0.15**
	7th	5.78 ± 0.08	2.94 ± 0.02**	2.84 ± 0.08**	1.07 ± 0.08**
	14th	5.85 ± 0.02*	2.95 ± 0.01**	2.90 ± 0.02**	1.02 ± 0.01**
	21st	5.83 ± 0.01**	2.95 ± 0.01**	2.88 ± 0.01**	1.03 ± 0.01**
	28th	5.82 ± 0.01**	2.95 ± 0.01**	2.88 ± 0.01**	1.02 ± 0.01**

**Significant at P<0.01

*Significant at P<0.05

Table 18-A: Abstracts of ANOVA - Biochemical observations: Serum total protein

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	3.31	1.21
Among groups	3	2.34^{NS}	24.74^{**}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 0.28

Group	EX	FX	NX	BM
Mean	6.74	5.82	5.79	5.78

NS : Non-significant

** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 18-B: Abstracts of ANOVA - Biochemical observations: Serum albumin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.44	0.45
Among groups	3	5.28*	15.79**
Error	15		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.14

Group	FX	BM	NX	EX
Mean	2.95	2.92	2.92	2.56

Pre-treatment : CD : 0.60

Group	FX	BM	NX	EX
Mean	2.75	2.20	2.01	1.63

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 18-C: Abstracts of ANOVA - Biochemical observations: Serum globulin

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	1.91	1.51
Among groups	3	1.73^{NS}	108.68^{**}
Error	15		

Means of post-treatment are arranged in descending order

Post-treatment : CD : 0.19

Group	EX	FX	BM	NX
Mean	4.17	2.88	2.86	2.85

NS : Non-significant

** Significant at $P < 0.01$

Mean values grouped together by a common under line do not differ significantly among themselves

Table 18-D: Abstracts of ANOVA - Biochemical observations: Serum albumin and globulin ratio

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	0.30	0.72
Among groups	3	3.29*	208.49**
Error	15		

Means (post-treatment followed by pre-treatment) are arranged in descending order

Post-treatment : CD : 0.04

Group	FX	BM	NX	EX
Mean	1.026	1.024	1.023	0.614

Pre-treatment : CD : 0.34

Group	FX	BM	NX	EX
Mean	0.94	0.62	0.57	0.47

** Significant at P < 0.01
* Significant at P < 0.05

Mean values grouped together by a common under line do not differ significantly among themselves

Table 19: Comparison of serum biochemical means of specific anthelmintic treated groups (BM, NX, FX) with Broad spectrum anthelmintic (EX) group

Group	Day	Mean Values	
		Aspartate amino transferase (units/ml)	Alanine amino transferase (units/ml)
EX	0th	118.80 ± 6.19	23.39 ± 1.63
	7th	89.16 ± 4.02	17.76 ± 0.40
	14th	76.11 ± 0.91	17.32 ± 0.31
	21st	75.27 ± 0.75	17.06 ± 0.11
	28th	74.72 ± 0.67	17.17 ± 0.18
BM	0th	132.08 ± 9.01**	24.78 ± 3.83
	7th	103.60 ± 1.70**	18.53 ± 1.06
	14th	79.58 ± 1.16	19.47 ± 0.64
	21st	79.30 ± 1.23	18.15 ± 0.16
	28th	79.30 ± 1.23	18.02 ± 0.13
NX	0th	112.77 ± 3.44	21.04 ± 1.98
	7th	77.77 ± 0.67**	17.87 ± 0.05
	14th	77.77 ± 0.67	17.87 ± 0.04
	21st	77.44 ± 0.74	17.84 ± 0.04
	28th	77.50 ± 0.34	17.85 ± 0.04
FX	0th	128.61 ± 6.10*	21.81 ± 2.16
	7th	90.41 ± 3.04	18.44 ± 0.32
	14th	78.05 ± 0.87	18.18 ± 0.33
	21st	76.11 ± 0.61	17.80 ± 0.05
	28th	76.24 ± 0.17	17.69 ± 0.03

**Significant at P<0.01

*Significant at P<0.05

Table 19-A: Abstracts of ANOVA - Biochemical observations: AST

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	14.12	0.93
Among groups	3	6.67*	0.51 NS
Error	15		

Means of pre-treatment are arranged in descending order

Pre-treatment : CD : 10.35

Group	BM	FX	EX	NX
Mean	132.08	128.61	118.80	112.77

* Significant at $P < 0.05$
NS - Non significant

Mean values grouped together by a common under line do not differ significantly among themselves

Table 19-B: Abstracts of ANOVA - Biochemical observations: ALT

Source of variation	df	'F' ratio	
		Pre-treatment	Post-treatment
Among animals	5	6.03	1.73
Among groups	3	2.23NS	2.48NS
Error	15		

NS : Non-sigificant

Fig.6 : Haemoglobin (g%) in Healthy Control and different groups before and after therapy

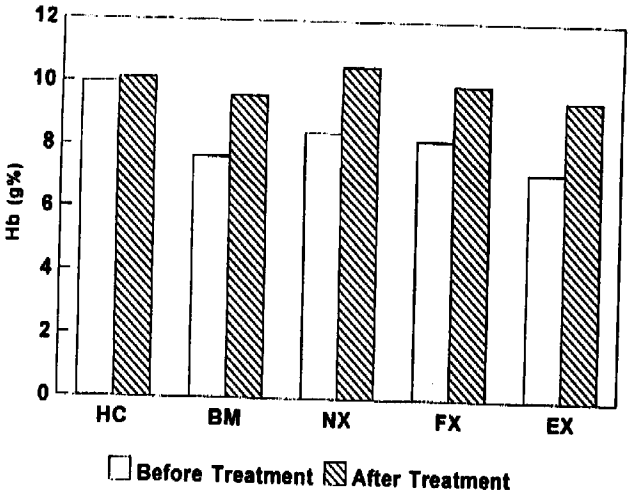


Fig.6-A : Haemoglobin (g%) in broad spectrum and specific drug groups before and after therapy

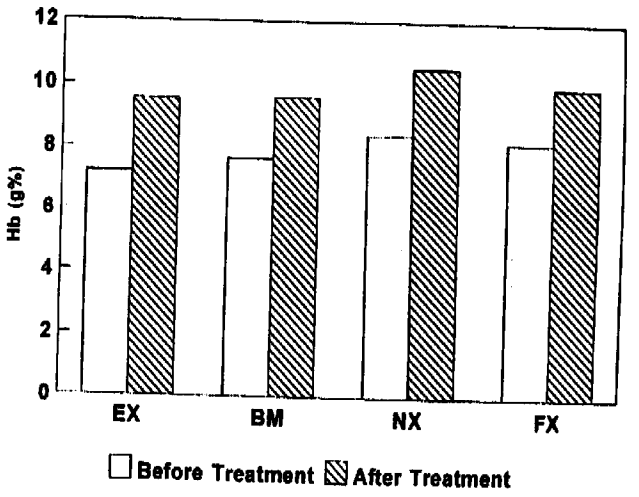


Fig.7 : Packed cell volume (%) in healthy control and different groups before and after therapy

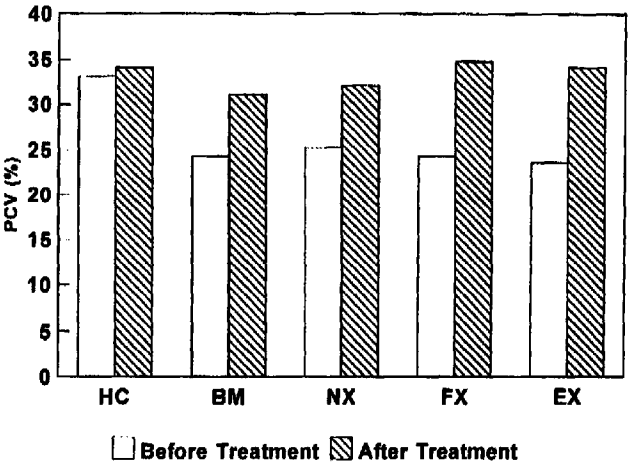


Fig.7-A : Packed cell volume (%) in broad spectrum and specific drug groups before and after therapy

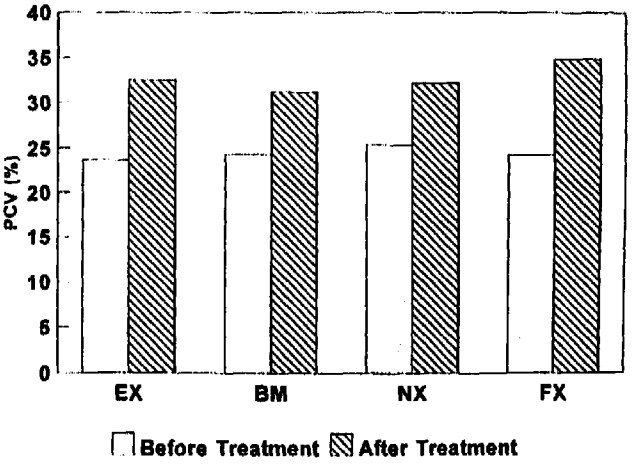


Fig.8 : Total erythrocyte count (millions/cmm) in healthy control and different groups before and after therapy

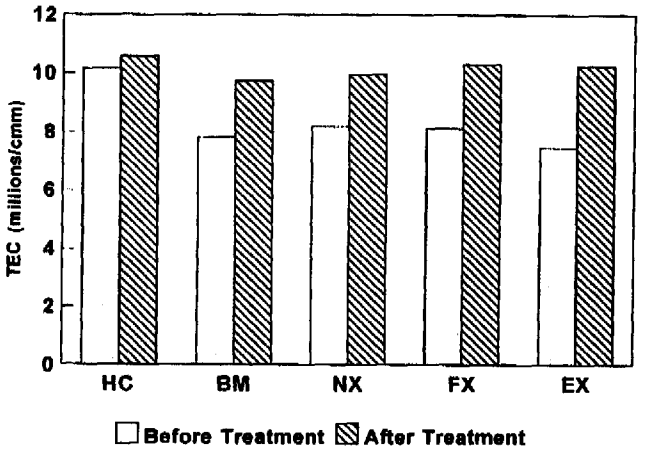


Fig.8-A : Total erythrocyte count (millions/cmm) in broad spectrum and specific drug groups before and after therapy

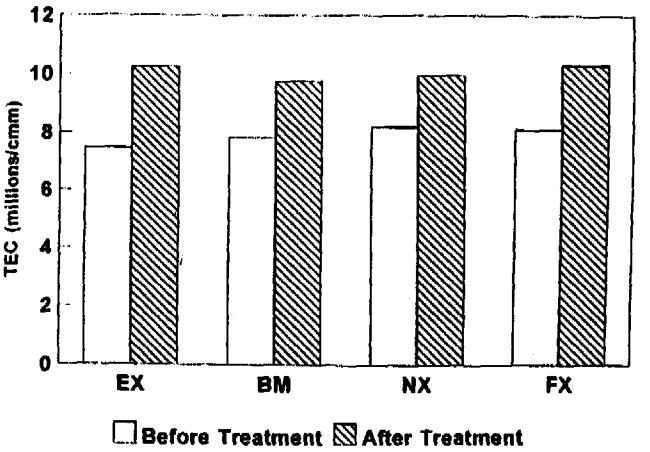


Fig.9 : Mean corpuscular volume (fl) In healthy control and different groups before and after therapy

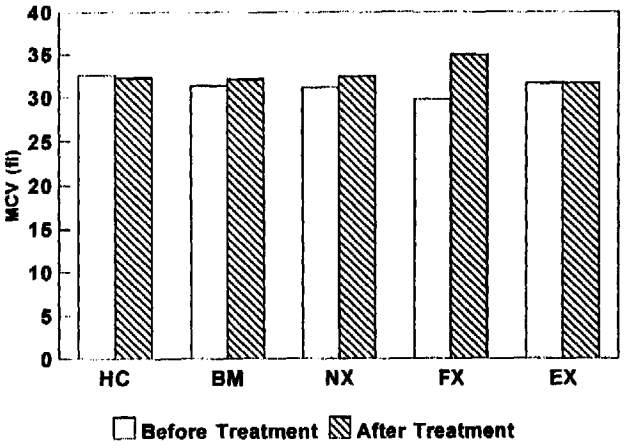


Fig.9-A : Mean corpuscular volume (fl) in broad spectrum and specific drug groups before and after therapy

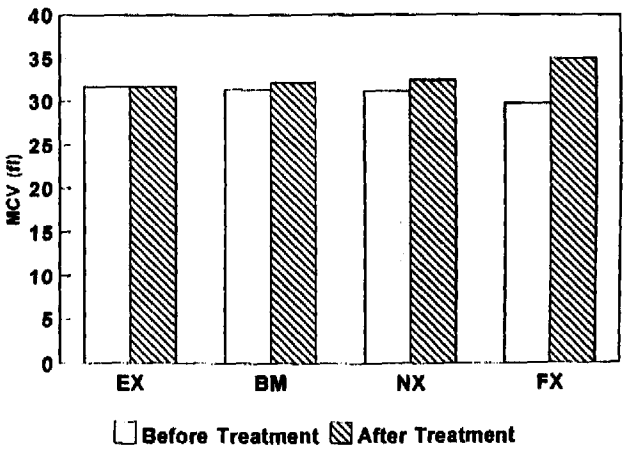


Fig.10 : Mean corpuscular haemoglobin (pg) in healthy control and different groups before and after therapy

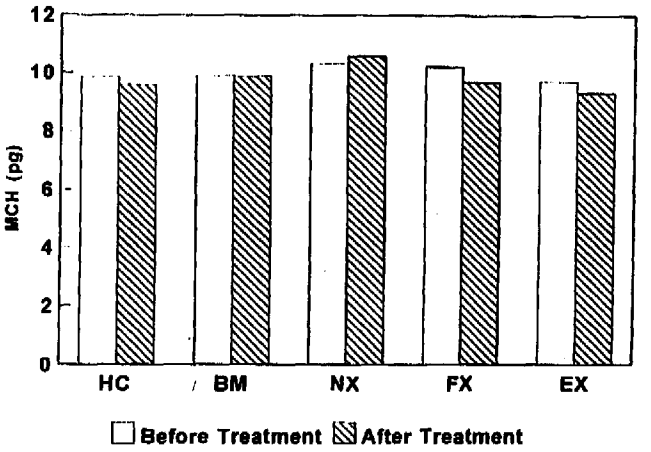


Fig.10-A : Mean corpuscular haemoglobin (pg) in broad spectrum and specific drug groups before and after therapy

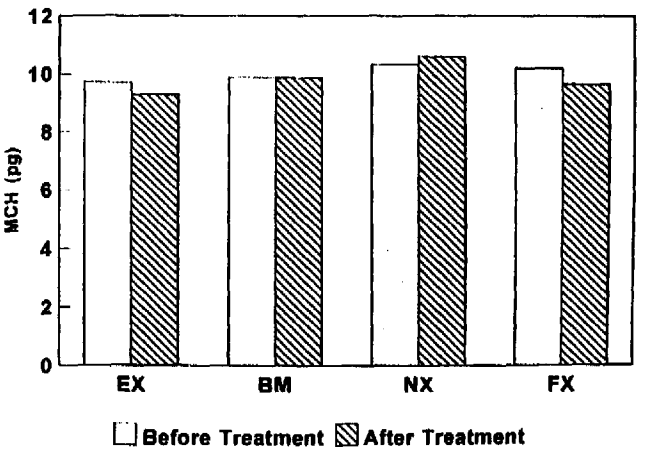


Fig.11 : Mean Corpuscular haemoglobin Concentration (%) in healthy control and different groups before and after therapy

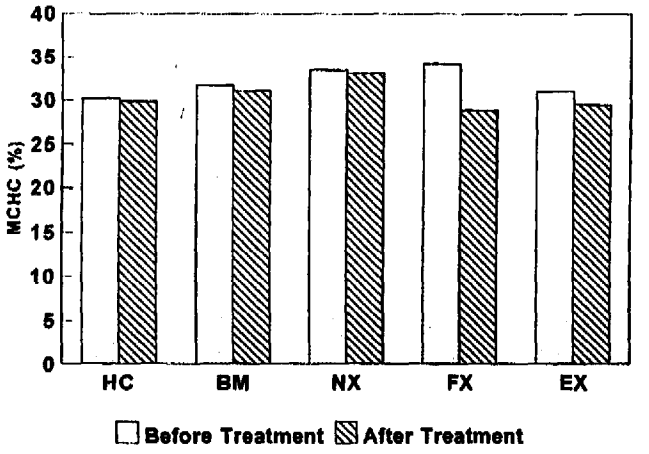


Fig.11-A : Mean Corpuscular haemoglobin Concentration (%) in broad spectrum and specific drug groups before and after therapy

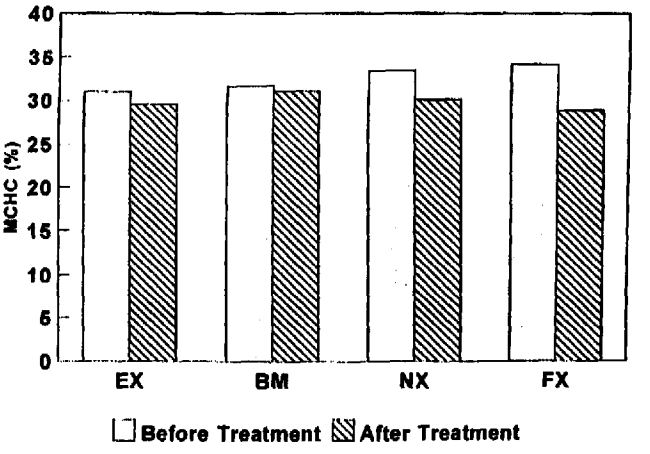


Fig.12 : Total leukocyte count (thousands/cmm) In healthy control and different groups before and after therapy

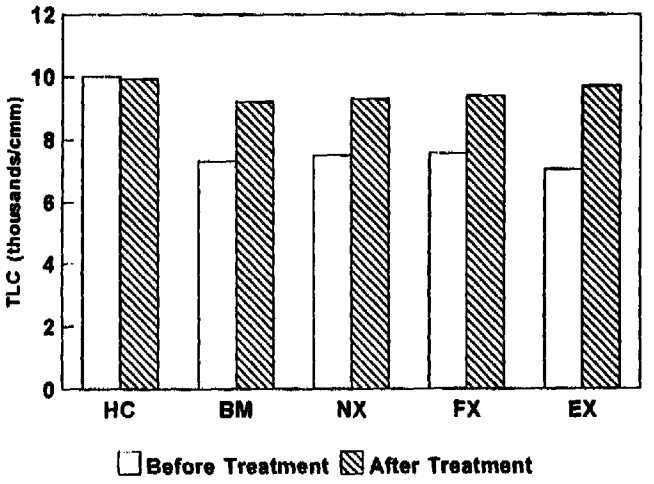


Fig.12-A : Total leukocyte count (thousands/cmm) In broad spectrum and specific drug groups before and after therapy

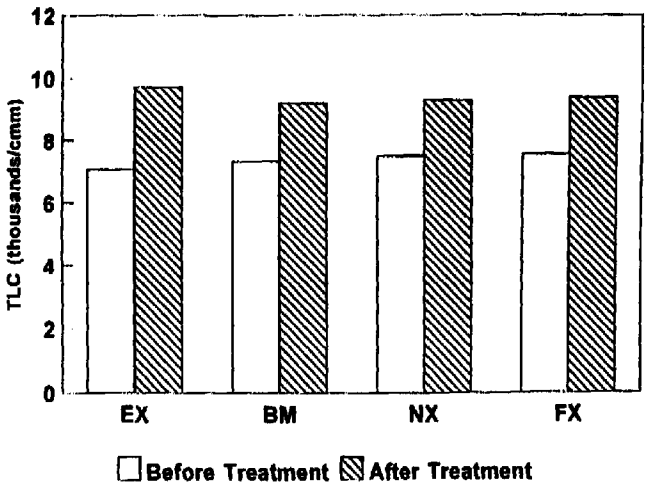
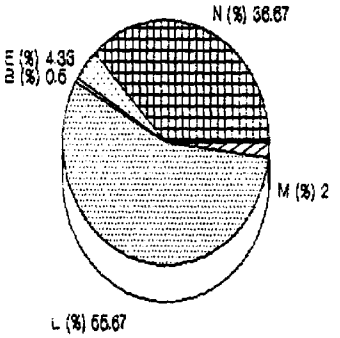
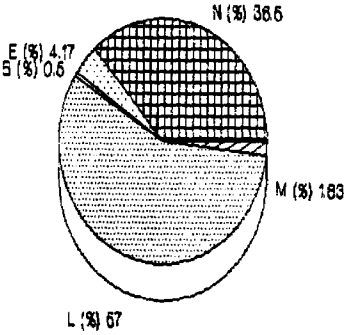


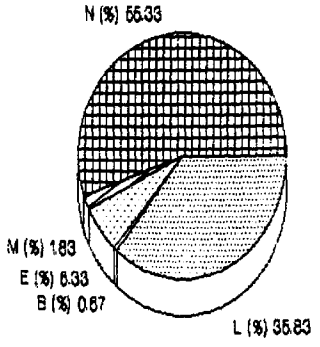
Fig. 13 Differential count (%) in Healthy control and Banminth Therapy



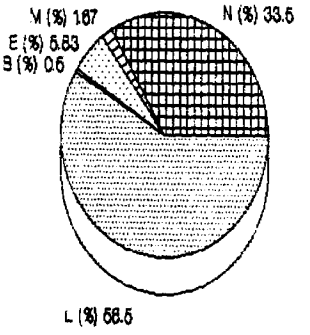
Healthy control (0th day)



Healthy control (28th day)

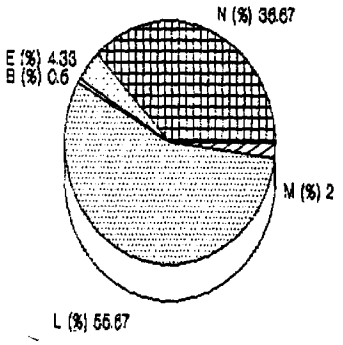


Banminth BT

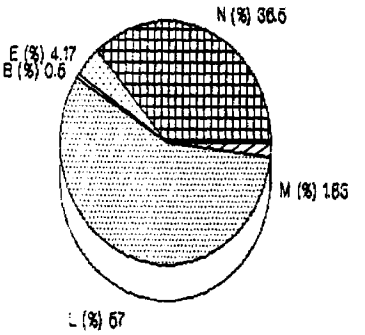


Banminth AT

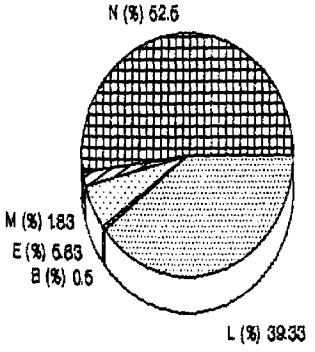
Fig. 14 Differential count (%) in Healthy control and Niclex therapy



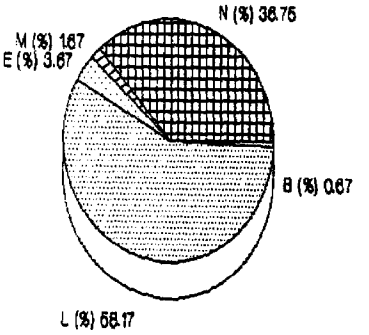
Healthy control (0th day)



Healthy control (28th day)

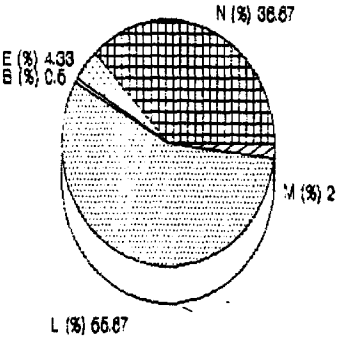


Niclex BT



Niclex AT

Fig. 15 Differential count (%) in Healthy control and Fasinex therapy



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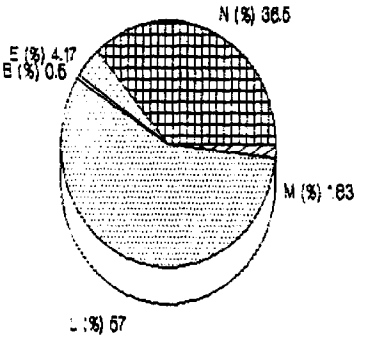
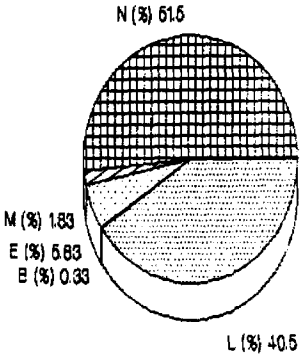
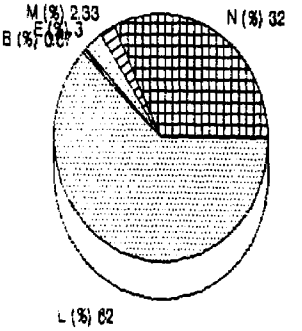


Healthy control (28th day)

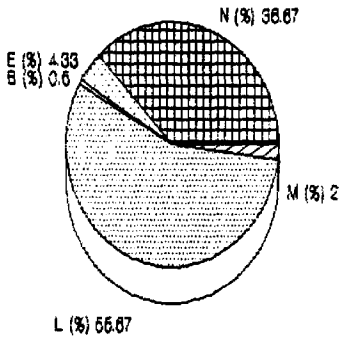


Fasinex BT

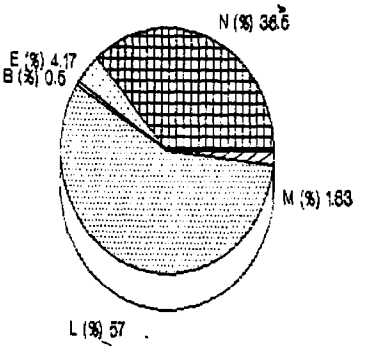


Fasinex AT

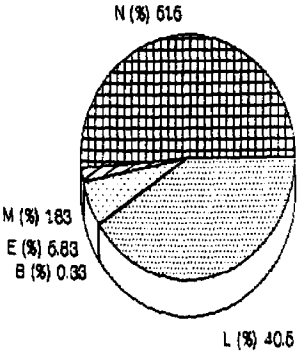
Fig. 16 Differential count (%) in Healthy control and Exinot therapy



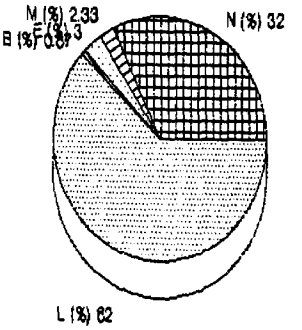
Health control (0th day)



Healthy control (28th day)

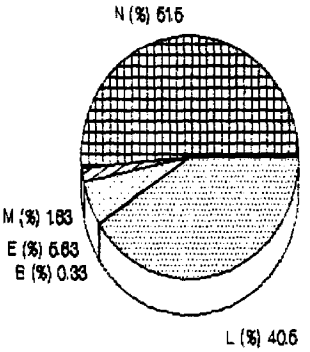


Exinot BT



Exinot AT

Fig. 17 Differential count (%) in broad spectrum drug (Exinot therapy) and specific drug (Banminth Therapy)



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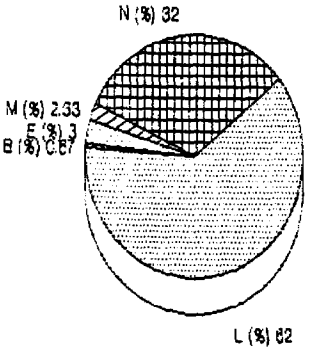
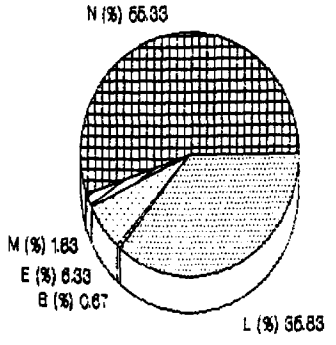
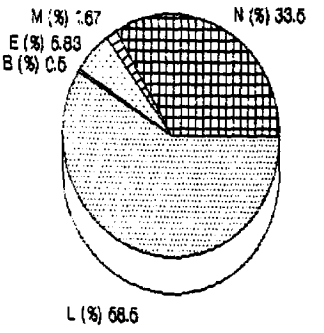


Exinot AT

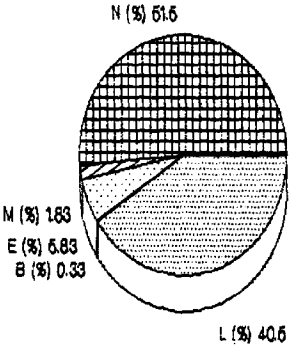


Banminth BT

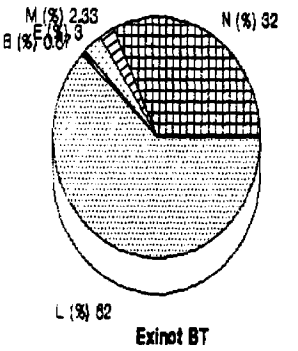


Banminth AT

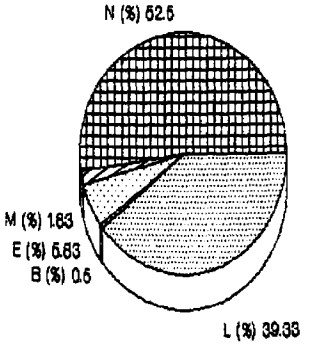
Fig. 18 Differential count (%) in broad spectrum drug (Exinot therapy) and specific drug (Niclex Therapy)



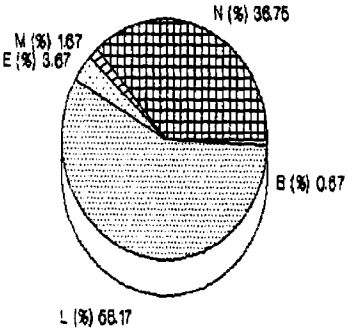
Exinot BT



Exinot AT

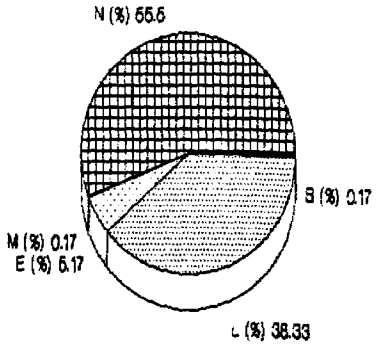


Niclex BT



Niclex AT

Fig. 19 Differential count (%) in broad spectrum drug (Exinot therapy) and specific drug (fasinex therapy)



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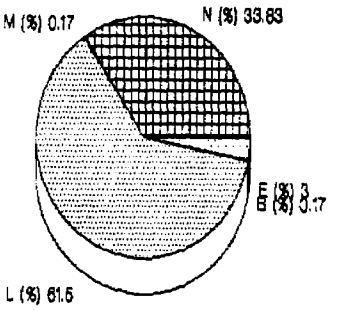
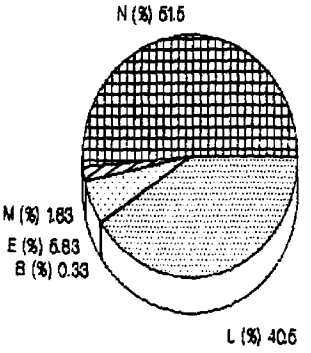
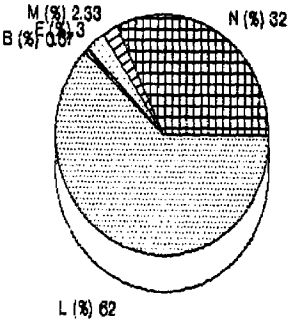


Exinot AT



Fasinex BT



Fasinex AT

Fig.20 : Total serum protein (g/dl) in healthy control and different groups before and after therapy

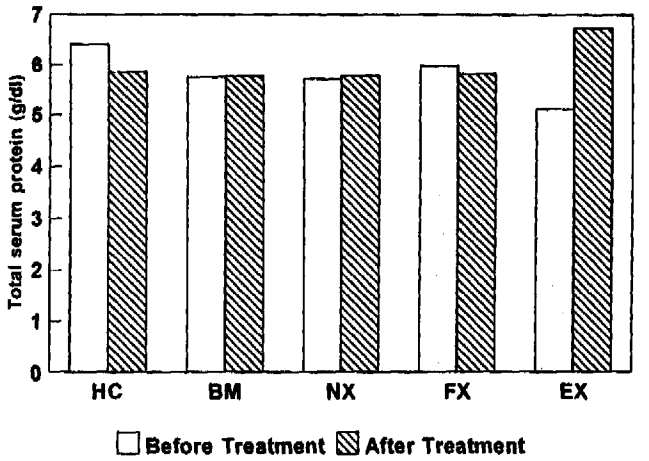


Fig.20-A : Total serum protein (g/dl) in broad spectrum and specific drug groups before and after therapy

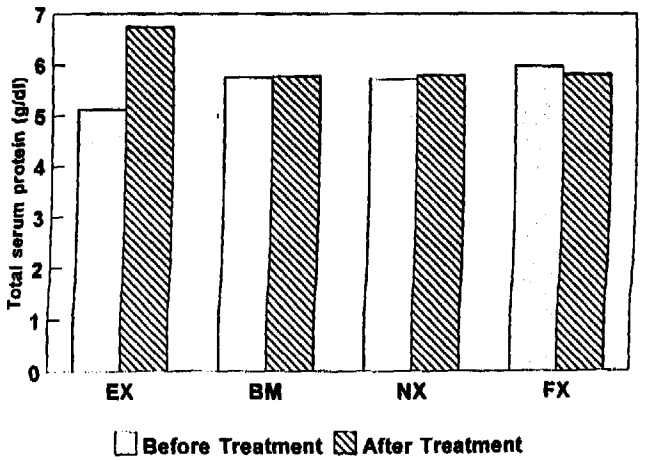


Fig.21 : Serum albumin (g/dl) in healthy control and different groups before and after therapy

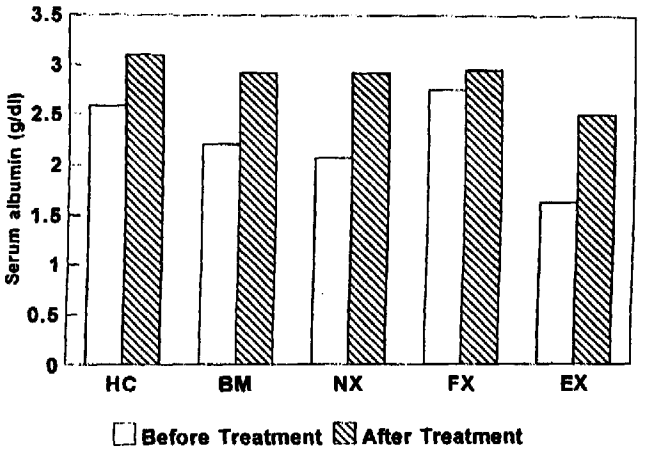


Fig.21-A : Serum albumin (g/dl) in broad spectrum and specific drug groups before and after therapy

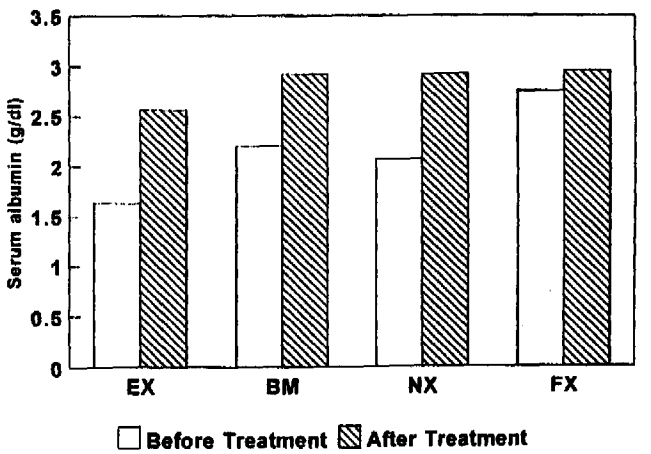


Fig.22 : Serum globulin (g/dl) in healthy control and different groups before and after therapy

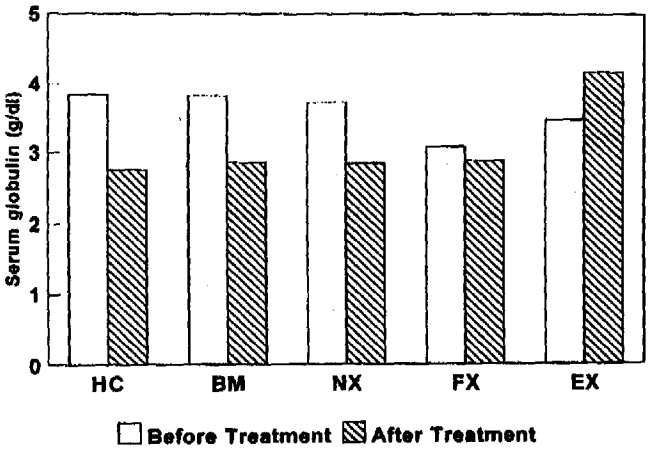


Fig.22-A : Serum globulin (g/dl) in broad spectrum and specific drug groups before and after therapy

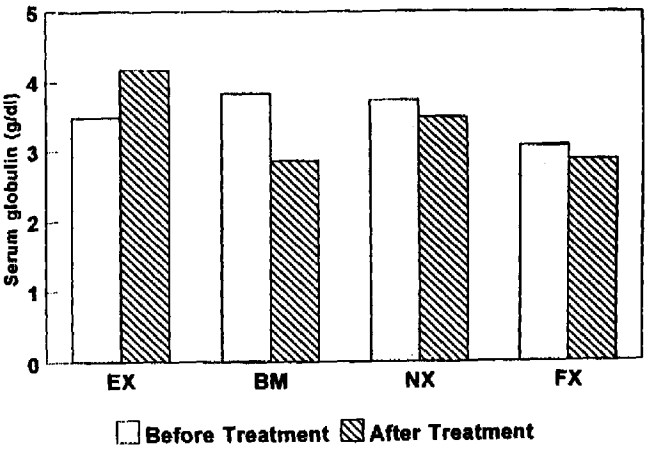


Fig.23 : Serum albumin and globulin ratio in healthy control and different groups before and after therapy

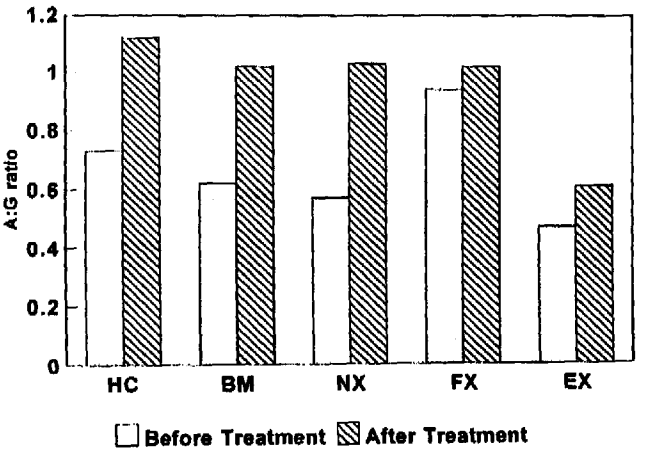


Fig.23-A : Serum albumin and globulin ratio in broad spectrum and specific drug groups before and after therapy

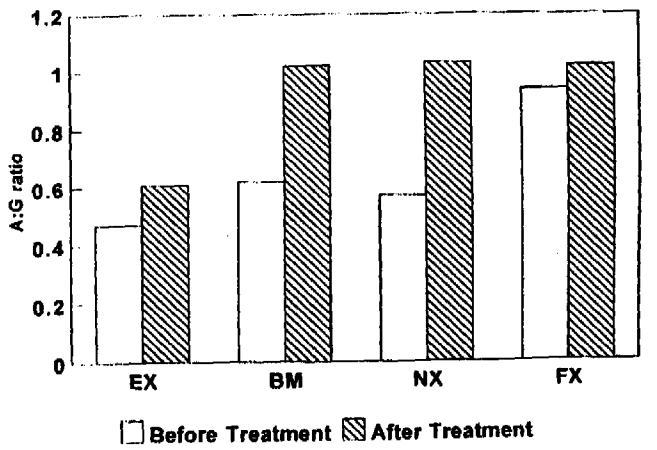


Fig.24 : AST (units/ml) in healthy control and different groups before and after therapy

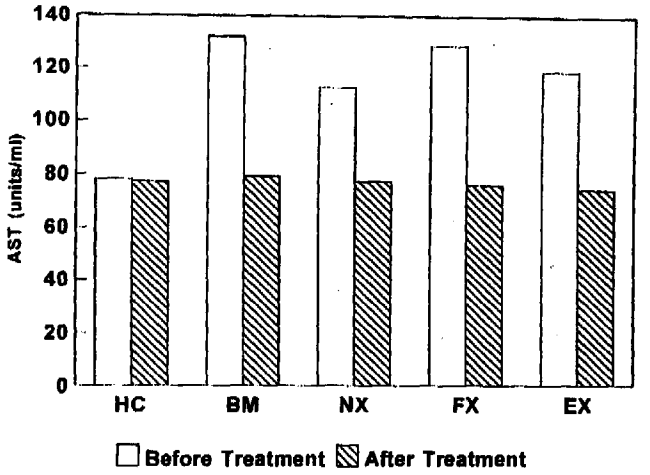


Fig.24-A : AST (units/ml) in broad spectrum and specific drug groups before and after therapy

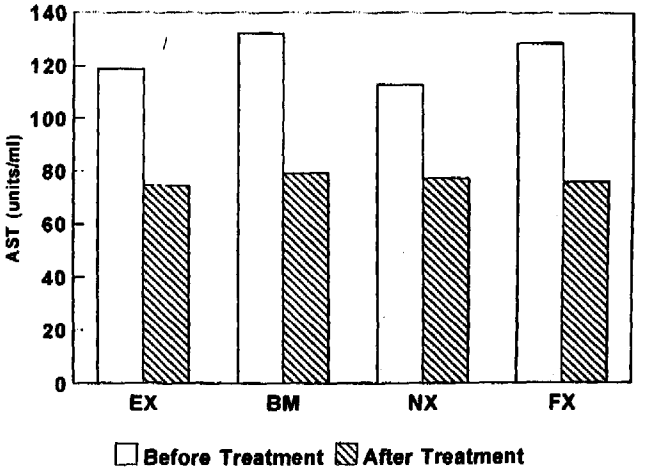


Fig.25 : ALT (units/ml) in healthy control and different groups before and after therapy

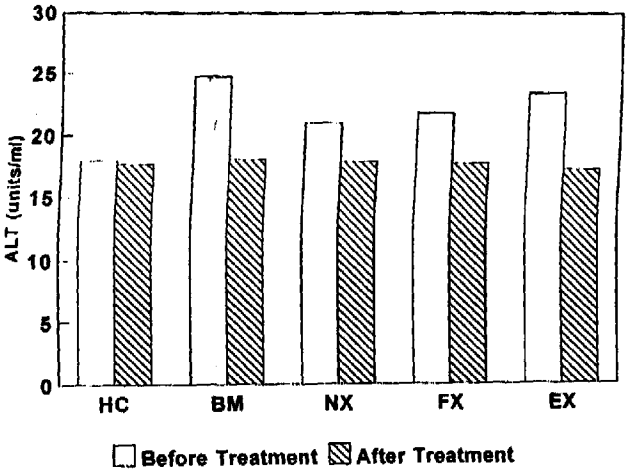
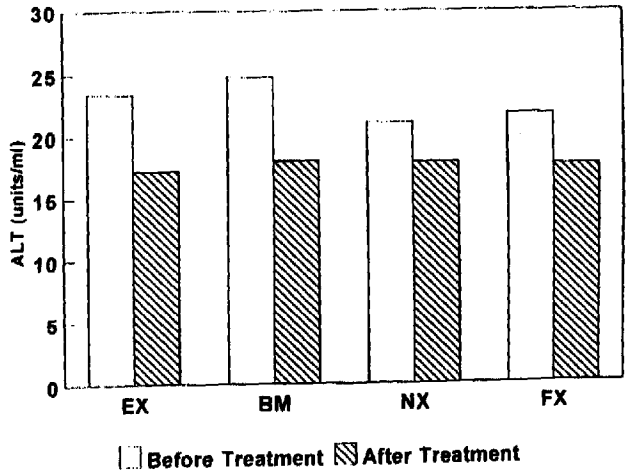


Fig.25-A : ALT (units/ml) in broad spectrum and specific drug groups before and after therapy



Discussion

CHAPTER - V

DISCUSSION

Sheep are important species of livestock in India due to their multifaceted utilization for production of meat, milk, wool, and other by products such as manure, animal casings and offals. Sheep can be easily domesticated and one person can manage a large flock. Their hardy nature enables to thrive well on shrubs, leaves and forages by a low nutritive value and thus, sheep farming is usually economical in arid, semi-arid and hilly regions of the country, where agricultural farming is difficult and natural feed resources are scarce.

Lambs are susceptible to several biotic and abiotic stresses that affect their health. One of the major constraints for the sheep enterprise is the lack of information on various causes and data on lamb mortality and appropriate health cover package in different parts of the country. Particularly helminthiasis is a serious threat to the health of lambs under field conditions causing decline in sheep population. Though mortality is uncommon due to helminthiasis, lambs with high worm burden together with poor nutrition might occasionally succumb to the disease and do not gain the required body weight leading to substantial loss in the productivity and thereby reduce the economic returns to sheep farmers.

In order to findout the incidence of lamb mortality, an epidemiological survey was undertaken for the period from January 1985 to December 1994 (Ten years) in eleven organised sheep farms in Andhra Pradesh.

The survival rate of lambs is the most important single factor that determines the viability and profitability of a sheep farm. Reduced mortality of lambs not only stabilises the enterprise but also is economical in maintaining the flock. Investigations were undertaken by a number of researchers in various organised sheep farms as well as flocks raised by farmers. Majority of their findings indicated that the incidence of mortality ranged from less than one per cent (Dennis and Leipold, 1972) to as high as 51 per cent (Sudan *et al.*, 1990) due to various causes across varied environment.

In the presnet study, the mortality rate of the lambs ranged from 4.08 per cent in composite live stock farm, Chintaladevi to 29.94 per cent in live stock research station, Garividi with a mean mortality percentage of 13.2 across eleven centres surveyed.

Assessment of incidence of lamb mortality in the three geographical segments of Andhra Pradesh indicated that a minimum of 8.82 per cent lamb mortality occurred in coastal region and a maximum of 16.59 per cent lamb mortality occurred in Telangana region, while 13.95 per cent lamb mortality was recorded in Rayalaseema region (Table 1-A). Differences in the magnitude of incidence of lamb mortality in different centres and different geographical situations of Andhra Pradesh may be ascribed to various managemental and agro-climatic variations. Blain *et al.* (1984) analysed the extent and the cause of mortality in lambs and concluded that various

environmental factors like temperature, humidity, atmospheric gases etc., were responsible for lamb mortality and the same views were also expressed by Ducrot *et al.* (1989).

The influence of the body weight of the dam at lambing on the lamb mortality was indicated as the status of the dam and the data was recorded in four centres only. The mortality of lambs across four centres was found to be minimum when the dam's body weight at lambing was between 36 to 40 kg, while the lamb mortality found to be maximum when the dam's body weight at lambing was between 26 to 30 kg. McDonald (1962) opined that the nutritional status of the dam had a profound influence on the lamb mortality. The influence of body weight of the dam at lambing on the survivability of lambs has been documented by Dennis (1970), Mahajan and Acharya (1980), Dumon and Seegers (1984) and Olson *et al* (1987). All the above authors undisputedly recorded that healthy dam with more body weight at lambing has resulted in maximum survivability of the lambs corroborating the findings of the present study.

Lamb mortality was assessed in all the organised sheep farms in relation to the age of lamb at the time of death. The data on the lamb mortality was presented with respect to age of the lamb in months upto four months (Table 3) as well as in relations to weaning i.e., pre-weaning and post-weaning (Table 3-A). The pre-weaning lamb mortality was considered upto three months age and the post-weaning lamb mortality was considered from fourth to six months afer lambing. Out of the total lamb mortality (2266), the maximum number of lambs (491) died during second month after birth and the minimum number of lambs (276) died during the fourth month after lambing.

The mortality of the lambs was higher during the post-weaning period (1325) than the pre-weaning period (941). Survey of literature did not reveal higher extent of mortality during the post-weaning. Probably harsh climate, improper adaptability of the lambs to feed and fodder and infections during the post-weaning period might have contributed the lamb mortality to a greater magnitude in the present study.

The lamb mortality did not differ prominently between the sexes (Table 4). The percentage of mortality with reference to total number of births was 12.09 and 12.08 in males and females respectively. Similar findings of sex as non-determinant factor for lamb mortality has been reported by Singh and Singh (1970), Sudan *et al.* (1990), Yapi *et al.* (1990) and Otesile (1994). However, variations in the lamb mortality due to sex has been observed by Dennis (1972) and Dennis and Leipold (1972).

An attempt was made to assess the lamb mortality among different breeds based on the data available at the centre Network programme on sheep improvement, Palamaner. Five breeds viz., Dorset x Nellore, Dorset x Mandya, Nellore brown, Nellore synthetic and Mandya were considered for comparison. Among the five breeds, the lamb mortality was maximum (53.61%) in Dorset x Nellore, while that of the Mandya breed was minimum (2.24%). Among the other breeds the percentage of mortality was in the order of 20.65, 15.19 and 8.73 in the breeds of Dorset x Mandya, Nellore brown and Nellore synthetic respectively. The large magnitude of lamb mortality in Dorset x Nellore breed and Dorset x Mandya compared to Mandya breed could be due to climatic unsuitability of the crossbred sheep having exotic germplasm of Dorset, whereas for the Nellore and Mandya breeds it is the home breeding tract.

Variation in lamb mortality in relation to breed has also been reported round the globe (Shelton, 1964; Rama Rao *et al.*, 1980; Jagtap, 1989; Sudan *et al.*, 1990 and Kulkarni and Deshpande, 1991).

The pattern of lamb mortality among different seasons viz, summer, monsoon and winter was assessed by survey across eleven centres of the state. Out of the total number of 2266 lambs died in all the centres, the maximum number of lambs (1103) died during the summer season with a mortality percentage of 48.68. Lamb mortality was lowest (495) during monsoon season with a mortality percentage of 21.84, while 668 lamb deaths were recorded during winter season accounting to 29.48 per cent mortality. Regardless of the location of the farm, the pattern of lamb mortality with the season was almost similar in all the centres. Largest mortality percentage during summer has been recorded by Juma *et al.* (1974), Rama Rao *et al.* (1980), Kabuga and Akowuah (1990) and Sekar *et al.* (1991). Thus, the findings of the present investigation are in accordance with the observations of earlier workers. The larger extent of mortality of lambs associated with the summer season could be due to the harshness of the climate like higher temperature and lesser humidity (Sekar *et al.*, 1991).

Out of total of 2266 lambs died due to infectious causes across the eleven centres surveyed (Table 7-A) death of 1100 lambs was due to pneumonia accounting to 48.54 per cent. The other infectious causes of lamb mortality were parasitic enteritis, hepatitis, blue tongue and sheep pox which resulted in the death of lambs to the extent of 298, 191, 38 and 132 accounting to 13.15, 8.43, 1.68 and 5.83 per cent

respectively. Though the percentage of lamb mortality due to parasitic enteritis is far lesser than that due to pneumonia but was higher than the other infectious causes. The extensive survey of earlier research as well as the clinical experiences amply indicated that parasitic enteritis seldom resulted in higher percentage of lamb mortality. However, parasitic infections are known to cause debility in the lambs ultimately reflecting in reduced growth rates and responsible for greater economic loss of the farmers. Higher percentage of lamb mortality due to infectious causes has been reported by Gray (1966), Stamp (1967), Broadbent (1972), Harris (1974), Rama Rao *et al.* (1980), Malone *et al.* (1985), Dubey *et al.* (1989), Hovers *et al.* (1994) and Manohar *et al* (1995). The above researchers attributed lamb mortality to an array of causes viz., pneumonia, lung defects, listerial infection, coccidiosis, pasteurellosis, enteritis, nematode infections, septicaemia, sheep pox, gastrointestinal parasites, hepatosis and mastitis.

Similarly deaths recorded across the eleven centres surveyed (Table 7-B) due to different non-infectious causes in the present study included dystocia, hypothermia, Starvation Mis-mothering Exposure (SME) complex and trembling which caused the death of lambs to the extent of 55, 28, 111 and 55 accounting to 2.43, 1.24, 4.90 and 2.43 per cent respectively. Verification of lambs mortality due to non-infectious causes in the present study indicated that starvation mis-mothering exposure (SME) complex was the major cause among the four. A range of non-infectious causes have been reported by a number of earlier researchers to manifest lamb mortlity though in many instances the percentage of incidence of the particular cause was not available for comparison. Hypomyelinosis (Barr, 1964), trembling (Darcel, 1964), neonatal starvation

(Dennis, 1969), hypothermia (Eales and Gilmour, 1982), dystocia (Gumbrell, 1985) and Starvation Mis-Mothering Exposure (SME) complex (Bekele *et al.*, 1992) were responsible for effecting the mortality of lambs.

Miscellaneous causes resulted in the mortality of 258 lambs out of the total 2266 lambs died across the eleven centres during the year from 1985-1994 (Table 7-C). Among these 111 lambs died due to heat stress, while 56 lambs died due to their poor birth weight, 37 lambs were killed by predators, 34 lambs died due to copper deficiency and 20 lambs died by drinking the contaminated water with a mortality percentage of 4.9, 2.47, 1.63, 1.50 and 0.88 respectively. Among various miscellaneous causes resulting in lamb mortality, heat stress was found to be the major cause in the present study. Similar to the present observations a variety of miscellaneous causes also contributed for the lamb mortality such as copper deficiencies (Yeomon, 1983), climatic stres (Blain *et al.*, 1984), zinc and cobalt deficiency (Barnovin, 1985), contaminated drinking water (Malone *et al.*, 1985) and poor birth weight (Jordan and Feuvre, 1989).

Among endoparasitic infections, haemonchosis, monieziasis and fascioliasis are of much concern in adult sheep and lambs. Several drugs have been tried for the treatment of these infections. Of these oral solution of closentel (Exinot), the new salicylanide compound has been introduced into the market (M/s Cadila Pharmaceuticals Private Limited, Ahmedabad) and its broad spectrum antiparasitic effects in sheep and other livestock have been widely acclaimed. Detailed study regarding its anthelmintic efficacy against haemonchosis and fascioliasis in lambs on one hand and the efficacy of

the specific anthelmintic drugs like morantel citrate (Banminth, M/s Pfizer Limited, Bombay), niclosamide (Niclex, M/s Alved Pharmaceuticals Pvt. Ltd., Madras) and triclabendazole (Fasinex, M/s Hindustan Ciba-Geigy Ltd., Bombay) against haemonchosis, monieziasis and fascioliasis respectively on the other hand has been taken up for comparative evaluation of the broad spectrum anthelmintic activity as compared to the activity of specific anthelmintic drugs.

Lambs of the Department of Animal Science, College of Veterinary Science, Tirupati and sheep belonging to the village Tondavada, near Tirupati of Chittoor district have been screened for helminthic infections. Twenty four lambs which were positive for helminthiasis and exhibiting clinical symptoms were chosen for the comparative drug trial. For identification, these animals were divided at random into four groups of 6 each. The lambs which were positive for haemonchosis, monieziasis, fascioliasis and mixed infection of haemonchosis and fascioliasis were divided into group II, III, IV and V and named as Group BM, NX, FX and EX respectively. Another group of six randomly selected lambs that were healthy and free from any infection and receiving no treatment served as group I or Healthy control (HC) group. Morantel citrate (Banminth) @ 5.94 mg/kg orally for group II, niclosamide (Niclex) @ 100 mg/kg orally for group III, triclabendazole (Fasinex) @ 10 mg/kg orally for group IV and closantel (Exinot) @ 0.1 ml/kg orally for group V were administered as single doses. Observations on the clinical examination, EPG count, haematological and biochemical estimations of the lambs belonging to all the five groups were recorded at weekly intervals for 4 weeks considering 0th day as pre-treatment.

In the healthy control group, the lambs did not show any abnormality in general appearance during the period of investigation. The mean temperature, pulse and respiration rates were 102.33 ± 0.27°F, 82 ± 2.37/mg and 19.5 ± 0.34/mt respectively, which are within the normal range described for this species (Kelly, 1974 and Radostits *et al.*, 1994). The lambs of healthy control group were active with moist muzzle, soft, pliable and smooth body coat and having normal appetite and the faeces was in the form of pellets being absolutely normal. No helminthic ova could be found in their faeces during any period of the course of study. The congunctival mucous membrane was light red coloured. Further, lambs selected for this study also were free from parasitic infection and any other noticeable clinical illness through out the period of study and therefore could be conidered as healthy.

A cursory glance at the weekly haematological and biochemical observations recorded in the HC group (Tables 10 to 14) clearly indicate that the variation in the values of different parameters was very minimal and statistically insignificant during the experimental period. The weekly mean values for haemoglobin, PCV and TEC were found to vary from 9.94 to 10.14 g%, 32.33 to 34.17 % and 9.77 to 10.57 millions/cmm respectively. The values of weekly means of MCV, MCH and MCHC ranged from 32.11 to 33.13 fl, 9.58 to 10.02 pg and 29.85 to 30.88% respectively which again are within the prescribed range for healthy sheep (Jain, 1986).

The weekly mean values of TLC during the course of investigation ranged from 9.96 to 10.28 thousands/cmm. The differential leukocyte count during the experimental period on weekly mean basis was variable among different parameters of DLC, while

the variation within each of the parameters was negligible. The values of neutrophils, lymphocytes, eosinophils, basophils and monocytes ranged from 35.00 to 36.83%, 55.17 to 57.50%, 4.17 to 5.17%, 0.50 to 1.00% and 1.83 to 2.25% respectively which are similar to the values mentioned by Jain (1986) for healthy sheep.

The weekly mean values pertaining to various biochemical parameters viz., serum total protein, serum albumin, serum globulin and A/G ratio did vary between 5.82 and 6.42 g/dl; 2.58 and 3.13 g/dl; 2.68 and 2.84 g/dl and 0.72 and 1.17 respectively. The weekly mean values of AST and ALT ranged from 76.11 to 78.19 units/ml and 17.49 to 17.93 units/ml respectively and are similar to those reported by Kaneko (1989) and Radostits *et al.* (1994).

The clinical symptoms observed in lambs suffering from haemonchosis (Group II/BM) before the commencement of treatment were dullness, poor appetite, anaemia, diarrhoea with rough skin and coarse body coat. Out of 6 lambs in this group, three had exhibited intermandibular oedema one of them displayed neck oedema which could be due to hypoproteinemia associated with hypoalbuminaemia. Similar symptoms of haemonchosis in lambs have been amply documented (Lapage, 1956; Udall, 1964; Owen, 1970; Jensen, 1974; Morgan and Hawkins, 1983; Rao, 1992 and Radostits *et al.*, 1994).

The body temperature and respiration rate of all the lambs were almost within normal range throughout the period of study, while the pulse rate of infected lambs was slightly higher than the HC group but was not statistically significant (Table 8-B).

Spectacular recovery was noticed in the clinical condition of the infected lambs by 7th day after treatment with disappearance of all the clinical symptoms observed initially which could be due to stoppage of blood loss in view of expulsion of the haemonchosis and better feed assmilation. Similar findings have been reported by Singh *et al.* (1987) and Rao (1992).

In all the 6 lambs of this group EPG count varied between 900 and 1400 prior to the commencement of treatment. According to Lapage (1956) EPG count exceeding 1000 is an indication of notable infection requiring treatment and his views have been consistently supported by several workers (Malviya *et al.*, 1979 and Reddy and Hafeez, 1987). Thus, according to their opinion, the EPG count recorded in the present study indicates the need of treatment to eliminate the helminthic infection. A specific drug i.e., morantel citrate for the treatment of haemonchosis infection has been tried in this study.

Treatment with morantel citrate reduced the EPG count to zero level by 7th day after the administration of drug subsequently followed upto 28th day indicating 100% efficacy of the drug against haemonchosis. This finding is in agreement with the findings of Misra and Ruprah (1972).

The pre-treatment means (0th day) of the haemoglobin in haemonchosis infected lambs were significantly lower than the HC group which indicate moderate degree of anaemia. Lower haemoglobin concentration in sheep infected haemonchosis confirms the earlier findings of Levin (1968), Pachlag *et al.*, (1973) and Rao (1992). In the

present study the observations of pale mucous membranes is nothing but a clinical manifestation of the reduced haemoglobin content in infected lambs due to blood loss (Sousby, 1982 and Jain, 1986). With the administration of the drug the haemoglobin content consistently increased from 7.67 g% of the pre-treatment level to 9.61 g% by 28th day.

The mean PCV value of the infected lambs prior to treatment was 24.33% which was significantly lower than the HC group, whose mean PCV value was 33.17%. Lower PCV values in the haemonchosis infected lambs have been reported by various earlier researchers which is (Owen, 1970; Anosa, 1977; Soulsby, 1982 and Rahman and Collins, 1990). Treatment with morantel citrate has steadily and progressively enhanced the PCV value upto 21st day after treatment and showed a marginal decrease there after.

The mean value of TEC prior to treatment was 7.83 millions/cmm which was significantly lower than the HC group 10.16 millions/cmm. Lesser TEC values in the haemonchosis infected lambs than the HC group have been reported by several authors (Sahai 1966, Misra and Ruprah 1972 and Rao 1992). Treatment with morantel citrate increased TEC values consistently upto 28th day after treatment.

Significant differences in the values of MCH and MCHC were noticed between helminthic infected lambs before treatment and HC group, while the difference in the MCV value was statistically non-significant. Treatment with morantel citrate has favourably altered the above said parameters closer to the corresponding values of HC

group indicating the efficacy of specific morantel citrate against haemonchosis as could be seen from altered erythrocytic indices on par to that of healthy control. The opinions of Morgan and Hawkins (1983) and Das *et al.* (1992) corroborates the findings of the present investigation.

In the haemonchosis infected lambs of group II the haemoglobin, PCV, TEC, MCH and MCHC were significantly lower than the healthy control group. Heavy haemonchosis infection in sheep results in acute blood loss, macrocytic hypochromic anaemia. In chronic infection there is microcytic normochromic and normochromic, normocytic anaemia with little or no evidence of reticulocytosis. Following treatment with morantel citrate there was gradual improvement in the above mentioned haematological parameters which became almost similar to the HC group values by 28th day could be due to stoppage of blood loss from gastrointestinal tract due to elimination of the parasites however resulted to better assimilation of the nutrients (Radostits *et al.*, 1994)

The mean TLC value of the infected lambs differed significantly with HC group, having lesser TLC value being associated with infected group than that of HC group. Yaman *et al.* (1988) did not notice any difference between infected and healthy lambs, while Misra and Ruprah (1972) and Pachlag (1973) did notice reduced total leukocyte count in infected lambs. The reduced TLC could be due to thymic atrophy and decrease in lymphocytes (Misra and Ruprah, 1972 and Adams, 1981). Treatment with morantel citrate against haemonchosis has improved the total leukocyte count progressively upto 28th day.

Significant variations in the differential leukocyte count were observed between the infected and healthy control groups. The mean pre-treatment values of neutrophils and eosinophils were significantly higher in the infected lambs while lymphocyte value was lesser than the HC group. The association of eosinophilia in helminthiasis is well documented (Jain, 1993). The mean pre treatment values of lymphocyte and basophil did not differ significantly with the HC group. Altered values of DLC in infected lambs have been reported by earlier researchers (Sahai 1966; Misra and Ruprah 1972; Adams 1981 and Rahman and Collins, 1990). Treatment with morantel citrate which resulted in expulsion of the parasites has subsequentially altered the percentage of granulocytes and agranulocytes to almost within the normal range as mentioned for the healthy lambs except that the monocytes did not return to normal value as prescribed for healthy lambs probably due to incomplete elimination of larval stages.

The mean pre-treatment values of serum total protein and albumin differed significantly between infected and healthy groups, while there was no noticeable variation in the values of globulin and A/G ratio between the two groups. Anaemia and hypoproteinaemia have been observed in acute and chronic haemonchosis in cattle and sheep. Anaemia is due to blood sucking in addition to short T½ of RBC. From chronic blood loss hypoproteinaemia and hypoalbuminaemia due to protein loosing enteropathy in which anorexia malabsorption and oedema of lips, intermandibular and neck region developing with serum hypoproteinaemia. Lower values of serum total protein and albumin in the infected sheep were reported by Martin *et al.* (1957), Owen

(1970), Kelly *et al.* (1978) and Rao (1992). Treatment with morantel citrate could improve the serum total protein and albumin by 7th day after treatment which remained almost constant upto 28th day. Thus, indicating instant efficacy of the drug in altering the biochemical parameters favourably closer to normal range of healthy lambs.

The mean pre-treatment values of serum amino transferases differed significantly between infected and healthy groups, with higher values being associated with infected lambs. The serum alanine aminotransferase is not liver specific in ruminants. However increase in the level of aspartate amino transferase is indicative of damage of the liver and/or intestines, heart and skeletal muscles could be due to the parasites. Higher values of serum amino transferases in infected lambs have been recorded by Thorpe (1965), More and Sahni (1979) and Siddiqua *et al.* (1989). Treatment with morantel citrate has substantially brought down the values of serum amino transferases by 7th day after treatment beyond which the decrease was progressively steady upto 28th day, bringing the values closer to that of healthy lambs.

The clinical symptoms observed in monieziasis infected lambs belonging to group III (NX) prior to the commencement of treatment were dullness, poor appetite with pale visible mucous membranes, occasional diarrhoea with rough skin and coarse body coat.

The body temperature, pulse and respiration rates of all the infected lambs were almost with in the normal ranges through out the period of study. There was a remarkable recovery in the clinical condition of the infected lambs by 7th day after treatment and by 14th day all the clinical symptoms in the lambs noticed prior to treatment totally disappeared thereby maintained normal health through out the period of study indicating the efficacy of niclosamide against monieziasis.

The pre-treatment EPG value was 950 with a range of 900 to 1100. Treatment with niclosamide reduced EPG count to nil by 7th day after treatment and this situation continued upto 21st day proving its efficacy against monieziasis in lambs. However, three lambs of this group showed a mild re-infection with the mean of 50 EPG count which might be due to incomplete elimination of parasite or re-infection. Thus, niclosamide proved its 100% efficacy as a specific drug against monieziasis which conferred the clinical findings of Terblanche (1983).

The pre-treatment mean haemoglobin value (8.43 g%) of the infected lambs with monieziasis were found to be significantly lesser than the HC group (9.98 g%) and the treatment with niclosamide resulted in steady increase in the haemoglobin from 7th day to 28th day post-treatment. The clinically observed pale mucous membranes prior to the treatment tended to improve consistently to light red colour from 7th day to 28th day after treatment. Thus, the haemoglobin content has improved with the treatment bringing the values almost equal to that of the HC group. Such increase of the

haemoglobin content in the infected lambs amply indicates the therapeutic efficacy of niclosamide against monieziasis. Terblenche (1983) also observed increase in the haemoglobin content in the monieziasis infected lambs with niclosamide treatment.

The mean pre-treatment value of PCV in infected lambs of this group (25.33%) was substantially and significantly lower than that of HC group (33.17%). Treatment with niclosamide has progressively increased the PCV value from 7th and subsequently maintained upto 28th day after treatment. However, the drug was found to be effective beyond 14th day post-treatment. The changes in PCV value can be ascribed to the alterations in haemoglobin status of treated lambs, which was also reported by Kell *et al.* (1978).

The pre-treatment mean TEC value (8.20 millions/cmm) was significantly lower than that of HC group (10.16 millions/cmm). Administration of niclosamide tended to increase the values of TEC steadily and progressively from 7th and thereby on 28th day after treatment which was closer to HC group. The changes in TEC value following treatment with niclosamide was similar as that of haemoglobin and PCV values recorded in the same group.

The pre-treatment mean values of MCH and MCHC of the infected lambs of this group differed significantly with HC group while the MCV value was found to be non significant. Treatment with niclosamide has progressively enhanced the values of

MCH from 7th to 28th day but it did not come to the normal range of healthy lambs. The MCHC value tended to decline from 7th to 21st day post-treatment beyond which it has spurted back closer to the pre-treatment value. Thus, the erythrocytic indices did respond inconsistently to the administration of niclosamide against monieziasis infected lambs. However, this inconsistancy was within the statistical limits indicating the fact that the efficacy of niclosamide against monieziasis should not be undermined. These findings confirmed the reports of Misra and Ruprah (1972), Morgan and Hawkins (1983) and Das *et al.* (1992).

The anaemia with associated changes in haemoglobin, PCV, TEC and erythrocytic indices could be due to improper assimilation of nutrients by the host, utilisation of essential nutrients by the parasites and also could be due to impaired erythropoieses (Jain, 1993; Soulsby, 1982 and Radostits *et al.*, 1994). After administration of niclosamide most of the worms are expelled and there could be better availability and assimilation of nutrients with improved erythropoieses resulting in increase in the haemoglobin, PCV, TEC and erythrocytic indices.

The mean TLC value of the infected lambs was lower than that of HC group and the differences were significant. Treatment with niclosamide has steadily increased the TLC value in the infected lambs upto 28th day post-treatment but the value was maintained below normal as observed in the healthy lambs.

The variations in DLC were significant in some components and non significant in others. The mean pre-treatment values of neutrophils and eosinophils were significantly higher in infected lambs which is generally observed in helminthiases (Jain, 1993). This could have also resulted in relative decrease in the values of lymphocytes and monocytes. Basophils did not differ between the infected and HC group. Treatment with niclosamide has favourably altered the DLC closer to the range of normal as in healthy animals. The differential behaviour of different components of DLC in infected lambs and treatment with the specific drug niclosamide against monieziasis has been documented by earlier workers (Pachlag, 1973 and Rahman and Collins, 1990).

The mean pre-treatment serum total protein and albumin values were significantly lower in infected lambs of this group when compared to HC group, while the values of globulin and A/G ratio did not differ significantly between the two groups. Treatment with niclosamide progressively increased serum total protein from 7th to 28th day after treatment. The albumin level found elevated with the treatment on 7th day beyond which it remained almost constant with a meagre decline upto 28th day. It is evident that niclosamide is therapeutically effective to alter the biochemical parameters favourably closer to the range of healthy animals. This finding is in concurrence with that of Kell *et al.* (1978) and Rao (1992).

The mean pre-treatment AST value in infected lambs was significantly higher than that of HC group which could be due to damage to liver or gastrointestinal tract (Kaneko, 1989). The ALT value did not differ significantly between these two groups. Treatment with niclosamide has markedly reduced the values of AST and ALT by 7th day after treatment which remained almost constant upto 28th day post-treatment. It is to be noted that the serum amino transferases dropped to normal range in infected lambs by 7th day after treatment undoubtedly indicating the therapeutic efficacy of niclosamide against monieziasis which was not only instant but also consistent. Out come of the present investigation is in agreement with the documentation of More and Sahni (1979) and Siddiqua *et al* (1989).

The clinical symptoms observed in the lambs infected with fascioliasis (group IV, FX) prior to the treatment were dullness, poor appetite, anaemia, diarrhoea with rough skin and coarse body coat. One of the six lambs exhibited oedema of both neck and intermandibular space and one lamb displayed only intermandibular oedema. Symptoms of fascioliasis in lambs have been reported earlier by Jenson (1974), Hawkins (1983) and Radostits *et al.* (1994) which are similar to those recorded in this study.

The body temperature, pulse and respiration rates of all the infected lambs were however almost within the normal range compared to those of HC group throughout the period of study. Remarkable recovery was observed in the clinical condition of the infected lambs immediately after the administration of triclabendazole as could be

seen from disappearance of all clinical symptoms noticed initially by 7th day post treatment.

In all the six lambs of this group, EPG count varied between 900 to 1100 with a mean of 1033.33 prior to the treatment. After the administration of triclabendazole, the EPG count has come down to zero level by 7th day post-treatment and the same status was maintained through out the period of study, indicating the efficacy (100%) of triclabendazole against fascioliasis. The efficacy of triclabendazole against fascioliasis has been amply established through earlier clinical research (Armour and Bogan 1982, Smeal and Hall 1983 and Misra 1987).

The pre-treatment mean value of haemoglobin in the infected lambs was substantially and significantly lower than the HC group. Similar reports have also been published by Levine (1968). After the treatment with triclabendazole, the haemoglobin content has progressively increased from 7th to 28th day reaching almost to similar range of the HC group, indicating the absolute efficacy of the drug against fascioliasis. This finding is in accordance with the reports of Smeal and Hall (1983) and Avasthi (1988).

The mean pre-treatment PCV value in the infected lambs of this group was significantly lesser than that of HC group. After the treatment the PCV value was

elevated by 21st day and continued to increase upto 28th day to reach the normal values of HC group indicating the flukicidal efficacy of the drug.

The difference in the TEC value was found to be significant between infected and healthy lambs, with lower values being associated with infected lambs. Such indications have already been documented by Sahai (1966) and Rao (1992). Treatment with triclabendazole by Sahai (1966) and Rao (1992). Treatment with triclabendazole has steadily and progressively enhanced the TEC values from 7th to 28th day which brought back the TEC values to normal range of healthy group.

The erythrocytic indices did not show any significant variation between the infected and HC group. However, the numerical values of MCH and MCHC were slightly on higher side, while the MCV value was on lower side in infected lambs when compared to HC group. The development of anaemia and associated significant changes in haemoglobin, PCV, TEC, MCH and MCHC could be due to the destruction of parenchyma by the adult as well as immature flukes leading to haemorrhage (Jain, 1993 and Radostits *et al.*, 1994) which gradually started improving and became almost normal by 28th day. Treatment with triclabendazole eliminated the fasciola worms and tended to enhance the MCV value consistently from 7th to 28th day. As regards to MCH and MCHC values, there was a progressive reduction from 7th to 28th day after treatment to bring back to the normal levels of the HC group. Similar observations have been reported by Morgan and Hawkins (1983) and Das *et al.* (1992).

The mean pre-treatment TLC value of infected lambs of this group was significantly lower than HC group. After the treatment the TLC values increased progressively from 7th to 28th day, reaching closer to the values of HC group.

The variations in the values of DLC between the infected and healthy lambs were significantly different in respect of some components of DLC and non-significant in others. The mean pre-treatment values of neutrophils and eosinophils were significantly higher, while lymphocytes and monocytes were significantly lower in infected lambs than HC group. Basophils did not differ significantly between the two groups Treatment with triclabendazole has favourably altered the values of DLC and brought them closer to the range of normal values of HC group. Differential behaviour of different components of DLC in infected lambs was recorded by Ross and Chick (1980). The successful usage of triclabendazole with high level of efficacy has been demonstrated by Smeal and Hall (1983), Misra *et al* (1987) and Avasthi (1988).

The mean pre-treatment serum total protein and A/G ratio differed significantly when compared to healthy control group while the values of serum albumin and globulin did not differ between the two groups. Treatment with triclabendazole has progressively made up the values of serum total protein and A/G ratio from 7th to 28th day after treatment. It is evident that in fascioliasis there is liver damage resulting in lowered albumin synthesis by liver thereby giving a significantly low A/G ratio (Kaneko,

1989). Effective treatment of fascioliasis by triclabendazole has resulted in significant increase in A/G ratio closer to the range of healthy lambs. This finding is in agreement with that of Misra *et al.* (1987) and Das *et al.* (1992).

The mean pre-treatment values of serum amino transferases (AST and ALT) in infected lambs were significantly higher than those of HC group probably because of the damage to liver and release of liver specific enzymes such as AST and to a lesser extent ALT. Treatment with triclabendazole has markedly reduced the values of AST and ALT by 7th day after treatment and further reduction was steady upto 28th day by which time the AST and ALT values reached the levels comparable to the normal range. Subsequently there was no further liver damage and the repair and regeneration process was completed Thus, the therapeutic efficacy of triclabendazole against fascioliasis has been established in this study. This finding is in accordance with the reports of Avasthi (1988) and Rao (1992).

All the lambs of group V (EX) which were having mixed infection of fasciola and haemonchus were dull in appearance with poor appetite and pale mucous membranes prior to the treatment. The consistency of faeces was diarrhoeic in three lambs and semisolid in the others. The skin was rough and the body coat was coarse in all the lambs. By 7th day after treatment with closantel, there was a spectacular improvement in the clinical condition of the lambs and by 14th day the clinical

symptoms noticed prior to the treatment did appear normal and comparable to that of HC group.

The body temperature, pulse and respiration rates of all the infected lambs were almost with in the normal range and comparable to that of HC group throughout the course of investigation.

In all the lambs of group V, EPG count varied from 1200 to 1400 with a mean of 1300 prior to the treatment. After the administration of closantel, the EPG count has come to zero level by 7th day and the same status contiued throughout the period of study indicating the absolute therapeutic efficacy (100%) against helminthiasis. Hall (1981), Kovalev (1984), Dash (1986) and Yadav *et al.* (1992) have unequivocally reported the therapeutic efficacy of closantel against helminthiasis.

The mean pre-treatment value of haemoglobin in the infected lambs was found to be significantly lower than the HC group. After the commencement of treatment with closantel, the haemoglobin content tended to increase progressively from 7th and thereby upto 28th day post-treatment. But the values of haemoglobin were not brought closer to that of HC group during any period of the course of investigation indicating that closantel could not improve the haemoglobin in the infected lambs closer to the normal range of HC group.

The PCV value of the infected lambs prior to the treatment was significantly ($P<0.01$) lower than that of the HC group. Treatment with closantel has steadily and progressively improved the PCV value from 7th to 28th day post-treatment, by which time the value of PCV returned to normal showing parity with that of HC group.

The mean TEC value in the infected lambs prior to the treatment was found significantly lower ($P<0.01$) than that of HC group and the treatment with closantel has progressively elevated the TEC values from 7th to 28th day post treatment. The therapeutic efficacy of closantel in altering the TEC values in the infected lambs was established favourably by 28th day after treatment, by which time the TEC values in the infected lambs returned to normal and was comparable to that of HC group.

The values of erythrocytic indices of this group prior to treatment did not show any appreciable and statistically detectable variation with those of HC group inspite of low haemoglobin indicating normochromic and normocytic anaemia (Jain, 1993). Treatment with closantel tended to alter the values of erythrocytic indices from 7th to 28th day, bringing them very close to normal values of HC group.

The mean TLC value in the infected lambs of this group prior to treatment was significantly lower than HC group probably due to lymphopenia and decreased leukocytosis (Jain, 1993) and the treatment with closantel was consistent and resulted

in progressive increase in the TLC values from 7th to 28th day after treatment, bringing the values in parity with those of HC group.

The values of DLC showed differential variation in different components between the infected lambs of group V and HC group. The mean pre-treatment values of neutrophils and eosinophils was significantly higher in infected lambs than the HC group the reasons for which have already mentioned (*Vide infra*). The variation in the basophils and monocytes was not statistically detectable between the infected and HC groups. Treatment with closantel has favourably altered the values of different components of DLC by bringing them closer to the range of normal values of healthy lambs by 28th day post-treatment.

The mean pre-treatment values of serum total protein, albumin and A/G ratio were significantly lower in the infected lambs of group V than HC group which was presumably due to blood loss resulting from haemonchosis and liver damage due to fascioliasis, while the values of serum globulin did not show any significant variation between the groups under comparison. Treatment with closantel has eliminated both haemonchus and fasciola which could have progressively decreased the protein loss thereby augumenting the A/G ratio from 7th to 28th day after treatment. However, the serum total protein was significantly higher than the HC group, while the serum albumin though improved but was significantly lower than the HC group. The serum globulin was significantly higher in this group even by 28th day as compared to HC

group. The A/G ratio was also significantly lower in this group. These findings could be attributed to the effect of mixed infection, and prolonged repair process though closantel eliminated both the parasites effectively.

The mean pre-treatment values of serum amino-trasferases differed significantly between the infected and healthy groups, with higher values of AST and ALT being associated with infected lambs which could be due to the hepatic damage by fasciola. Treatment with closantel has substantially brought down the values of serum aminotransferases by 7th day after treatment and the decrease was progressively meagre from 14th to 28th day post-treatment, by which time the values of AST and ALT returned to normal similar to those of HC group.

From the above it is evident that in all the four groups i.e., group II, III and IV treatment with specific anthelmintics and group V treated with broad spectrum anthelmintic there was improvement in the clinical symptoms from 7th day by which time the EPG also became nil. Only in group III there was a mean EPG of 50 ± 20.41 recorded again by 28th day which might be due to incomplete elimination of parasite or re-infection. There was marked improvement noticed by 7th day in various haematological parameters which consistently improved further upto 28th day post-treatment.

Comparison of serum biochemical parameters among the drug treated groups (Tables 18 and 19) indicated differential efficacy of different drugs in bringing the pre-treatment values closer to the range of normal and healthy animals. However, in the lambs of group V which were treated with closantel the clinical recovery and improvement in haematological parameters were similar to other groups and healthy control. The values of serum total protein and globulin were significantly higher, while the serum albumin and A/G ratio were lower than all other three groups i.e., group II, III and IV, but there was no statisticaly significant difference. Treatment with different drugs resulted in bringing down the elevated serum amino transferase values in the lambs of all the groups.

In the present study the therapeutic efficacy of each of the four drugs was assessed based on the recovery of the clinical symptoms, decrease in the egg count and improvement of haematological and biochemical alterations as compared to healthy control. However, the comparison of a broad spectrum anthelmintic with specific anthelmintics would be more meaningful particularly in mixed helminthic infections where a single treatment could be time and labour saving. Thus, the efficacy of closantel, a broad spectrum anthelmintic was assessed in mixed infection of hamonchosis and fascioliasis, while the efficacy of morantel cirtrate, niclosamide and triclabendazole was assessed for single infection with *haemonchus*, *moniezia* and *fasciola* respectively.

Summary

SUMMARY

An epidemiological survey was conducted in eleven organised sheep farms in Andhra Pradesh to assess the extent of lamb mortality during the period from 1985 to 1994. Out of 17157 lambs born 2266 lambs died accounting to an average mortality of 13.20 per cent. The maximum lamb mortality of 29.94 per cent at Live Stock Research Station, Garividi, while the minimum was 4.08 per cent mortality at composite Live Stock farm, Chintaladevi.

The average lamb mortality was found to be minimum when dam's body weight at lambing was between 36-40 kg, while it was maximum when dam's body weight at lambing was between 26-30 kg.

Largest number of lambs (2.44%) died within the second month, while the mortality was minimum (1.61%) during the fourth month after lambing. Similarly the mortality of lambs was higher (58.48%) in the post-weaning period than the pre-weaning period (41.52%).

With reference to sex the lamb mortality did not differ significantly (males 13.21% and females 13.20%). The lamb mortality was found to be very high (53.6%) in crossbreds (Dorset x Mandya) and it was very low (2.24%) in the local breed. The lamb mortality was maximum (48.68%) during summer season and minimum (21.84%) during monsoon season.

Analysis of various causes of death indicated infectious agents result in 77.63 per cent mortality, while the non-infectious caused 10.99 per cent and 11.38 per cent of mortality was due to miscellaneous causes. Among infectious causes pneumonia, parasitic enteritis, hepatitis, blue tongue and sheep pox resulted in 48.54%, 13.15%, 8.43%, 1.68% and 5.83% lamb deaths respectively. Starvation Mis-mothering Exposure (SME) complex (4.90%) was the prominent cause of death due to non-infectious causes, while heat stress (4.90%) was the major factor among reason due to miscellaneous causes.

Lambs of department of Animal Science, College of Veterinary Science, Tirupati and those belonging to Tondavada village have been screened for helminthic infectons. Six apparently healthy lambs free from helminthic infections were selected as healthy control (Group I). A batch of six lambs each of which were positive for haemonchosis, monieziasis, fascioliasis and mixed infection of haemonchosis and fascioliasis were named as group II, III, IV and V respectively. Lambs of group II, III and IV were dewormed with morantel citrate, niclosamide and triclabendazole respectively, while closantel, a broad spectrum anthelmintic was tried on the infected lambs of group V.

Clnical examination of the lambs, examination of faeces for EPG, haematological and biochemical investigations were carried out on 0th day (pre-treatment) and at weekly intervals thereafter upto 28th day after initiation of treatment.

In the lambs of healthy control group the temperature, pulse and respiration rates did not show any marked variation with those of normal range of values. The

lambs of this group (group I) were healthy with soft, pliable and smooth body coat with normal appetite. No helminthic ova could be traced in the faeces during the period of investigation.

The mean of the weekly observations of the haematological and biochemical parameters recorded in the lambs of healthy control group (Group I) did not vary to a notceable extent during the course of investigation. The weekly mean values of haemoglobin, PCV and TEC varied between 10.14g%, 34.17% and 10.57 millions/cmm respectively, the weekly mean values of MCV, MCH and MCHC ranged from 32.11 to 33.13 fl, 9.58 to 10.02 pg and 29.85 to 30.88% respectively. The weekly mean values of TLC, neutrophils, lymphocytes, eosinophils, basophils and monocytes per cent ranged from 9.96 to 10.28 thousands/cmm, 35.00 to 36.83, 55.17 to 57.50, 4.17 to 5.17, 0.50 to 1.00 and 1.83 to 2.25 respectively. The weekly mean value of serum total protein, albumin, globulin, A/G ratio, AST and ALT ranged from 5.82 to 6.42 g/dl, 2.58 to 3.13 g/dl 2.68 to 2.84 g/dl, 0.72 to 1.17, 76.11 to 78.19 units/ml and 17.49 to 17.93 units/ml respectively.

The lambs infected with haemonchosis (group II) were dull, anaemic, diarrhoeic with poor appetite and with rough skin and coarse body coat with slightly higher pulse rate. The clinical condition of the haemonchosis infected lambs (group II) improved spectacularly by 7th day post treatment of oral administration of morantel citrate at the rate of 5.94 mg/kg. All the clinical symptoms observed initially prior to the treatment disappeared. The mean EPG count which was 1116.67 ± 64.18 in the pre-treated

lambs has steeply came down to zero level by 7th day post-treatment and continued to be so upto 28th day.

In the haemonchosis infected lambs of group II the haemoglobin, PCV and TEC were significantly lower while the MCV, MCH and MCHC did not differ significantly as compared to the HC group. The TLC and lymphocyte per cent were significantly lower whereas the neutrophil and eosinophil per cent were significantly higher than the HC group. All the haematological parameters returned to normal by 28th day post-treatment. The values of serum total protein and albumin were significantly lesser and the serum amino aspertate and alanine transferases were significantly higher in the infected lambs which came nearer to normal by 7th day post-treatment. Serum globulin and A/G ratio of this group did not show any marked deviation from those of healthy lambs.

The lambs infected with monieziasis (group III) were dull, anaemic, occasionally diarrhoeic with poor appetite, rough skin and coarse body coat. The temperature, pulse and respiration rates were almost within the normal range. After oral administration of niclosamide at the rate of 100 mg/kg the clinical condition of the lambs improved remarkably by 7th day and by 14th day all the clinical symptoms disappeared. The EPG which was initially 950 ± 31.17 became zero by 7th day post-treatment and the same status was maintained upto 21st day post-treatment.

In the lambs of group III, the pre-treatment values of haemoglobin, PCV, TEC, TLC were significantly lower, while MCH, MCHC, eosinophils and neutrophils values

were significantly higher than the healthy control group. Following treatment with niclosamide the above parameters became almost normal by 7th day and remained so upto 28th day post treatment. The values of serum total protein and albumin were significantly lower in infected lambs which came very close to the normal range after the treatment. The values of serum globulin and A/G ratio did not differ significantly between the two groups. The AST value in the infected lambs was significantly higher, whereas ALT value was comparable with HC group. Treatment with niclosamide has markedly reduced the value of AST closer to normal by 7th day which maintained the same level upto 28th day.

The lambs infected with fascioliasis (group IV) were dull, anaemic, diarrhoeic with poor appetite, rough skin and coarse body coat. One of the lambs displayed oedema of both neck and intermandibular space and another lamb displayed intermandibular oedema. All the lambs of the group IV improved substantially with the oral administration of triclabendazole at the rate of 10 mg/kg and by 7th day post-treatment the clinical symptoms totally disappeared. Before starting of treatment the mean EPG count recorded in the lambs of this group was 1033.33 ± 30.42 which came down to zero on the 7th day of treatment with triclabendazole by 7th day and the same status continued throughout the course of this investigation.

In the lambs of group IV, haemoglobin, PCV and TEC were significantly lower than that the healthy control group. There was leucopenia and lymphopenia with eosinophilia and neutrophilia in the lambs of this group. Treatment with triclabendazole

has progressively immproved above parameters from 7th day onwards and returned to normal by 28th day post-treatment.

The values of serum total protein and A/G ratio were significantly lower in infected lambs of this group than the healthy control group, while serum albumin and globulin did not differ significantly between the two groups. The AST and ALT values in infected lambs were significantly higher than the HC group. Treatment with triclabendazole has markedly reduced the values of AST and ALT closer to normal values by 28th day after treatment.

The lambs infected with mixed infection of haemonchosis and fascioliasis (group V) were dull, anaemic, occasionally diarrhoeic with poor appetite and with rough skin and coarse hair coat. Oral administration of closantel at the rate of 0.1 ml/kg has brought back the clinical condition of the lambs to normal and comparable to that of healthy group by 14th day post-treatment. The mean EPG count of the lambs of group V was 1300 ± 30.42 (haemonchus 783.33 ± 33.40 and fasciola 516.67 ± 19.38) and it has reached to zero level by 7th day after treatment with closantel and the same status continued throughout the course of study.

The mean pre-treatment values of haemoglobin, PCV, TEC and TLC (7.22 ± 0.19, 23.67 ± 1.17, 7.47 ± 0.23 and 7.07 ± 0.30) in the lambs of group V were significnatly lower than the corresponding values of healthy control group. Treatment with closantel has resulted in progressive increase of the above parameters bringing them closer to that HC group from 7th to 28th day post treatment. The values of

erythrocytic indices (MCV, MCH and MCHC) of this group were 31.63 ± 0.86 fl, 9.72 ± 0.37 pg and 31.01 ± 1.91 % before treatment, which did not show any statistically detectable variation with those of healthy control group. There was increase in the percentage of neutrophils and eosinophils which came closer to the normal values by 28th day. The values of serum total protein, albumin and A/G ratio (5.12 ± 0.34 g/dl, 1.63 ± 0.16 g/dl and 0.47 ± 0.04) were significantly lower, but the serum globulin did not show any significant variation. Similarly the values of serum amino transferases (AST and ALT) weres significantly higher (118.80 ± 6.19 and 23.39 ± 1.63 units/ml) in the infected lambs before treatment. The serum transferases values became normal by 7th day after treatment, while the serum total protein and globulins were remained significantly higher and albumin and A/G ratio continued to be significantly lower upto 28th day post-treatment

From the above findings it can be concluded that all the three specific anthelmintics viz., morantel citrate, niclosamide and triclabendazole were cent per cent effective against specific infections viz., haemonchosis, monieziasis and fascioliasis respectively and closantel, the broad spectrum anthelmintic was equally efficacious against mixed infection of haemonchosis and fascioliasis in lambs as evident from negative faecal count, improvement in clinical symptoms associated with restoration of the haematological and biochemical parameters to normal by about 7th day continued through out the course of investigation. Closantel was also found cent per cent effective against mixed infection with haemonchosis and fascioliasis. In such flocks where mixed infection is prevalent treatment with broad spectrum antihelmintic like closantel is recommended.

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Appendices

Appendix-I: Variation (from HC group means) in pre and post-treatment haematological and biochemical means of BM group

S.No.	Parameter	Pre-treatment				Post-treatment			
		BM group mean	HC group mean	Variation from HC group	%	BM group mean	HC group mean	Variation from HC group	%
A.	**Haematological**								
1.	Haemoglobin (g%)	7.67	9.98	-2.31	-23.15	9.61	10.14	-0.53	-5.23
2.	PCV (%)	24.33	33.17	-8.84	-26.65	31.17	34.17	-3.00	-8.78
3.	TEC (millions/cmm)	7.83	10.16	-2.33	22.93	9.75	10.57	-0.82	-7.76
4.	MCV (fl)	31.32	32.56	-66.58	-204.48	32.11	32.23	-0.12	-0.37
5.	MCH (pg)	9.90	9.85	0.05	0.51	9.88	9.58	0.30	3.13
6.	MCHC (%)	31.68	30.20	1.48	4.67	31.07	29.85	1.22	3.93
7.	TLC (thousands/cmm)	7.33	10.03	-2.70	26.92	9.23	9.96	-0.73	-7.33
8.	DLC								
	a) Neutrophils (%)	55.33	36.67	18.66	50.89	33.50	36.50	-3.00	-8.22
	b) Lymphocytes (%)	35.83	55.67	-19.84	35.64	58.50	57.00	1.50	2.63
	c) Eosinophils (%)	6.33	4.33	2.00	46.19	5.83	4.17	1.66	39.81
	d) Basophils (%)	0.67	0.50	0.17	34.00	0.50	0.50	0.00	0.00
	e) Monocytes (%)	1.83	2.00	-0.17	-8.50	1.67	1.83	-0.16	-8.74
B.	**Biochemical**								
1.	Serum total protein (g/dl)	5.76	6.42	-0.66	10.28	5.78	5.86	-0.08	-1.36
2.	Serum albumin (g/dl)	2.20	2.58	-0.38	14.73	2.92	3.10	-0.18	-5.81
3.	Globulin (g/dl)	3.83	3.84	-0.01	0.26	2.86	2.76	0.10	3.62
4.	Serum albumin and globulin ratio	0.62	0.73	-0.11	15.07	1.02	1.12	-0.10	-8.93
5.	AST (units/ml)	132.08	78.19	53.89	68.92	79.30	77.22	2.08	2.69
6.	ALT (units/ml)	24.78	17.93	6.85	38.20	18.02	17.65	0.37	2.10

Appendix-II: Variation (from HC group means) in pre and post-treatment haematological and biochemical means of NX group

S.No.	Parameter	Pre-treatment				Post-treatment			
		NX group mean	HC group mean	Variation from HC group	%	NX group mean	HC group mean	Variation from HC group	%
A.	**Haematological**								
1.	Haemoglobin (g%)	8.43	9.98	-1.55	-15.53	10.55	10.14	0.41	4.04
2.	PCV (%)	25.33	33.17	-7.84	-23.64	32.17	34.17	-2.0	-5.85
3.	TEC (millions/cmm)	8.20	10.16	-1.96	-19.29	9.96	10.57	-0.61	-5.77
4.	MCV (fl)	31.14	32.56	-1.42	-4.36	32.42	32.23	0.19	0.59
5.	MCH (pg)	10.35	9.85	0.50	5.08	10.61	9.58	1.03	10.75
6.	MCHC (%)	33.48	30.20	3.28	9.79	33.08	29.85	3.23	9.76
7.	TLC (thousands/cmm)	7.50	10.03	-2.53	-25.22	9.32	9.96	-0.64	-6.42
8.	DLC								
	a) Neutrophils (%)	52.50	36.67	15.83	43.17	36.75	36.50	0.25	0.68
	b) Lymphocytes (%)	39.33	55.67	-16.34	-29.35	58.17	57.00	1.17	2.05
	c) Eosinophils (%)	5.83	4.33	1.50	34.64	3.67	4.17	-0.50	11.99
	d) Basophils (%)	0.50	0.50	0.00	0.00	0.67	0.50	0.17	34.00
	e) Monocytes (%)	1.83	2.00	-0.17	-8.50	1.67	1.83	-0.16	8.74
B.	**Biochemical**								
1.	Serum total protein (g/dl)	5.72	6.42	-0.7	-10.90	5.79	5.86	-0.07	1.19
2.	Serum albumin (g/dl)	2.07	2.58	-0.51	-19.77	2.92	3.10	-0.18	5.81
3.	Globulin (g/dl)	3.73	3.84	-0.16	4.17	2.85	2.76	0.09	3.26
4.	Serum albumin and globulin ratio	0.57	0.73	-0.16	21.92	1.03	1.12	-0.09	8.04
5.	AST (units/ml)	112.77	78.19	34.58	44.22	77.50	77.22	0.28	0.36
6.	ALT (units/ml)	21.04	17.93	3.11	17.34	17.85	17.65	0.20	1.13

Appendix-III: Variation (from HC group means) in pre and post-treatment haematological and biochemical means of FX group

S.No.	Parameter	Pre-treatment				Post-treatment			
		FX group mean	HC group mean	Variation from HC group	%	FX group mean	HC group mean	Variation from HC group	%
A.	**Haematological**								
1.	Haemoglobin (g%)	8.22	9.98	-1.76	-17.64	9.98	10.14	-0.16	-1.58
2.	PCV (%)	24.33	33.17	-8.84	-26.65	34.83	34.17	0.66	1.93
3.	TEC (millions/cmm)	8.13	10.16	-2.03	-19.98	10.31	10.57	-0.26	-2.46
4.	MCV (fl)	29.74	32.56	-2.82	-8.66	34.94	32.23	2.71	8.41
5.	MCH (pg)	10.23	9.85	0.38	3.86	9.68	9.58	0.10	1.04
6.	MCHC (%)	34.20	30.20	4.00	11.69	28.83	29.85	-1.02	-3.54
7.	TLC (thousands/cmm)	7.58	10.03	-2.45	-24.43	9.42	9.96	-0.54	-5.42
8.	DLC								
	a) Neutrophils (%)	55.50	36.67	18.83	51.35	33.83	36.50	-3.83	-10.49
	b) Lymphocytes (%)	38.33	55.67	-17.34	31.15	61.50	57.00	4.50	7.89
	c) Eosinophils (%)	5.17	4.33	-0.84	-19.40	3.00	4.17	-1.17	-28.06
	d) Basophils (%)	0.17	0.50	-0.33	-66.00	0.17	0.50	-0.33	-66.00
	e) Monocytes (%)	0.17	2.00	-1.83	-91.50	0.17	1.83	-	-
B.	**Biochemical**								
1.	Serum total protein (g/dl)	5.98	6.42	-0.44	-6.85	5.82	5.86	-0.04	-0.68
2.	Serum albumin (g/dl)	2.75	2.58	0.17	6.59	2.95	3.10	-0.15	-4.84
3.	Globulin (g/dl)	3.08	3.84	-0.76	-19.79	2.88	2.76	0.12	4.35
4.	Serum albumin and globulin ratio	0.94	0.73	0.21	28.77	1.02	1.12	-0.10	-8.93
5.	AST (units/ml)	128.61	78.19	50.42	64.48	76.24	77.22	-0.98	-1.27
6.	ALT (units/ml)	21.81	17.93	3.88	21.64	17.69	17.65	0.04	0.23

Appendix-IV: Variation (from HC group means) in pre and post-treatment haematological and biochemical means of EX group

S.No.	Parameter	Pre-treatment				Post-treatment			
		EX group mean	HC group mean	Variation from HC group	%	EX group mean	HC group mean	Variation from HC group	%
A.	**Haematological**								
1.	Haemoglobin (g%)	7.22	9.98	-2.76	-27.66	9.54	10.14	-0.60	-5.92
2.	PCV (%)	23.67	33.17	-9.50	-28.64	32.50	34.17	-1.67	-4.89
3.	TEC (millions/cmm)	7.47	10.16	-2.69	-26.48	10.25	10.57	-0.32	-3.03
4.	MCV (fl)	31.63	32.56	-0.93	-2.86	31.64	32.23	-0.59	-1.83
5.	MCH (pg)	9.72	9.85	-0.13	-1.32	9.30	9.58	-0.28	-2.92
6.	MCHC (%)	31.01	30.20	0.81	2.61	29.52	29.85	-0.33	-1.11
7.	TLC (thousands/cmm)	7.07	10.03	-2.96	-29.51	9.73	9.96	-0.23	-2.31
8.	DLC								
	a) Neutrophils (%)	51.50	36.67	14.83	40.44	32.00	36.50	-4.50	-12.33
	b) Lymphocytes (%)	40.50	55.67	-15.17	-27.25	62.00	57.00	5.00	8.77
	c) Eosinophils (%)	5.83	4.33	1.50	34.64	3.00	4.17	-1.17	-28.06
	d) Basophils (%)	0.33	0.50	-0.17	-34.00	0.67	0.50	0.17	4.08
	e) Monocytes (%)	1.83	2.00	-0.17	-8.50	2.33	1.83	0.50	27.32
B.	**Biochemical**								
1.	Serum total protein (g/dl)	5.12	6.42	-1.30	-20.25	6.74	5.86	0.88	15.02
2.	Serum albumin (g/dl)	1.63	2.58	-0.95	-36.82	2.56	3.10	-0.54	-17.42
3.	Globulin (g/dl)	3.48	3.84	-0.36	-9.38	4.17	2.76	1.41	51.09
4.	Serum albumin and globulin ratio	0.47	0.73	-0.26	-35.62	0.61	1.12	-0.51	-45.54
5.	AST (units/ml)	118.80	78.19	40.61	51.94	74.72	77.22	-2.5	-3.24
6.	ALT (units/ml)	23.39	17.93	5.43	30.28	17.17	17.65	-0.48	-2.72

Appendix-V: Variation from EX group means in pre and post-treatment haematological and biochemical means of BM group

S.No.	Parameter	Pre-treatment				Post-treatment			
		BM group mean	EX group mean	Variation from EX group	%	BM group mean	EX group mean	Variation from EX group	%
A.	**Haematological**								
1.	Haemoglobin (g%)	7.67	7.22	0.45	6.23	9.61	9.54	0.07	0.73
2.	PCV (%)	24.33	23.67	0.66	2.79	31.17	32.50	-1.33	-4.09
3.	TEC (millions/cmm)	7.83	7.47	0.36	4.82	9.75	10.25	-0.50	-4.88
4.	MCV (fl)	31.32	31.63	-0.31	0.98	32.11	31.64	0.47	1.48
5.	MCH (pg)	9.90	9.72	0.18	1.85	9.88	9.30	0.58	6.24
6.	MCHC (%)	31.68	31.01	0.67	2.11	31.07	29.52	1.55	4.98
7.	TLC (thousands/cmm)	7.33	7.07	0.26	3.68	9.23	9.73	-0.50	-5.14
8.	DLC								
	a) Neutrophils (%)	55.33	51.50	3.83	7.44	33.50	32.00	1.50	4.69
	b) Lymphocytes (%)	35.83	40.50	-4.67	-11.53	58.50	62.00	-3.50	5.64
	c) Eosinophils (%)	6.33	5.83	0.50	8.58	5.83	3.00	2.83	94.33
	d) Basophils (%)	0.67	0.33	0.34	103.03	0.50	0.67	-0.17	-25.37
	e) Monocytes (%)	1.83	1.83	0.00	0.00	1.67	2.33	-0.66	28.33
B.	**Biochemical**								
1.	Serum total protein (g/dl)	5.76	5.12	0.64	12.50	5.78	6.74	-0.96	-14.24
2.	Serum albumin (g/dl)	2.20	1.63	0.57	34.97	2.92	2.56	0.36	14.06
3.	Globulin (g/dl)	3.83	3.48	0.35	10.06	2.86	4.17	-1.31	31.41
4.	Serum albumin and globulin ratio	0.62	0.47	0.15	31.91	1.02	0.61	0.41	67.21
5.	AST (units/ml)	132.08	118.80	13.28	11.18	79.30	74.72	4.58	6.13
6.	ALT (units/ml)	24.78	23.39	1.39	5.94	18.02	17.17	0.85	4.95

Appendix-VI: Variation from EX group means in pre and post-treatment haematological and biochemical means of NX group

S.No.	Parameter	Pre-treatment				Post-treatment			
		NX group mean	EX group mean	Variation from EX group	%	NX group mean	EX group mean	Variation from EX group	%
A. Haematological									
1.	Haemoglobin (g%)	8.43	7.22	1.21	16.76	10.55	9.54	1.01	10.59
2.	PCV (%)	25.33	23.67	1.66	7.01	32.17	32.50	-0.33	1.02
3.	TEC (million./cmm)	8.20	7.47	0.73	9.77	9.96	10.25	-0.29	-2.83
4.	MCV (fl)	31.14	31.63	-0.49	-1.55	32.42	31.64	0.78	2.46
5.	MCH (pg)	10.35	9.72	0.63	6.48	10.61	9.30	1.31	14.09
6.	MCHC (%)	33.48	31.01	2.47	7.37	33.08	29.52	3.56	10.76
7.	TLC (thousands /cmm)	7.5	7.07	0.43	6.08	9.32	9.73	-0.41	-4.21
8.	DLC								
	a) Neutrophils (%)	52.50	51.50	1.00	1.94	36.75	32.00	4.75	14.84
	b) Lymphocytes (%)	39.33	40.50	-1.17	-0.28	58.17	62.00	-3.89	-6.18
	c) Eisonophils (%)	5.83	5.83	0.00	0.00	3.67	3.00	0.67	22.33
	d) Basophils (%)	0.50	0.33	0.17	51.52	0.67	0.67	0.00	0.00
	e) Monocytes (%)	1.83	1.83	0.00	0.00	1.67	2.33	-0.66	28.33
B. Biochemical									
1.	Serum Total Protein (g/dl)	5.72	5.12	0.60	11.72	5.79	6.74	-0.95	-14.09
2.	Serum albumin (g/ld)	2.07	1.63	0.44	26.99	2.92	2.56	0.36	14.06
3.	Globulin (g/dl)	3.73	3.48	0.25	7.18	2.85	4.17	-1.32	31.65
4.	Serum albumin and globulin ratio	0.57	0.47	0.10	21.28	1.03	0.61	0.42	68.85
5.	AST (units/ml)	112.77	118.80	-6.03	-5.08	77.50	74.72	2.78	3.72
6.	ALT (units/ml)	21.04	23.39	-2.35	-10.05	17.85	17.17	0.68	3.96

Appendix VII: Variation from EX group means in pre and post treatment haematological and biochemical levels of FX group

S.No.	Parameter	Pre-treatment				Post-treatment			
		FX group mean	EX group mean	Variation from EX group	%	FX group mean	EX group mean	Variation from EX group	%
A. Haematological									
1.	Haemoglobin (g%)	8.22	7.22	1.00	13.85	9.98	9.54	0.44	4.61
2.	PCV (%)	24.33	23.67	0.67	2.79	34.83	32.50	2.33	7.17
3.	TEC (million./cmm)	8.13	7.47	0.66	8.83	10.31	10.25	0.06	0.58
4.	MCV (fl)	29.74	31.63	-1.89	-5.98	34.94	31.64	3.30	10.43
5.	MCH (pg)	10.23	9.72	0.51	5.25	9.68	9.30	0.38	4.09
6.	MCHC (%)	34.20	31.01	3.19	9.32	28.83	29.52	-0.69	-2.39
7.	TLC (thousands /cmm)	7.58	7.07	0.51	7.21	9.42	9.73	-0.31	-3.19
8.	DLC								
	a) Neutrophils (%)	55.50	51.50	4.00	7.77	33.83	32.00	1.83	5.72
	b) Lymphocytes (%)	38.33	40.50	-2.17	-5.36	61.50	62.00	-0.50	-0.81
	c) Eisonophils (%)	5.17	5.83	-0.66	-11.32	3.00	3.00	0.00	0.00
	d) Basophils (%)	0.17	0.33	-0.16	-48.48	0.17	0.67	-0.50	-74.63
	e) Monocytes (%)	0.17	1.83	-1.66	-90.71	0.17	2.33	-2.16	-92.70
B. Biochemical									
1.	Serum Total Protein (g/dl)	5.98	5.12	0.86	16.80	5.82	6.74	-0.92	-13.65
2.	Serum albumin (g/ld)	2.75	1.63	1.12	68.71	2.95	2.56	0.39	15.23
3.	Globulin (g/dl)	3.08	3.48	-0.40	-11.49	2.88	4.17	-1.29	-30.94
4.	Serum albumin and globulin ratio	0.94	0.47	0.47	100.00	1.02	0.61	0.41	67.21
5.	AST (units/ml)	128.61	118.80	9.81	8.26	76.24	74.72	1.52	2.03
6.	ALT (units/ml)	21.81	23.39	-1.58	-6.76	17.69	17.17	0.52	3.03